



Manufacturer's Record Book

XXXXXXXXXXXXXXXXXXXXXXXXXX

**Natural Gas Pressure Reduction
Skid Package**

PO:

Natpro SO: 338716

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SECTION 1.0

PURCHASE ORDERS & SUB-ORDERS SCHEDULE

SECTION 2.0
INSTALLATION, OPERATING AND MAINTENANCE

Erection and Installation Procedures

Shell Canada Carmon Creek Project
Field Facilities and Infrastructure Phase 1&2
PO Number: 4512109130

1 Scope

- 1.1 This Construction Specification covers the general requirements for erection of field erected permanent and temporary steel structures, bolting and anchor materials if applicable.
- 1.2 This Specification does not cover grouting, coating or painting of steel structures.

2 References

- 2.1 See Package General Arrangement, Structural Skid, Lifting Plan, Building Drawings etc as required....

3 General Erection

- 3.1 Provisions shall be made for all erection loads and sufficient temporary bracing to maintain the structure in a safe, stable, and plumb manner and in true alignment until erection is complete.
- 3.2 Each part of a structure shall be properly aligned before completing field connections. All members in completed frames shall be true to line and free from bends, twists, or open joints.
- 3.3 Generally, all field connections shall be bolted. Field welded connections shall be made only where specified on the design drawings.
- 3.4 Fitting-up bolts and drift pins shall not be used to bring improperly fabricated or aligned members or parts into place that cause strain on bolts in finished work. Drift pins shall not be driven with such force as to damage adjacent metal. No packing, shimming or wedging shall be permitted to correct faulty work.
- 3.5 No one shall cut, drill or otherwise alter the steel structures or the work of others to accommodate other trades or the Contractor's own work, unless such cutting, drilling or alteration is specified clearly in the contract documents.
- 3.6 Holes not furnished by the structural steel fabricator but required for erection shall be field drilled. A torch may not be used to make or enlarge holes.
- 3.7 Minor misfitting, which can be remedied by a moderate amount of reaming and slight cutting and/or grinding, shall only be permitted when approved in writing by Site Engineer.
- 3.8 Erection bolts used in welded constructions shall be tightened securely and left in place, or removed with the holes plug welded, ground smooth and coated with the same system as the adjacent steeland openings covered immediately after "dry-out".
- 3.9 The Contractor shall ensure the structure is in a "safe condition" prior to allowing general loading of the structure.
- 3.10 All ragged or sharp edges, as well as protruding bolts or other fasteners that might cause injury to personnel shall be ground smooth.
- 3.11 edge of canopy/hood.

Erection and Installation Procedures

- 4 Platforms(stairs, railings and landings)**

Attach the ship loose Platforms as per reference drawings (338715-100, 200).

 - 4.1 Sit the platform onto site concrete pad and bolt it down.
 - 4.2 Attach platforms to the package skid base.
- 5 HVAC Building Heater**

Attached the shiploose Heaters as per reference drawings (214067-7400).

 - 5.1 Reinstall the heater back to the structural bracket by bolting which has been preinstalled.
 - 5.2 Reconnect the electrical power to the heater.
- 6 Interior Lighting**
 - 6.1 Interior and exterior ballast bodies are to be reinstalled
 - 6.2 Fluorescent tubes are to be removed from the lighting fixtures and stored in a separate box protected from excessive vibrations are to be inserted and all lights tested. Put the cover back.
- 7 Building Completion**

Assemble the shiploose building parts as per reference drawings (15-5055).

 - 7.1 Centre canopy or storm hood over target objects (i.e. door or HVAC component)
 - 7.2 Fasten canopy or hood to wall via mounting flange using #10 screws@ 6" (150mm), O.C. the mounting flange will be the part of the canopy/hood that is in direct contact with the wall.
 - 7.3 Apply continuous bead of caulking along top
- 8 Odorizer Assembly**

Attach the ship loose Odorizer Assembly as per reference drawings (338715-100, 200)

 - 8.1 Support the assembly and position so it is level and in the correct position to bolt down.
 - 8.2 Attach the assembly to the package skid base
 - 8.3 Reinstall the piping
- 9 Envirobox (valve) Assembly**

Attach the ship loose Enviro box (valve) Assembly as per reference drawings (338715-100, 200).

 - 9.1 Support the assembly and position so it is level and in the correct position to bolt down.
 - 9.2 Attach the assembly to the package skid base
 - 9.3 Reinstall the piping

Preservation, Shipment and Storage Procedures

Shell Canada Carmon Creek Project
Field Facilities and Infrastructure Phase 1&2
PO Number: 4512109130

1 Purpose

- 1.1 Outline the process used to prepare packages for shipment and the steps required to prepare and maintain Unpacking and Preservation Procedure equipment when storage up to 6 month and more is anticipated.

2 Scope

- 2.1 This procedure applies to all packages with CS/SS piping and tubing c/w instrumentation, HVAC, and other installed equipment.
- 2.2 For electrical equipment preservation, shipment and storage procedures see Sections 6, 7, 8 of this document and manufacturer IOM Manuals.

3 Equipment, piping and fittings, HVAC, Building accessories.....

- 3.1 The equipment and piping system shall be cleaned of foreign objects and free of water and oil prior to shipment. All liquids used for cleaning or hydrostatic testing shall be completely drained from all units before shipment. All moisture to be "air-dried" and openings covered immediately after "dry-out".
- 3.2 Main Gas piping lines are to have a Nitrogen purge to 5 psi. A blind flange is to be installed on the discharge line and a blind flange with a threaded port (for Nitrogen installation) to be on the suction flange.
- 3.3 Machined surfaces or openings (Flanges) which will be exposed to the atmosphere in transit and subsequent storage shall be properly protected with plastic plugs or wooden blind (1/4" minimum thickness) with 4 full size studs.
- 3.4 Once blinds are removed for makeup flanges, dust covers shall be installed by personnel conducting this job.
- 3.5 Threaded openings shall be closed by threaded steel plugs.
- 3.6 Plastic plugs are acceptable for closing electrical and instrument connections.
- 3.7 Equipment containing insulating oils, anti-freeze solutions or other fluids/desiccants shall be tagged at openings to indicate the nature of the contents, and shipping and storage precautions.
- 3.8 MSDS for rust preventive, anti-freeze, desiccant if used, to be shipped along with equipment.
- 3.9 Packages with formed steel bases shall be mounted on pieces of lumber and bolted to the skid. All lumber is to be designed to give maximum protection and are to be longer and wider than the base plate. If applicable.
- 3.10 All packages which don't consist of a building shall be plastic wrapped and taped closed leaving no exposed surfaces to the environment.
- 3.11 All packages which consist of a building shall be secured closed for shipping.
- 3.12 Any opening to the building shall be temporarily sealed shut with either tin flashing or wood for transportation.
- 3.13 Secure any small unsupported piping to prevent damage during shipment.
- 3.14 Secure any loose items to base to prevent accidental loss or misplacement

Preservation, Shipment and Storage Procedures

during storage. All loose items to be specified in the Packing Slip and submitted to customer as well with the shipment.

- 3.15 Any ship loose items shall be properly tagged and marked. Each tag shall contain Customer PO#, NPE SLS #, Item name and tag # as per P&ID and BOM.
- 3.16 All items shipped separately shall be tagged and or clearly marked in a weather resistant manner. Tags shall indicate Customer PO#, NPE SLS #, Item name and tag # as per P&ID and BOM.
- 3.17 Set of shipping documentation shall be packed into moisture resistant plastic bag and secured to package.
- 3.18 Building door keys shall be inserted into plastic bag along with shipping documentation.
- 3.19 Vent caps are to be bolted onto the 2 vent lines.

4 Instrumentation

- 4.1 All instrumentation shall be shipped pre-mounted, wrapped in plastic coverings and taped closed. No instrument is to be left exposed to the environment during transit.
- 4.2 All instrument panels, cabinets or boxes containing electronic components shall be plastic wrapped after the installation of silica gel bags.

5 Valves

- 5.1 Ball and plug valves shall be shipped in the fully open position.
- 5.2 Gate, globe, butterfly valves shall be shipped in the closed position.
- 5.3 Actuated valves shall be shipped in the de-energized position.
- 5.4 Valve stems and threads shall be coated with rust inhibitor spray.

6 Electrical Equipment

- 6.1 Exterior Mounted Electrical Equipment (general)
 - 6.1.1 The procedures outlined below are necessary to prevent deterioration and/or damage to electrical equipment during shipment to the storage site.
 - 6.1.2 All exterior mounted electrical equipment has been selected for use in harsh environments (NEMA 4X). This would typically provide adequate protection against weather during shipment and long term storage. However, additional protection measures are recommended in order to minimize risks of damage due to unforeseen hazards related to shipment and storage.
 - 6.1.3 Equipment protruding beyond the building envelope should be protected against mechanical damage and any ingress of dust or moisture as defined below.
- 6.2 Transformers if applicable.
 - 6.2.1 Transformers in the building should be protected as follows:
 - 6.2.2 All ventilation openings and cable glands to be sealed.
 - 6.2.3 Transformers and cables are to be enclosed in a heavy shrink wrapping polyurethane sheet completely shrouding the units with silica gel desiccant bags inserted inside the wrapping (2 unit bag per transformer).
- 6.3 Junction Boxes

Preservation, Shipment and Storage Procedures

- 6.3.1 All external junction boxes are to be protected as follows:
- 6.3.2 All cable glands and drains to be sealed using watertight plugs.
- 6.3.3 Silica gel desiccant bags shall be inserted inside the junction boxes (2 Unit bag per junction box).
- 6.3.4 Junction boxes covers to be tightened and boxes enclosed in a heavy shrink wrapping polyurethane sheet completely shrouding the units.
- 6.3.5 Cable/Conduit Penetrations
- 6.3.6 All cable and conduit penetrations are to be completely sealed.
- 6.4 Interior Mounted Electrical Equipment (general)
 - 6.4.1 All interior mounted electrical equipment, including instrumentation, will be protected from the environment by the building enclosure that will be completely sealed thus preventing any ingress of dust or moisture. However, basic steps preventing condensation from occurring inside the electrical equipment are recommended.
- 6.5 Power Distribution Panels
 - 6.5.1 Panels should have cable glands sealed and should be closed with silica gel desiccant bags inserted inside the enclosures.
- 6.6 Emergency Light and Exit Sign
 - 6.6.1 The emergency battery pack is to be protected as follows:
 - 6.6.2 Battery pack must be disconnected, tagged and store inside the building separately.
 - 6.6.3 The light box should be closed with silica gel desiccant bag inserted inside the enclosure.
- 6.7 Lighting Fixtures
 - 6.7.1 Fluorescent tubes are to be removed from the lighting fixtures and stored in a separate box protected from excessive vibrations.

7 Electrical Equipment Long Term Storage

The procedures outlined below are necessary to maintain all electrical equipment described in this document in a “ready for operation” condition.

- 7.1 Exterior Mounted Electrical Equipment
 - 7.1.1 Upon arriving at the storage site, a receiving inspection should be performed to verify the status of the equipment protection and the integrity of the shrink wrapping material
 - 7.1.2 If water or dust/dirt has entered the equipment through damaged or improperly secured wrapping material, seals or plugs, the equipment must be cleaned and plugs/seals/wrapping restored.
 - 7.1.3 Where possible, status of the silica gel desiccant bags is to be verified by testing hardness of the bags. This should be done without affecting the integrity of the heat shrink wrapping material.
 - 7.1.4 Bi-weekly inspections should be performed over the entire duration of the storage.
- 7.2 Interior Mounted Electrical Equipment
 - 7.2.1 Upon arriving at the storage site a receiving inspection should be performed to verify the status of the equipment and the silica gel desiccant

Preservation, Shipment and Storage Procedures

bags. Any bags found to have hardened material must be replaced.

7.2.2 Bi-weekly inspections should be performed over the entire duration of the storage.

7.2.3 VFDs must be stored in dry places, free of dust, vibrations, and gases, corrosive smokes, under constant temperature (5 ° C and 40 ° C) and in normal position free from other objects.

8 Electrical Equipment Start-up Preparation

The following procedures will be required to prepare the electrical equipment for operation:

8.1 All shrink wrapping material and desiccant bags are to be removed.

8.2 Any dirty or damaged surfaces are to be restored.

8.3 Battery pack inside the Emergency Light and Exit Sign is to be connected and tested as per manufacturer's instruction

8.4 Fluorescent tubes are to be inserted and all lights tested

8.5 The grounding pads all grounding connections shall be cleaned and tested.

9 Inspection and maintenance requirements

General

9.1 Only qualified customer assigned personnel shall perform inspection and maintenance during shipment and storage of package.

9.2 Special protection measures can be coordinated if specified by customer

Weekly

9.3 All package items shall be inspected externally for visible signs of damage. Preservative shall be applied if required.

Monthly

9.4 Motor insulation resistance shall be measured and recorded monthly or quarterly.

Six Months and more

9.5 All separate stored parts shall be inspected. Damaged packing and desiccant shall be replaced.

9.6 Preservative shall be re-applied if required

HANDLING, STORAGE, PACKAGING AND DELIVERY PROCEDURE

1 PURPOSE

This procedure outlines the method used for handling, storage, packaging and delivery for goods in National Process Equipment shop.

2. SCOPE

This procedure applies to all products received in National Process Equipment shop which will be used for the completion of a contract.

3 RESPONSIBILITY

Shipper / Receiver

The Shipper/Receiver is responsible for handling, storage, packaging and delivery.

The Shipper / Receiver is responsible for:

- i. Packaging of product for shipment.
- ii. maintenance and operational safety of the equipment used for handling material and in-house movement of product.

Production Manager

The Production Manager is responsible for verifying that inspection of the product to be shipped has been accomplished.

4 METHOD

4.1 Handling and Storage

Appropriate equipment and adequate human resources are used for the handling of all goods in order to prevent damage or deterioration of the materials and equipment.

The Production Manager maintains instruction manuals of operation for the forklift and the chain blocks and ensures that the appropriate employees have been instructed how to operate the equipment. On a monthly basis, the Shipper / Receiver will verify the equipment visually and operationally for any damage or deterioration. Any damage or deterioration noted by an employee will be reported to the Production Manager for corrective action.

The Shipper/Receiver identifies the product received and it is then placed in the appropriate "bin" until it is incorporated into production according to the Production Route Card.

A "bin," which is clearly marked with inspection status and contract number, provides necessary protection from environment, damage and deterioration until the product is incorporated into the production process or shipped to a client. Bins are located outside the regular production area to prevent unnecessary or inadvertent contamination or damage.

Inventory items are stored in a designated parts area that is located outside the regular production area and separate from the "bins" in order to prevent unnecessary or inadvertent contamination or damage.

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National Process Equipment

PUMPS & COMPRESSORS

The Shipper/Receiver is the only personnel authorized to remove stock from the inventory area. Items are removed from inventory only when stipulated on a contract purchase order placed on National Process Equipment inventory. When pulled from inventory, equipment is treated as described above for products received from outside sources.

Product in stock is assessed every twelve months during the physical count of inventory. Should any product be found unfit for use, it shall be treated as non-conforming product according to QAP-013.

4.2 Packaging and Delivery

The Shipper/Receiver verifies the quantities of the product to be shipped against the shipping copy of the sales order that has been prepared for the contract. Any discrepancies that are found will be reported to the Contract Administrator for correction.

Standard National Process Equipment packaging will be suitable for transportation and will effectively protect the product against normal environmental and normal handling conditions until National Process Equipment responsibility ceases. Special packaging protection (marking and preservation) of the product shall be in accordance with contractual specification if such is defined in the purchase order.

The Shipper / Receiver performs one or more of the following steps for the appropriate product.

- i. products that can be shipped in boxes are packed for protection in transit. The appropriate combination of sub-packs or sufficient dunnage will be used to prevent damage in transit. Wherever possible environmentally friendly packing is used. The packing slip is then attached to the outside of the box displaying the consignee's address.
 - ii. products that are skid mounted are strapped into place ensuring that the product will not move or shift during transportation. Loose-shipped components should be placed in a box that is also strapped to the skid. The packing slip is then stapled to the skid displaying the consignee's address.
 - iii. products that require crates are packed with blocks to prevent movement in the crate while in transit. The packing slip is then stapled to the crate displaying the consignee's address.
 - iv. where applicable special marking required on crates will be done according to customer requirements.
- i. all flanged openings must be protected with a plastic cap or a wooden blank. External threads will be protected from damage if open packing is used.

Shipment method is determined by customer specifications. When delivery of the equipment is included in the contract and is National Process Equipment responsibility the appropriate carrier is selected by the shipper.

5 DOCUMENTS

Forms

NPESF0008 SFC Routing

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National Process Equipment

PUMPS & COMPRESSORS

Baan Production Order (SFC)
QAF-029 Quality Plan
Baan Sales Order (SLS)

Procedures

QAP-010 Inspection and Testing Procedure
QAP-013 Control of Non-conforming Product Procedure
Baan Order Entry Procedures

Other Documents

Packing Slip (Marked copy of sales order)

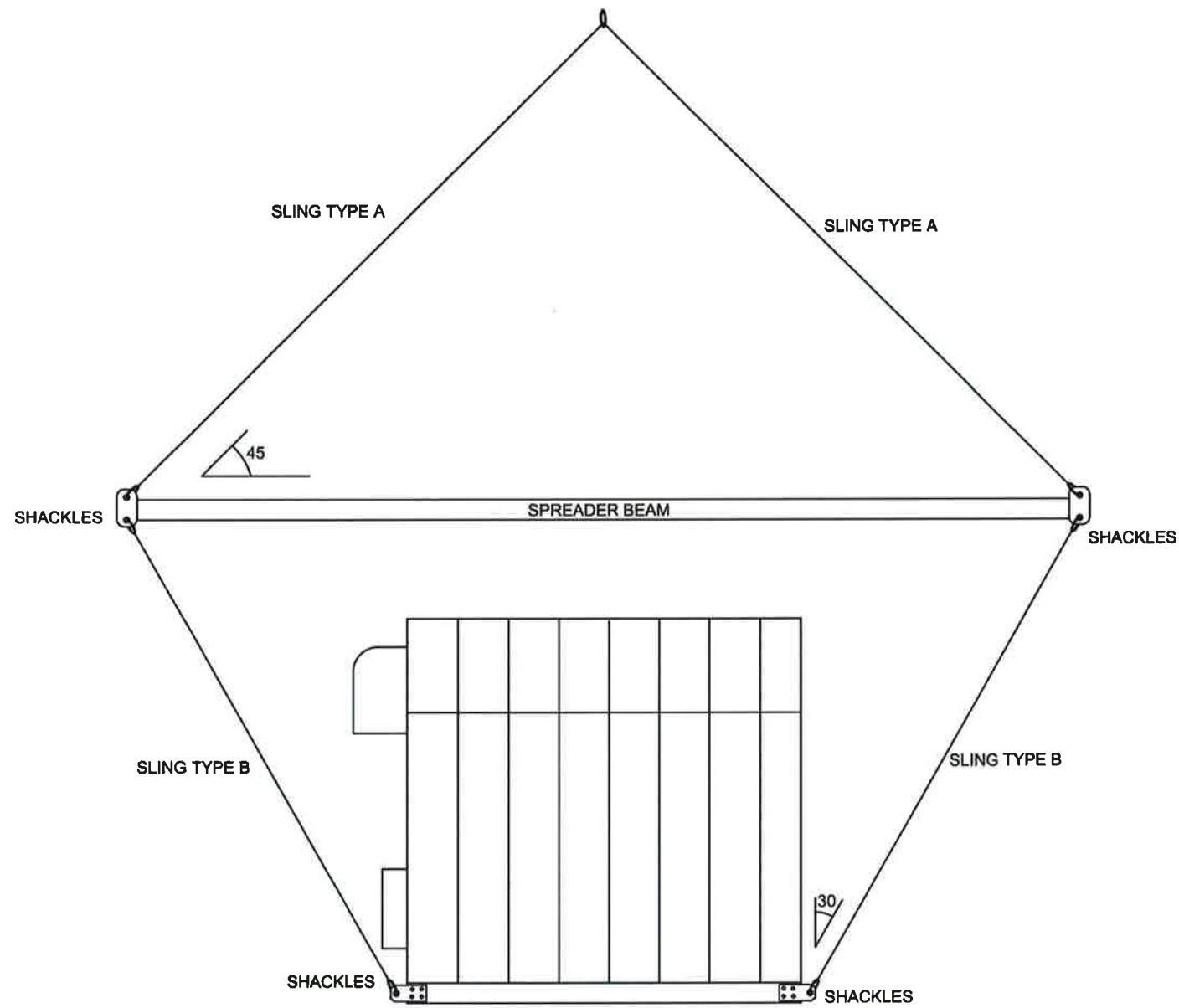
6 RECORDS

Upon shipment of the product a copy of the packing slip, and production routing are placed in the contract file.

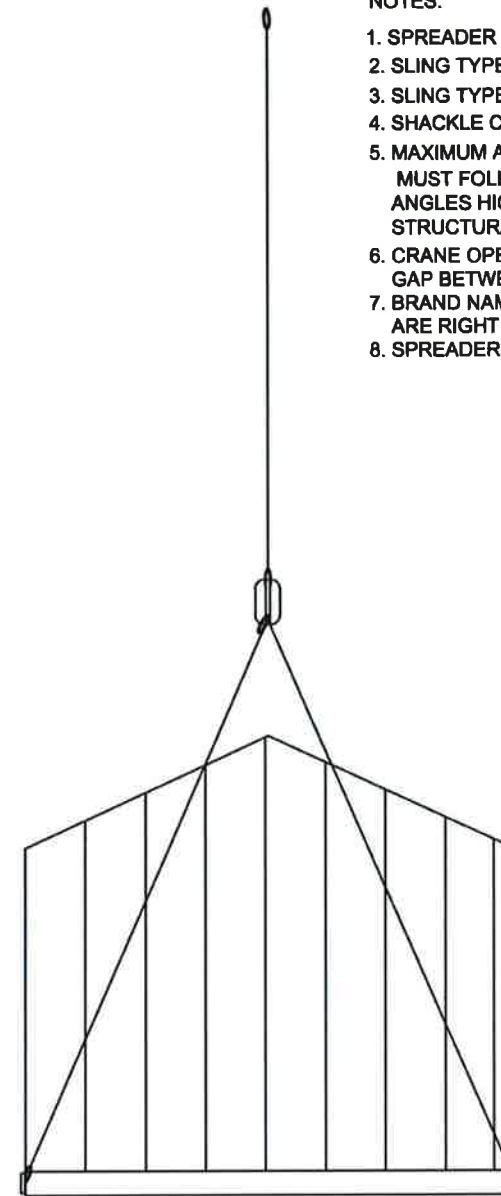
7 Note

QUALITY Group's Release for Shipment process shall be followed including CRITICAL documents required to be shipped with the skid for continuous transission of ownership

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ELEVATION VIEW -A-



ELEVATION VIEW -B-

NOTES:

1. SPREADER BEAM IS ADJUSTABLE AND CAPACITY IS 20 METRIC TON
2. SLING TYPE A CAPACITY IS 32,000 lbs EACH
3. SLING TYPE B CAPACITY IS 11,000 lbs EACH
4. SHACKLE CAPACITY IS 12 METRIC TON EACH
5. MAXIMUM ANGLES ARE WRITTEN ON DRAWING AND CRANE OPERATOR MUST FOLLOW. IF ANY REASON CRANE OPERATOR NEEDS TO CHANGE ANGLES HIGHER THAN ON DRAWING HE/SHE MUST INFORM NATPRO STRUCTURAL ENGINEER FOR APPROVAL.
6. CRANE OPERATOR MAKE SURE THAT THERE MUST BE MINIMUM 1 METER (4 FEET) GAP BETWEEN SPREADER BEAM AND TOP OF THE MODULAR BUILDING ROOF.
7. BRAND NAME FOR SHACKLES ARE CROSBY, AND FOR SLINGS ARE RIGHT IT RIGHT.
8. SPREADER BEAM IS HSS SQUARE STEEL.



THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.



PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030

REV	ISSUED FOR REVIEW	TG	JS	JS	MAY 26/15	SLS#	QUOTE	PO#
REV	DESCRIPTION	DWN	CHK	APP	DATE	338716	CGY2014-85	4512-109-130
	CMT NG PRESSURE REDUCTION SKID PACKAGE LIFTING DIAGM							
		DW BY: TG	DATE: MAY 26/15	DWG #:		338716-803-Rev0		
		DW BY: JS	DATE: MAY 26/15					
		APP BY: JS	DATE: MAY 26/15	PAGE: 1 OF 1		CAD: N/A	REV: 0	

DOCUMENT FRONT SHEET

PURCHASERS NAME	National Process Equipment
PURCHASE ORDER NO	PUR630248
EXHEAT REFERENCE	041167
SDR DOCUMENT NO	041167.IOM
CLIENT DOCUMENT NO	
DOCUMENT TITLE	Installation, Operation And Maintenanc

Doc Num	Revision	Issue	Date	Initials	Supplier's Approval Signature	Approval By
M02	1	1	03/07/2014	RDav		17/07/2014

To be filled by the reviewer of this document prior to its return

Tick Box	Code	Status	Description
<input type="checkbox"/>	E1	Approved	Approval given, no comments, final issue.
<input type="checkbox"/>	E2	Approved to Proceed	Approval given for work to proceed with document to be submitted as Final Issue providing comments are incorporated
<input type="checkbox"/>	E3	Not Approved	Document rejected and must be re-submitted with incorporation of comments. Work may NOT proceed
<input type="checkbox"/>	E4	Information Only	No comments made or approval given, for information purposes only.
<input type="checkbox"/>	E5	As-Built	Approval given for work to proceed provided comments incorporated in As-Built revision.

PAGES (Including this one)

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COMMENTS

Please be aware that EXHeat will not be held responsible for late approval of documents and will not be held liable for any liquidated damages as a consequence.

Late approval of documents by the client may impact on the contractual delivery date.

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**Installation, Operation & Maintenance
Instructions Manual**

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Third Edition (February 2014)

Refer to EXHEAT website for latest edition (www.exheat.com/iom)

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EXHEAT has provided versions of this manual in German, French, Italian, Spanish, Portuguese, Polish, Chinese and Russian. The foreign language versions can also be found at www.exheat.com/iom.

To maintain the equipment warranty and, if applicable, the Hazardous Area Certification, the instructions contained within this manual must be complied with in full.



Fitting any other device invalidates the hazardous area certification.

1. Contact Details

Sales Enquiries

UK, Europe & USA

EXHEAT Ltd
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Watton, Thetford
Norfolk, IP25 6NG, UK

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Fax: +44 (0) 1953 886 222

Email: sales@exheat.com

Website: www.exheat.com

Rest of the World

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8 Jalan Kilang Barat
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Fax: +65 6496 4601

Technical Support

UK, Europe & USA

Ex Services
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Watton, Thetford
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Tel: +44 (0) 1953 886 248

Fax: +44 (0) 1953 889109

Email: support@exservices.com

Website: www.exservices.com

Rest of the World

Ex Services Pte Ltd
8 Jalan Kilang Barat
Central Link #03-07
Singapore 159351

Tel: +65 6496 4628

Fax: +65 6496 4601

2. Description of equipment

Please refer to the Contract Manufacturing Data Book.

3. Safety

General

Electrical equipment must be designed, tested and installed such that, when it is used correctly, health and safety risks are kept to a minimum. The client must be provided with information about any necessary safety conditions, warned of any possible hazards that may arise during normal operation and told how to avoid them.

The client must ensure that:

- any employees working on the equipment are authorized and competent in the proper working procedures in order to ensure their safety. The plant must be maintained in a safe condition.
- safety interlocks are provided and maintained to ensure that the heater may only be energised when the design flow rate through the heater is attained and that the heater is de-energised should this flow rate be reduced or stopped.
- heater terminal enclosure covers are not removed whilst any precipitation, airborne dust or moisture is in the vicinity or when grinding, welding or similar activities are taking place nearby.

Provided the above conditions are adhered to, the equipment should be safe for use under normal operating conditions.

Safety hazards may arise when authorised and competent persons need to open doors or remove covers on control cubicles to carry out maintenance, testing or setting up to work. In the majority of these cases the equipment cannot be completely isolated before working on it.

It is virtually impossible to achieve conditions which are completely hazard-free when working on energised circuits. Responsibility for safe conduct of the competent person or persons operating on the equipment rests with those under whose authority they act.

Where the equipment is subject to the *Pressure Equipment Directive (97/23/EC)*:

- Prior to putting the equipment into service, the client must comply with the Essential Safety Requirements as stipulated by the directive.
- Refer to the Manufacturing Data Book for further details.

Installation



Should deviation from original design parameters occur, or change of original design structure be required, please refer back to EXHEAT for consultation prior installation.

Ensure that the equipment is correctly installed in a suitable location by technically qualified and competent persons.

Before operating the equipment, have the installation approved by a supervisor to ensure that the system is safe for operation.

Ensure compliance with any instructions and information provided in this manual and on the drawings supplied.



It is the client's responsibility to ensure that safe systems of work are used by all personnel operating and maintaining the equipment, including testing when 'live'.

Normal use

Observing the following points will minimise the risk of accidents to personnel using electrical equipment:

- Ensure that all persons operating the equipment are fully trained. This includes training in emergency shutdown procedures.
- Train operators to recognise signs of maloperation of the equipment and to know what actions to take in these circumstances.
- Keep all control cubicle doors closed and locked whilst the equipment is in operation and comply with any safety warning notices.
- Restrict access to heater terminal enclosures and keys for control cubicle doors to competent authorised personnel. Issue them only as part of a written safe system of work to ensure doors and terminal enclosure covers are:
 - not unlocked until electrical supplies are isolated
 - locked before electrical supplies are restored for normal operation of equipment.

Maintenance and testing

The client must ensure that maintenance, set up and testing of the equipment is only carried out by authorised and competent persons.

The following rules must be adhered to:

- Before starting maintenance work, isolate the equipment completely where possible.
- Comply with safe working conditions.
- Do not work alone on the equipment when it is energised.

- Be aware of hazards which may arise when working on energised equipment, and take all necessary precautions.
- Familiarise all persons working on the equipment with the instructions and information provided in this manual.

4. Preservation and storage instructions

Where specified in the contract, the equipment is supplied by EXHEAT suitably packed for storage.

Receipt of goods

Follow the guidelines below when goods are received:

- Use all design lifting points whenever moving the equipment from one area to another.



Lifting eyes fitted in the tube sheet of immersion heater bundles are designed for supporting only the bundle during removal and re-fitting, in conjunction with slings. They are not designed for the combined weight of the fitted heater in the vessel.

- Take care at all times to ensure that the equipment is moved safely and that no out of balance occurs during movement.
- On receipt of the equipment into the storage area:
 - Examine the equipment against the packing list to check that goods received match the packing list.
 - Check for any damage that may have occurred in transit. Any damage must be logged and reported to the site manager and EXHEAT within seven (7) days of receipt of goods.
 - Unless otherwise agreed in writing, store the equipment in an inside location that is dry, clean and well ventilated.
 - Ensure that equipment is not stacked and observe any 'This Way Up' markings.

Preservation materials



Further preservation instructions can be found in Section 12.

Suitable preservation materials, such as silica gel bags or equivalent, have been placed inside the packaging.

Additionally, spare silica gel bags, or equivalent, are supplied with all equipment.

It is the client's responsibility to ensure that, if the packaging is opened prior to installation, these bags are checked and replaced, if necessary.



For heaters, the preservation materials have been placed inside the main heater terminal enclosure and the auxiliary instrument junction box, if fitted. It is the client's responsibility to ensure that, if the terminal enclosure is opened prior to installation, these bags are checked and replaced if necessary.

Post Despatch & Storage

Ensure the equipment is stored in a proper manner in order to minimise the risk of accidental damage.

The following preservation instructions must be adhered to. Failure to do so could result in the equipment warranty being invalidated:

- Store the equipment at between 0°C and +50°C.
- Ensure that the equipment is not subjected to direct sunlight at ambient temperatures above 30°C.
- Do not store the equipment for more than 3 months unless packed for long term storage.
- Protect the equipment against external sources of vibration and/or impact.
- Leave the equipment in its original sealed packaging until required for installation.
- Where the storage period has been stated to be more than three months from the date of despatch from EXHEAT, moisture indicators may have been fitted to the packaging. These indicators should be checked every three months, the preservation materials replaced if necessary, and the packaging resealed.
- Where provided, anti-condensation heaters should be temporarily energised during storage and prior to installation. The temporary supply must be disconnected following the equipment being put into full operation.
- Should it be necessary to open a packing/heater terminal enclosure, for example to cable in an anti-condensation heater:
 - check the preservation materials and replace them if necessary.
 - replace the terminal enclosure cover immediately after the work has been carried out.
 - reseal the packaging.
- The erection contractor must carry out periodic inspections of the equipment during storage in order to:
 - detect any signs of deterioration.
 - check on limitations of time in storage.
 - ensure maintenance of proper conditions.
 - determine the current state of materials.
- When the periodic inspections are complete, complete the Storage Preservation Check Record in Appendix B.



Should it be necessary to enter the main heater terminal enclosure, replace the preservation materials and update the preservation record (found in the main heater terminal enclosure) accordingly.

5. Erection and installation instructions

Overview

This section covers the erection and installation requirements for most of the range of EXHEAT equipment, such as non-hazardous areas/locations.

This equipment includes:

- Increased Safety Ex e electric heaters and/or safe area control panels
- Flameproof Ex d electric heaters and/or safe area control panels.
- Class I, Div. 2 electric heaters and control panels
- Class I, Div. 1 electric heaters and control panels.

Refer to the relevant code of practice for the equipment:

- *IEC/EN 60079-14* for selection and installation
- *IEC/EN 60079-17* for inspection and maintenance of electric apparatus for use in potentially explosive atmospheres.

When installing these types of equipment, the installation contractor/operator shall be both familiar with and abide by the “Special conditions for safe use” on the Hazardous Area Certificate/s in the Data Book.

Compliance with these instructions is a warranty requirement and documented evidence must be maintained in the form of signed checklist and records as contained in Appendix B. Copies of completed checklists and records will be required in the event of a warranty claim.

Over-temperature trip devices

It is a mandatory requirement that the over-temperature devices (excluding spares) are connected back to the dedicated trip system to shut down electrical power to the heater in the event of over-temperature.

Be aware of the following important points:

Thermocouple

Note the polarity of the circuit for the sensor to operate correctly.

Ensure that the correct compensating cable is used for the type of thermocouple fitted, as detailed on the schedule drawings.

RTD

Note the correct connections to ensure that they operate as detailed on the schedule drawings.

Temperature transmitters

Note the polarity of each device to ensure that it functions correctly within the control loop, as detailed on the schedule drawings.

Thermostats

Note the connections shown in the drawing to ensure the correct operation.

- Where thermostats have been pre-set at EXHEAT they require no further adjustment.
- Adjust thermostats that have been supplied un-set to meet process requirements.



If there is any uncertainty about these points, contact EXHEAT for advice.

Over-temperature trip devices in protection circuits of Ex e heaters

Protective devices, such as PT100 resistance thermometers (also known as resistance temperature detectors or RTDs) and thermocouples with or without 4-20mA transmitters, **must** be set up in accordance with EXHEAT procedure *WI/09/131* in Appendix D.



Failure to comply could result in the Hazardous Area Certificate being invalidated.

Scope

The extent of equipment to be erected/installed is detailed in the drawing schedule specific to each contract.

Responsibilities

This section outlines the erection contractor's responsibility for the erection and installation of the equipment supplied by EXHEAT:

- Install the equipment under the surveillance of the client's site engineers, in accordance with these instructions.
- Carry out the installation in complete accordance with this document, which shall be read as complimentary to all associated contract documents (such as site conditions, contract specifications and drawings) and national legislation/regulations.
- Ensure that all employees are fully trained and supervised in the appropriate site working procedures in order to ensure their safety. The site must be maintained in a safe condition at all times.
- Ensure that all site installation personnel are issued with copies of all relevant drawings, material schedules and specifications necessary to fulfil their obligations.
- Provide all tools and equipment necessary to carry out the installation as required on the schedule drawings for that contract.

Pre-installation inspection

Before installation, inspect the equipment to ensure that all items are available and that all crates and/or packaging are in good condition and undamaged. Any damage must be reported to the site manager and to EXHEAT.

Moving the equipment into position

Follow the steps below to safely move the equipment into position:



Ensure that the equipment is moved and installed by technically qualified and competent persons experienced in the class of work involved.

- Carefully remove the packaging from each item and check for damage. Report any damage to the site construction manager immediately and to EXHEAT.
- Move the equipment by either crane or fork lift truck, using suitable lifting chains/slings to prevent damage to the heating elements. Observe the following safety points:
 - All lifting tackle/equipment must have a safe working load (SWL) capacity in excess of that of the equipment weight and include for snatch factors etc.



Certain equipment configurations may require a lifting beam to achieve a safe lift.

- The slings or ropes must be long enough to keep the angle between the slings/ropes and the top of the equipment greater than 45°.



If the sling/rope is too short it will reduce this angle and lead to unacceptably high stresses on the eyebolts/lifting lugs.

- Additional support should be provided when lifting, as necessary, to counteract any out of balance that may be present.
- Use a suitable method to prevent or reduce the swing of the suspended load.



Lifting eyes fitted in the tube sheet of immersion heater bundles are designed for supporting only the bundle during removal and re-fitting, in conjunction with slings. They are not designed for the combined weight of the fitted heater in the vessel. The same is true for lifting points on the terminal enclosures of air duct heaters – use these for bundle lift only. Lift the package using the lift points on the duct section.

- Only use a forklift truck to move equipment if absolutely necessary, particularly at the assembly site and on uneven ground. Use a crane whenever possible.
- If a forklift must be used, space the arms as far apart as the equipment allows and ensure they are long enough to go completely under the equipment.
- Ensure that the destination position is free from obstructions.
- Move the equipment into position and set the load down carefully and without bumping.
- Check the alignment prior to bolting it in position.

Installing the heater

Follow the steps below to install the heater:

- In the case of non-installed immersion heater bundles:
 - Inspect the gasket face prior to installation.
 - Inspect the immersed part of the heater bundle for any damage.
 - Check that the heating elements are not touching. This can lead to localised over-heating and premature element failure. Pay particular attention to the element ends furthest from the heater flange.
 - Report any damage or discrepancies to the site manager and EXHEAT.
- The equipment should be installed using industry recognised torqueing/Tensioning Procedure.
- Check the insulation resistance of the heating elements. Use a 500V dc megohmmeter to take a reading between the element sheath and the phase terminals. The reading should be better than 2 megohm. If it is lower than this, contact EXHEAT for advice.
- Ensure that the equipment is suitably supported, both internally and externally, and not subjected to undue stress or vibration.
- If a heater bundle is supplied without housing, the immersed part must be adequately supported within the respective vessel, tank or duct.
- Ensure that there is sufficient room around the heater to remove the heater bundle for maintenance.
- Each heater is fitted with safety devices as detailed on the drawing schedule for that contract. These safety devices **must** be kept in good working order and connected into the dedicated trip system as stated on the schedule drawings.
- Safety interlocks must be installed to ensure that the heater may only be energised when the design flow rate through the heater is attained and that the heater is de-energised should this flow rate be reduced or stopped.
- Ensure that the supply cable is of the correct type and is sized for the current being carried. Consider:
 - maximum ambient temperatures
 - cable routing method
 - volt drops due to cable runs.
- Ensure that the supply cables are suitably supported to prevent undue force/stress on the terminal points.
- Check that the voltage on the heater nameplate is compatible with the mains supply being used.
- Under no circumstances interfere with any EXHEAT internal cabling or connections. This includes re-routing and 'bunching' cables, which can have a serious adverse effect on the heat build-up generated within the terminal enclosure.

Terminal points

The terminal points for each heater are as follows:

- Power terminals and cable gland plates (or cable entries) for heater power supply.
- Control terminals and cable gland plates (or cable entries) for heater trip/alarms.
- Equipment earth terminals.

Earth-fault protection

For safety reasons, it is essential to limit the magnitude and duration of earth-fault currents. It is impractical to cover all possible systems, however note that, regardless of which system is used, the heater must be protected by a suitable device wired to shut down the heater in the event that a heater element fails to earth. Suitable devices include a residual current device (RCD) – this is the preferred method and should be used whenever possible – or an insulation monitoring device.

- Maximum recommended setting for the RCD: 300mA/10mS. The duration time of 10mS (ten milliseconds) ensures that any fault is detected within a single cycle of a thyristor system (where applicable).
- Maximum recommended setting for the insulation monitoring device: Insulation resistance is not greater than 50 ohms per volt of rated voltage.

Ensure that the equipment is earthed in accordance with the plant earthing philosophy.

If fitted, an anti-condensation heater must be protected by a 30mA earth leakage circuit breaker. Recommended systems are available from EXHEAT upon request.

Before commissioning the equipment, the completed installation should be approved by a qualified supervisor to ensure that it has been carried out correctly and that the system is safe for commissioning.

Heaters must only be immersed in the fluid they are designed to heat. Introducing alternative fluids even in small concentrations for purposes such as sterilising may cause serious damage to the heater and will invalidate the warranty.

Before switching the heater on, check that the heater elements and temperature sensors are fully immersed and that the rated process flow is passing over the heating elements.



Ensure that the terminal enclosure is not subjected to direct sunlight at ambient temperatures above 30°C.

Installing the control panel

Follow the guidelines below when installing a control panel:

- Ensure that there is sufficient room around the panel to open the panel door for maintenance.
- Ensure that all cables to be connected into the panel are of the correct type and are sized for the current being carried.
- Consider the:
 - maximum ambient temperatures
 - cable routing method
 - volt drop due to cable runs.
- Check that the voltage on the control panel nameplate is compatible with the mains supply being used.
- Following installation remove the lifting eyebolts, where fitted, and replace them with plugs.
- Before commissioning the equipment, have the completed installation approved by a qualified supervisor to ensure that it has been carried out correctly and the system is safe for commissioning.

Terminal points

The terminal points for each control panel are as follows:

- The input terminals and cable gland plates (or cable entries) for control panel power supply.
- The output terminals and cable gland plates (or cable entries) for heater power supply and trip/alarms.
- Equipment earth terminals.

Earth-fault protection

The heater must be protected by a suitable earth-fault protection device wired to shut down the heater in the event a heater element fails to earth. The reason for any trip condition initiated by the earth-fault protection device must be fully investigated and rectified before the system is reset and the heater switched on.

Where they have not been included in the control panel, recommended systems are available from EXHEAT upon request.

6. Pre-commissioning/commissioning instructions

Pre-commissioning

The following checks should be carried out prior to commissioning and the equipment should not be energised until all the checks have been completed.

Heaters

The pre-commissioning checks below should be carried out before installing heaters:

- Check the overall physical condition of the heater for any signs of damage.
- Ensure the layout of the installation is neat in appearance.
- Check for any loose components and tighten as required.
- Remove all debris from enclosures.
- Ensure that any preservation items, such as silica gel bags, are removed.
- Disconnect the main electrical supply cable and check the overall insulation resistance of the heater per stage. Use a 500V dc megohmmeter to take a reading between the element sheath and the phase terminals. The reading should be better than 2 megohm. If it is lower than this, contact EXHEAT for advice.
- Reconnect the cable ensuring terminations are secure.
- Ensure both the heater and instrument enclosure covers are closed and all fastenings are tight but not over-tight.



Where the enclosure is of sheet metal fabrication and uses a 6mm thick silicone sponge sealing gasket, the recommended torque for the M6 fasteners (on the cover, gland plate and back plate) is 6 N/m.

- Ensure all trip devices are functioning correctly (including over-temperature/low flow/no flow and over-pressure safety interlocks).
- Check that labels and tags are secure and correct.



In addition to the steps above, Ex e increased safety or Class I, Div. 2 and Ex d flameproof or Class I, Div. 1 explosion-proof heaters must be inspected in accordance with the relevant codes of practice concerning the inspection and maintenance of electrical installations in hazardous areas.

Compliance with the points listed above is a warranty requirement. Documented evidence must be maintained in the form of signed checklist and records as contained in Appendix B. Copies of completed checklists and records will be required in the event of a warranty claim.

Control panels

The following pre-installation checks must be performed on safe area control panels:

- The control panel is mounted correctly, in particular that it is square, rigid and there is no bowing of doors.
- The doors close and lock easily. Lubricate noisy hinges as required.
- The layout of the installation is neat in appearance.
- There are no loose components.
- There is no debris in enclosures.
- Any preservation items, such as silica gel bags, are removed.
- Filters on fan intakes and filter outlets, where fitted, are not blocked.
- Shrouds/covers are fitted over incoming and outgoing terminals.
- All incoming and outgoing cables are terminated in the proper manner.
- Correct lamps and coloured lenses are fitted.
- Labels and tags secure and correct.
- Overall physical condition – no signs of damage. Paintwork should be intact.

Electrical checks

The pre-commissioning electrical checks below should be carried out before installing equipment:



Before carrying out the following checks, take all electronic components in the panel out of circuit. Do this by removing control fuses or by physically disconnecting the electronic components.

- Disconnect the main supply cable and check the insulation resistance of the mains cable within the panel. Use a 1000Vdc megohmmeter (for 3 phase)/ 500Vdc (for Single phase) to take reading between the Terminal Busbar/Cable with reference to ground/earth. The reading should be better than 300 megohm. If it is lower than this, contact EXHEAT for advice.
- Reconnect the main supply cable ensuring terminations are secure.
- Ensure all emergency stops and safety interlocks are working correctly. All isolating devices should be open before work commences and only closed as the plant is put progressively into service.
- Before switching on the incoming feed to the control panel, ensure that the supply conform to the specified voltage on the control panel and/or heater nameplate at a nominal variance of +/- 5% of the specified voltage.

Compliance with these instructions is a warranty requirement. Documented evidence must be maintained in the form of signed checklist and records as contained in Appendix B. Copies of completed checklists and records will be required in the event of any warranty claim.

Commissioning

The procedures in this section should be carried out after completion of all the pre-commissioning checks. All prevailing site safety regulations should be adhered to at all times.

Control panel

These steps apply to heaters and panels with thermocouples or RTDs and heaters and panels with adjustable control thermostats.

- Isolate the heater then energise the control panel.
- Carry out the relevant test procedure as described in the Data Book for that equipment.

Heater

These steps apply to:

- Heaters with thermocouples or RTDs
- Heaters with adjustable control thermostats
- Heaters and panels with thermocouples or RTDs
- Heaters and panels with adjustable control thermostats.

The steps are as follows:

- Before switching the heater on, check that the heater elements and temperature devices are fully immersed and that the correct process flow is passing over the heating elements.



Low flow and low level protection must be provided elsewhere in the system so as not to be solely reliant the over-temperature trips from the heater, which have not expressly been provided for low flow and low level protection.

- Set the control device to approximately the required temperature.
- Switch on the power supply to the heater.
- Ensure all temperature sensing instruments are monitored and show rising temperature.
- Allow the process temperature to stabilise.
- Check the temperature and adjust the control devices to the required temperature.

Temperature controller (if installed)

- Configure and tune the temperature controller, if fitted, in accordance with the operating instructions in Appendix D to provide the required process conditions.

Trip amplifier (if installed)

- Refer to procedure *WI/09/131* in Appendix C for trip amplifier set-up.
- This is a mandatory certification requirement for Ex e type heaters and is recommended for all other types of heater.

Refer also to the relevant component data sheets in the Data Book for that equipment.

7. Operating instructions

General

This section describes the operating procedures for various pieces of equipment supplied by EXHEAT. Many of them contain information vital for ensuring the safe operation of the equipment and should be read by all operators/end users of the equipment.

Normal start-up

Ensure that each piece of equipment has an approved Initial Equipment Start Up Certificate by EXHEAT

Before starting the equipment, ensure process flow conditions are correct.

Provided that the controls are set correctly, the heating and temperature control is automatic.

Operation

Regardless of the heater type, it is vital to ensure correct operation so you should also refer to the Manufacturing Data Book for:

- Drawings
- Data sheets
- Any Essential Safety Requirements as stipulated by the *Pressure Equipment Directive (97/23/EC)* (where applicable).

Heater types where the heating elements are in direct contact with the process fluid

When operated correctly, these types of heater are not considered overly susceptible to perforation failure where the process fluid is able to permeate through the heating element into the terminal enclosure. However, this type of failure can be caused by extreme conditions, such as overheating, excessive thermal cycling, or vibration, either flow-induced or externally by other means.

Temperature control – heaters with adjustable control thermostats

The control temperature set points can only be changed by adjusting the thermostat inside the heater terminal enclosure cover.

If an increase in the process operating temperature of more than 10°C is required, contact EXHEAT to verify the resultant element surface temperature is acceptable.



Check for hazardous gases and isolate the electrical supply before removing the terminal enclosure cover.

If adjusting the thermostat for Ex d/Class I, Div.1 heaters:

- Take extreme care when removing/re-fitting enclosure covers to maintain the integrity of the flame-paths.
- Clean the flame-paths thoroughly and re-coat with an approved Ex d corrosion inhibitor before refitting the cover.

Refer to the relevant code of practice for selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres.

Temperature control – panel

The control temperature set points can only be changed by adjusting the temperature controller at the panel. This can be done while the system is in operation.

Over-temperature trip – control panel

The following applies to both EXHEAT and client-supplied control panels:

- A trip can only be reset at the control panel when the temperature at the sensor has fallen below the trip temperature set point.
- Investigate the reason for the trip before resetting the system.
- Only an authorised person is permitted to reset the trip using the key switch or special tool provided.

Over-temperature trip – heater

The following points apply to heater trips:

- The trip device will only operate if there is an over-temperature fault.
- Investigate the reason for the trip before resetting the system.



Test for hazardous gases and isolate the electrical supply before removing the terminal enclosure cover.

- A trip can only be reset at the heater. The trip device and reset button are inside the main heater terminal enclosure. It can only be reset when the temperature at the sensor has fallen below the trip temperature set point.



The above applies only to heaters where the latching trip (over-temperature or Hi-Hi thermostat) is located inside the heater terminal enclosure.

- For trips on Ex d/Class I, Div.1 heaters:
 - When removing/re-fitting enclosure covers, take extreme care to ensure that the integrity of the flame-paths is maintained.
 - Clean the flame-paths thoroughly and re-coat with an approved Ex d corrosion inhibitor before refitting the cover.
 - Refer to the relevant code of practice for selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres.

Normal shut down

To shut down the heater, press the Off button, either at the control panel or locally where this facility is provided.

Emergency shut down

Where the control panel is supplied by EXHEAT and the emergency shutdown facility is available, see the control panel operation information contained in the Data Book for the equipment.

8. Maintenance instructions

General Safety Precautions

- All prevailing site safety regulations shall be adhered to at all times.
- Before removing the terminal enclosure, allow sufficient time for the internal components to cool down after electrical isolation.
- Check for hazardous gases before and during any maintenance activity.
- Fully isolate the equipment from the electrical supply before and whilst any work is being carried out.

Heater

The following preventative maintenance should be carried out at the intervals shown below.

Any replacement parts, please contact EXHEAT

Compliance with these maintenance instructions is a mandatory requirement. Documented evidence must be maintained in the form of a signed checklist and the records in Appendix B. Copies of completed checklists and records will be required in the event of a warranty claim.



If heaters are not used for more than three months they must be tested for insulation resistance.

Three-monthly checks

Carry out a general inspection of the equipment to check for external damage.

Six-monthly checks

The following checks should be carried every six months:

- Isolate the electrical supply and remove the terminal enclosure cover, taking care not to damage the flame paths.



Do not remove the terminal enclosure cover during wet or humid conditions as this will lead to a reduction in insulation resistance of the heater.

- Ensure that internals are clean, dry and free from debris.
- Ensure that electrical terminations are undamaged and secure.
- Measure the overall insulation resistance of the heater per stage. Use a 500V dc megohmmeter to take a reading between the element sheath and the phase terminals. The reading should be better than 2 megohm. If it is not, contact EXHEAT.
- Ensure that the gasket or 'o'-ring, as applicable, is in good condition and carefully refit the cover.



For Ex d flameproof or Class I, Div.1 explosion-proof heaters, ensure that the flame path surfaces are in good condition and apply approved Ex d corrosion inhibitor. Report any damage to EXHEAT. Carefully refit the cover.

- Ensure that earth conductors are correctly fitted between all earth points and main structure.
- Ensure all trip devices are working properly (including over-temperature/low flow/no flow and over-pressure safety interlocks).

Annual checks

Ensure that the following checks are carried out if equipment is in storage for a year or more:

- Check for element failure by comparing phase resistance values. On a healthy three phase system these values should be equal. If there is an element failure or low insulation resistance, contact EXHEAT for further advice.



Only EXHEAT or EXHEAT approved Services Representative are authorised to replace elements and/or heater related components. The hazardous area certification will be invalidated if this requirement is not strictly observed.

- For heaters immersed in an electrically non-conductive process, carry out a hydrostatic test of the vessel with the heater installed. Record the insulation resistance of each element, including any spares, before and after this test. Follow the instructions set out in Section 13.
- For Ex d flameproof heaters, replace terminal enclosure cut-outs. These cut-outs are set and sealed by EXHEAT.



Fitting any other device invalidates the hazardous area certification.

- Where capillary thermostats require replacement, refer to Appendix D.

24-monthly checks

If necessary, carry out the following checks every two years:

- Remove the heater bundle from immersion heaters and thoroughly inspect the condition of immersed parts, in particular the elements, for signs of abrasion or distortion. It is recommended that EXHEAT is employed for this purpose.
- Notify EXHEAT immediately of any defects and do not return the heater to service until authorised.



If Section 13 specifies additional requirements for all or some of the heaters, both of the 24-monthly preventative maintenance checks included on the *Routine Maintenance Check Record* must be carried out.

Control Panel

This section describes the regular maintenance checks that should be carried out on control panels.

Three-monthly checks

Generally inspect the equipment for external damage.

Six-monthly checks

The following checks should be carried every six months:

- Isolate the incoming electrical supply and open the panel door.
- Clean out any dust or debris that may have accumulated inside the enclosure.
- Check the electrical connections for tightness.
- Clean out fan intake and outlet filters, where fitted.
- Check the component mountings for tightness.
- Ensure that all earth conductors are correctly fitted between all earth points and main structure.
- Check that lamps are working properly.
- Check that all external glands and connections are complete, tight and conform to the correct specification for use in a hazardous area (if applicable)

Annual checks

- Check contactors for flamepath contact points
- Check MCCB
- Test ACBs Electronic Trip Unit (ETU) for correct function (if applicable)

9. Fault finding and correction

All air heaters

See Maintenance instructions for procedures relating to these faults.

Fault	Check	Resolution
Heater fails to achieve required design air temperature	<ul style="list-style-type: none"> Isolate power supply. Supply fuses. Temperature control device set points are correct. All elements still operative. Take load resistance reading. Resistance between phases should be equal. Air flow not greater than design rating. 	Contact EXHEAT for advice.
Air temperature too high	<ul style="list-style-type: none"> Temperature control device set points correct. Air flow not less than design rating. 	
Heater trips	<ul style="list-style-type: none"> Air flow not less than design rating and evenly distributed across duct cross section. Supply voltage is correct. All trip devices functioning correctly and sensors not failed. Ambient temperature within design limits. 	Refer to Appendix A.
Earth leakage trip	<p>Limiting earth-fault currents (magnitude and/or duration) is essential for safety. The earth-fault protection device is intended to provide critical safety protection if there is current leakage to earth. Fully investigate and rectify any trip condition before resetting the system and operating the heater. In addition, where process is gas, de-pressurise system during investigation.</p>	<p>Where an earth leakage trip has occurred, isolate the heater and:</p> <ul style="list-style-type: none"> Check insulation resistance is according to Section 8. Check settings of earth leakage protection device are according to Section 5. <p>Where a heating element has failed, remove and replace it before returning the heater to service. If this is not possible it may be acceptable to disconnect the failed element and suitably isolate it, provided that:</p> <ul style="list-style-type: none"> EXHEAT agrees to and approves proposed remedial action prior to work commencing. The failed element has been capped to an EXHEAT approved procedure. Refer also to additional requirements in Section 13.

All immersion heaters

See Maintenance Instructions for procedures relating to these faults.

Fault	Check	Resolution
Heater fails to achieve required design process temperature	<ul style="list-style-type: none"> • Isolate power supply • Supply fuses. • Temperature control device set points correct. • All elements still operative by taking load resistance reading. Resistance between phases should be equal. • Air flow not greater than the design rating 	Contact EXHEAT for advice.
Process temperature too high	<ul style="list-style-type: none"> • Temperature control device set points are correct. • Process flow within design limits 	
Heater trips	<ul style="list-style-type: none"> • Process flow not less than design rating and within design limits • Supply voltage is correct. • All trip devices functioning correctly and sensors not failed. • Ambient temperature is within design limits. 	Refer to Appendix A.
Earth leakage trip	<p>Limiting earth-fault currents (magnitude and/or duration) is essential for safety.</p> <p>The earth-fault protection device is intended to provide critical safety protection if there is current leakage to earth. Fully investigate any trip condition and rectify prior to resetting the system and operating the heater. Where the process is gas, de-pressurise system during investigation.</p>	<p>Where an earth leakage trip has occurred, isolate the heater and:</p> <ul style="list-style-type: none"> • Check insulation resistance is according to Section 8. • Check the settings of the earth leakage protection device are correct according to Section 5. <p>Where a heating element has failed, remove and replace it before returning the heater to service. If this is not possible it may be acceptable to disconnect the failed element and suitably isolate it, provided that:</p> <ul style="list-style-type: none"> • EXHEAT agrees to and approves proposed remedial action prior to work commencing. • The failed element has been capped to an EXHEAT approved procedure. • Refer also to additional requirements in Section 13.

All control panels

See Maintenance instructions for procedures relating to these faults.

Fault	Check	Resolution
No controls operating and no lamps lit	<ul style="list-style-type: none"> • Check that main incoming switch is turned on. • Check control supply fuses are healthy. 	Replace fuses as required with identical fuses.
Any heater fault lamp lit	<ul style="list-style-type: none"> • Check control devices are set correctly. If control devices are set correctly then check the heater. • Check all remote interlocks. 	Reset control devices in accordance with project documentation. Reset interlocks.
Panel over-temperature lamp lit	<ul style="list-style-type: none"> • Check operation of cooling fans. • Check control devices are set correctly. • Check for dust in panel filters. 	Remove any objects fouling the blades. Reset control devices in accordance with project documentation. Clean out any dust from panel filters.
Any thyristor fault lamp lit	<ul style="list-style-type: none"> • Check control devices on the thyristor unit. 	Remove any objects fouling the blades.
No heater output control	<ul style="list-style-type: none"> • Check all remote interlocks and control devices. • Check there are no faults present. 	Reset control devices in accordance with project documentation.
Earth leakage trip	<p>Limiting earth-fault currents (magnitude and/or duration) is essential for safety.</p> <p>The earth-fault protection device is intended to provide critical safety protection if there is current leakage to earth. Fully investigate any trip condition and rectify prior to resetting the system and operating the heater. Where the process is gas, de-pressurise system during investigation.</p>	<p>Where an earth leakage trip has occurred, isolate the heater and:</p> <ul style="list-style-type: none"> • Check the insulation resistance in accordance with Section 8. • Check the settings of the earth leakage protection device are correct in accordance with Section 5.

10. COSHH statement

Health and safety information

There are no hazardous or toxic substances applied with this order as defined in COSHH (control of substances hazardous to health) regulations (2002).

11. Control panel operation

Because each EXHEAT control panel is individually designed, the control panel procedures are tailored to suit the requirements of the individual product. These procedures are delivered as part of the Data Book.

For details of the control panel operation for a particular product, refer to the corresponding Data Book.

12. Electrical heater insulation resistance

Introduction

This procedure shall be read in conjunction with any procedures that have been supplied with the equipment. Any contradictions or conflicts must be brought to the attention of EXHEAT for clarification.

Warranty

All EXHEAT warranties are subject to EXHEAT Guarantee Terms and Conditions; www.exheat.com/manufacturers-guarantee.html.

EXHEAT guarantees that the insulation resistance (IR) of the heater is at an acceptable level when the heater is dispatched from our factory. Evidence of this can be found on the test certificate provided with the equipment.

As EXHEAT has no control over the storage or initial or ongoing preservation of the heater, EXHEAT does not provide any warranty (inferred or otherwise) for minimum IR of the electrical heater.

Overview

The internal insulation of the element is constructed from compressed magnesium oxide powder (MgO). This powder is highly hygroscopic (it attracts moisture from the atmosphere).

Additionally, many heaters are shipped with a very high IR value which may reduce significantly over time. This time period is dependent on a number of factors but mainly on how stringently preservation procedures are followed during storage, installation, commissioning and ongoing maintenance/operation.

Heaters have many individual elements connected together in parallel. Whilst all the individual elements have an acceptable IR value, once they are connected in parallel this reduces significantly, ie $1/R_{\text{total}} = 1/R_1 + 1/R_2 + \dots \dots \dots \text{etc}$

- Example 1 - 50 elements each with an individual IR value of 100 megohm will have a connected value of 2 megohm.
- Example 2 - 70 elements each with an individual IR value of 10 megohm will have a connected value of 0.143 megohm.
- Example 3 - 48 elements each with an individual IR Value of 100 megohm plus 2 individual elements with an IR value of 2 megohm will have a connected value of 0.676 megohm.
- Example 4 - 48 elements each with an individual IR Value of 100 megohm plus 2 individual elements with an IR value of 0.1 megohm will have a connected value of 0.0488 megohm.

Construction

During manufacture of the individual elements, each element is dried in a high-temperature oven and subsequently sealed using a very strict procedure. However, this is a manual procedure and the final results are dependent on a variety of factors and produce varying IR values. These factors include:

Drying oven

How long the heater elements were baked in the oven. EXHEAT has no stipulated maximum time. This can mean that some elements are left in the oven much longer than others and will hence be dryer and have higher IR values than others.

Sealing of elements

The elements are sealed after they have been dried in the ovens. The length of time before the elements have their first seal applied determines how much atmospheric moisture they absorb. This varies depending on how many elements are in the ovens at any time, atmospheric humidity and so on. After sealing the elements are tested and, provided the IR is above the minimum acceptable value, they are passed regardless of the variations in the upper levels of IR. Electric elements only have to have a minimum IR value.

Terminal enclosure seal

EXHEAT heaters have terminal enclosures that are completely sealed against ingress of moisture when dispatched from the factory. However, it is the client's responsibility to ensure that this seal is maintained once the equipment leaves our factory to ensure there is no ingress of moisture into the terminal enclosure which can be absorbed by the elements.

Poor preservation

Once the equipment is dispatched to site, EXHEAT have no control on how it is preserved. Strict preservation procedures are issued to clients by EXHEAT. However, in our experience, clients/operators do not adhere to them eg:

- on many occasions the terminal enclosure covers are removed for long periods.
- silica gel is not replaced.
- terminal enclosure covers are removed for cabling and left off during periods of rain or high atmospheric humidity. All this will cause moisture to enter the terminal enclosure and ultimately degrade the IR levels.

IR level after use

Once the elements are switched on, any microscopic amounts of moisture inside the elements migrate along the hot portion of the element and accumulate at the hot/cold intersection of the element. This can cause a drop in overall IR value.

All elements are tested after sealing to ensure they meet our minimum criteria before assembly into the heater bundle.

Every heater that is shipped from EXHEAT has a terminal enclosure that is sealed from moisture present in the atmosphere. However, every time the terminal enclosure is opened, moist and/or humid air enters the terminal enclosure. This then condenses on the terminals and/or internal wires or at worst can even be absorbed into the element insulation MgO.

Preservation

EXHEAT recommend the following to ensure that there is no significant reduction in IR values that could prevent the heater from being operated satisfactorily:

Pre-installation /storage

When the heater is dispatched from our factory, the terminal enclosure has silica gel (or equivalent) inside. The terminal enclosure has also been sealed from atmospheric moisture and pressure tested to ensure it is pressure/air/moisture tight. Do not remove the terminal enclosure cover, gland plates or any other opening that may breach the integrity of the terminal enclosure until it is time to carry out the cabling and installation. This will allow moisture inside the terminal enclosure which will cause reduction of IR levels.

During cabling/installation

It is not necessary to remove the terminal enclosure cover to install the heater into the vessel/pipe work. Cable installation shall be done as quickly as possible and shall never be carried out during wet weather conditions. Under no circumstances shall water/moisture be allowed to enter the terminal enclosure. Keep the terminal enclosure gland plates and other openings sealed at all times unless it is critical to the installation that they are removed.

Once the cables have been installed and tested:

- check the terminal enclosure for any foreign objects, e.g. strands of armour cable, strands of copper cable/wire, tools or other objects that cause short circuits
- put fresh silica gel into the terminal enclosure and document the date of installation.
- replace the terminal enclosure cover
- tighten all terminal enclosure and gland plate bolts to ensure the weatherproof integrity of the terminal enclosure.

Post installation preservation

If the heater is not to be used for a significant period of time after installation, the following is recommended to ensure the inside of the terminal enclosure does not contain moisture that could reduce the IR value of the heating elements.

- Put fresh silica gel (or equivalent) inside the terminal enclosure and write the date on the cover.
- Reduce or remove trapped moist air after refitting the terminal enclosure cover as follows:
 - Purge the terminal enclosure with clean, dry air after fitting/replacing and sealing the terminal enclosure cover, gland plates and any other openings.
 - Purge for approximately 10- 20 minutes by means of a temporary air hose connection.
 - It is critical that the terminal enclosure is never pressurized: isolate the air supply first and close the vent 10/20 seconds later.
 - Disconnect the air hose and seal the connections.

On occasion, the heater is not to be used for a long period of time but regular IR values are required to ensure the integrity of the heater at start-up.

In this case, EXHEAT recommends that a small core cable be attached to the each phase bus-bar/main cable connection point and brought outside the terminal enclosure so that IR

values can be taken without opening the terminal enclosure cover and allowing moisture to enter the terminal enclosure.

This can be done with a small diameter multi-core instrument cable and brought out of the terminal enclosure via a weatherproof gland in the gland plate.

Mark the individual cables so that accurate records can be taken and maintained.



Remove this cable and plug the cable entry hole with a suitably certified blanking plug before any power is applied to the heater.

Recovering insulation resistance

Once the IR value has reduced, there are no procedures that can guarantee to bring it back up to the levels that were present before despatch from EXHEAT. However, following the steps in the post installation preservation procedure can prevent further reduction of IR values and may in many cases increase the IR value of the heater. Invariably, the final IR value, will dependant on whether the moisture is in the terminal enclosure or inside the heating elements.

Failure to increase IR values

If the IR value continues to reduce, or does not increase to an acceptable level, we recommend the following tests are carried out:

- Conduct a full inspection of the heater terminal enclosure to ensure that the terminal enclosure is now sealed from atmospheric humidity. If not, seal the enclosure and follow the steps in the post installation preservation procedure.
- If it is considered that the enclosure is sealed, measure the IR level of each element. If any are found to be excessively low these can be disconnected, spares fitted and, if they are at a higher level, connected into the circuit.



There is a ceramic insulator fitted to the end of each element. Take extreme care to ensure that it is not disturbed, cracked or broken during this process. When replacing wires or connections to the ends of elements, fully tighten the ceramic retaining nut to prevent localised heating. Do not over tighten the nut as this can overstress the ceramic and cause it to break or crack.

All the above procedures can be carried out by EXHEAT site personnel if required. Relevant chargeable site rates prevail and can be provided upon request.

If the client elects to carry out the above procedures using other than EXHEAT personnel, it is the client's responsibility and they shall ensure that all hazardous area certification, safety requirements and regulations are fully complied with.

13. Additional requirements

'Dry' Process Fluids



The points contained in this section apply to heaters with 'dry' process fluids. They are important requirements that are additional to the other sections of this manual.

Some process fluids are considered 'dry', meaning that they are electrically inert and non-conductive. A dry fluid leaking through a perforation in the element sheath will not necessarily initiate an earth-fault trip, or show as low insulation resistance in the heating element.

For this reason, it is very important that you check the integrity of the element sheath as part of your routine maintenance checks. Refer to the maintenance instructions for more details.

Where possible, remove and replace a failed element before returning the heater to service. If this is not possible it may be acceptable to disconnect the failed element and suitably isolate it, provided that:

- EXHEAT agrees to and approves the proposed remedial action **prior** to carrying out the work.

Where the process fluid is gas:

- Take routine samples to check for leakage inside the terminal enclosure
- Sample the gas using an appropriate Ex certified reducer and stop end fitted to the terminal enclosure to assist with access.
- Follow all approved site operating procedures during sampling.

Corrosive Environment

The environment can be both the external environment and/or the process.

It is important any corrosive substance is removed from the heater when not in use.

High chromium steels, whilst having good corrosion resistance, require the surface to be free from contamination and washed with clean water in order to maintain the self passivating chromium rich oxide layer.

Appendix A. Heater datasheet

See Heater Manufacturing Data Book.

Appendix B. Check reports/certificates

Instructions for completing and submitting check reports and certificates

Complete and sign off all *Pre-Commissioning Check Records* as pre-commissioning progresses; one check report must be completed for each piece of equipment supplied. When pre-commissioning is complete, submit all *Pre-Commissioning Check Records* to EXHEAT for acceptance.

Check all load resistance, insulation resistance and trip settings at the commissioning stage. Record the results on the appropriate *Commissioning Check Record*. When commissioning is complete, submit all *Commissioning Check Records* to EXHEAT for acceptance.

If the equipment is to be stored between completion of commissioning activities and start-up, refer to the appropriate preservation and requirements in this manual. Record all test results on the appropriate *Storage Preservation Check Record*.

When the equipment is ready for start-up, complete the *Equipment Start-Up Certificate* and submit it to EXHEAT for acceptance.



If Section 13 specifies additional requirements for all or some of the heaters, carry out the additional preventative maintenance checks included on the Routine Maintenance Check Record.

Carry out all routine maintenance activities at the intervals determined by the *Routine Maintenance Check Record*. These records must be completed, signed off and submitted to EXHEAT for acceptance if requested.

Check records/certificates can either be e-mailed to commissioning@exheat.com marked for the attention of the After Sales Department.



Forms shall be completed and registered with EXHEAT to continue the equipment warranty and, the Hazardous Area Certification. Failure to do so may potentially result in warranty becoming void.

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STORAGE / PRESERVATION CHECK RECORD

Electric Heater/ Control Panel



Tag No	
Description	
PO No	
Reference No	
Goods Despatch date:	
Expected Installed Date:	
Expected Commissioning Date:	

Date	Storage Temp	Storage Humidity	Check Form SPC-01 completed?	ACH Energised Date	Dessicant Bags Changed Date	Signed	Print
			(YES/NO)				
			(YES/NO)				
			(YES/NO)				
			(YES/NO)				
			(YES/NO)				
			(YES/NO)				
			(YES/NO)				
			(YES/NO)				
			(YES/NO)				
			(YES/NO)				
			(YES/NO)				
			(YES/NO)				
			(YES/NO)				

Carry out the inspection in accordance with relevant codes of practice concerning inspection and maintenance of electrical installations in non-hazardous or hazardous areas whichever is applicable.

Verified	Fabrication/ Construction	Hook-Up/ Commissioning	EXHEAT Ltd
Name			
Signature			
Date			

STORAGE / PRESERVATION CHECK

Electric Heater/ Control Panel



Tag No	
Description	
PO No	
Reference No	
Goods Despatch date:	
Expected Installed Date:	
Expected Commissioning Date:	

	Inspection Checklist	Status Codes	Name	Date	Comment
	<u>ELECTRIC HEATER</u>				
01	Ensure the heater is not stored in direct sunlight				
02	Ensure the heater is stored indoors in a regulated environment				
03	Check overall physical condition of the heater/packaging for any sign of damage.				
04	Check that Terminal enclosures are undamaged				
05	Review any previous documentation. If any recommendations were noted on the previous documentation, have they been implemented?				
06	Check the storage environment and record the details on the Storage / Preservation Check Record (SPCR-01)				
07	Check the ACH Status and record details on the Storage / Preservation Check Record (SPCR-01)				
08	If desiccant bags have been changed, record the date on the Storage / Preservation Check Record (SPCR-01)				
09	Check the heater insulation resistance and record readings on Form IR-H01				
10	Check Heater load resistance values and record on form LR-02				
	<u>CONTROL PANEL</u> Note! If Control Panel is supplied with Heater, ensure Panel is in the same storage condition as the heater,				
01	Ensure the Panel is not stored in direct sunlight				
02	Ensure the Panel is stored indoors in a regulated environment				
03	Check overall physical condition of the panel/packaging for any sign of damage.				
04	Check that enclosures are undamaged				
05	Review any previous documentation. If any recommendations were noted on the previous documentation, have they been implemented?				
06	Check the storage environment and record the details on the Storage / Preservation Check Record (SPCR-01)				
07	Check the ACH Status and record details on the Storage / Preservation Check Record (SPCR-01)				
08	If desiccant bags have been changed, record the date on the Storage / Preservation Check Record (SPCR-01)				
09	Check the control panel insulation resistance and record readings on Form IR-P01				

Carry out the inspection in accordance with relevant codes of practice concerning inspection and maintenance of electrical installations in non-hazardous or hazardous areas whichever is applicable.

Verified	Fabrication/ Construction	Hook-Up/ Commissioning	EXHEAT Ltd
Name			
Signature			
Date			

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PRE-COMMISSIONING CHECK RECORD

Electric Heater



Tag No	
Description	
PO No	
Reference No	

Inspection Checklist	Status Codes	Name	Date	Comment
01	Check overall physical condition of the heater for any signs of damage.			
02	Check that terminal enclosures are undamaged			
03	Check that the heater conforms to contract drawings (refer to the schedule provided within Appendix A of the contract IOM)			
04	Check that all fasteners, glands and stoppers are complete, tight and conform to the correct specification for use in a hazardous area (if applicable).			
05	Check that there is no dirt, debris, loose items or moisture within the terminal enclosure.			
06	Check that earthing is complete and satisfactory			
07	Check that enclosure gaskets are undamaged and fit correctly			
08	Check that all electrical connections are tight including any spare unused terminals			
09	Check that creepage and clearance distances are correct.			
10	Check that there is no obvious damage to internal wiring.			
11	Check that the apparatus is adequately protected against corrosion, the weather, vibration and any other adverse factors.			
12	Check that guards, where required, are present and correctly located.			
13	Check flame paths are undamaged.			
14	Check the heater insulation resistance and record readings on form IR-H01			
15	Check all labels and tags are present, secure and correctly marked.			
16	Check heater and instrument enclosure covers are closed and all fasteners are fitted, tight and of the correct type			
17	Check all trip devices are set and functioning correctly; (record set-points on form TR-02)			
18	Earth leakage system in place and set points checked (record set-points on form TR-02)			

Carry out the inspection in accordance with relevant codes of practice concerning inspection and maintenance of electrical installations in non-hazardous or hazardous areas whichever is applicable.

Verified	Fabrication/ Construction	Hook-Up/ Commissioning	EXHEAT Ltd
Name			
Signature			
Date			

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PRE-COMMISSIONING CHECK RECORD

Control Panel



Tag No	
Description	
PO No	
Reference No	

Inspection Checklist	Status Codes	Name	Date	Comment
01				Check the control panel for any signs of damage.
02				Check that the control panel has been mounted correctly in particular that it is square, rigid and there is no bowing of doors. Doors should close and lock easily. Oil noisy hinges as required.
03				Check that the control panel conforms to contract drawings (refer to the schedule provided within Appendix A of the contract IOM) List drawings and revisions used in Comment column.
04				check that all external glands and connections are complete, tight and conform to the correct specification for use in a hazardous area (if applicable)
05				Check that where any interconnections have been made between cubicles during installation that no cables have become trapped or damaged.
06				Check that there is no dirt, debris, loose items or moisture within the control panel enclosure
07				Check that earthing is complete and satisfactory
08				Check that enclosure gaskets are undamaged and fit correctly
09				Check for 50% of the main electrical connections are at the specific torque value of the contract document. If any are found to be loose, then a further 100% should be checked
10				Check that creepage and clearance distances are correct.
11				Check that there is no obvious damage to internal wiring.
12				Check that any fans and filters are free of debris and that the fans can spin freely.
13				Check flame paths are undamaged.
14				Check that guards, where fitted, are present and correctly located
15				Check all door locks operate correctly and any isolation interlocks with the panel doors operate.
16				Check the control panel insulation resistance and record readings on form IR-P01
17				Check all labels and tags present, secure and correctly marked
18				Check all trip devices including internal thermostats are set and functioning correctly; record set-points on form TR-02

Carry out the inspection in accordance with relevant codes of practice concerning inspection and maintenance of electrical installations in non-hazardous or hazardous areas whichever is applicable.

Verified	Fabrication/ Construction	Hook-Up/ Commissioning	EXHEAT Ltd
Name			
Signature			
Date			

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CHECK RECORD
 Insulation Resistance
 Electric Heater



Tag No													
Description													
PO No													
Reference No													
	Insulation Resistance M.ohm											Megger Test Date	Comments
	Stage to Stage								Phase to Earth				
Stage	1	2	3	4	5	6	7	8	L1	L2	L3		
1	■												
2		■											
3			■										
4				■									
5					■								
6						■							
7							■						
8								■					
Verified	Fabrication/ Construction								Hook-Up/ Commissioning			EXHEAT Ltd	
Name													
Signature													
Date													

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CHECK RECORD
 Load Resistance
 Electric Heater



Tag No								
Description								
PO No								
Reference No								
	Load Resistance (ohm)						Test Date	Comments
Stage	L1-L2	L1-L3	L2-L3	L1-N	L2-N	L3-N		
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
Verified	Fabrication/ Construction			Hook-Up/ Commissioning			EXHEAT Ltd	
Name								
Signature								
Date								

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COMMISSIONING CHECK RECORD

Control Panel



Tag No	
Description	
PO No	
Reference No	

Inspection Checklist	Status Codes	Name	Date	Comment
01				Ensure all pre-commissioning checks have been carried out.
02				Carry out a full function test on the control panel; in accordance with the Control Panel Test Procedure provided within the manufacturing data book <u>OR</u> listed in Appendix A of the contract IOM) List drawings and document revisions used in Comment column. A completed Control Panel Test Procedure must be returned with the check lists.

Carry out the inspection in accordance with relevant codes of practice concerning inspection and maintenance of electrical installations in non-hazardous or hazardous areas whichever is applicable.

Verified	Fabrication/ Construction	Hook-Up/ Commissioning	EXHEAT Ltd
Name			
Signature			
Date			

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COMMISSIONING CHECK RECORD

Trip Settings



Tag No	
Description	
PO No	
Reference No	

See IOM: Appendix D for Overtemperature Trip Setting Procedure.

Inspection Checklist	Tag Number	Status / Verified Trip Setpoint	Name	Date	Comment
01 Check all temperature sensors and transmitters are correctly located, undamaged and functioning correctly.					
02 Check temperature trip set points and record details below.					
03 Check earth leakage trip time and record details below:					
04 Item Description:					
05 Item Description:					
06 Item Description:					
07 Item Description:					
08 Item Description:					
09 Item Description:					
10 Item Description:					
11 Item Description:					
12 Item Description:					
13 Item Description:					

Carry out the inspection in accordance with relevant codes of practice concerning inspection and maintenance of electrical installations in non-hazardous or hazardous areas whichever is applicable.

Verified	Fabrication/ Construction	Hook-Up/ Commissioning	EXHEAT Ltd
Name			
Signature			
Date			

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INITIAL EQUIPMENT START-UP CERTIFICATE



Tag No	
Description	
PO No	
Reference No	

Inspection Checklist	Sign	Name	Date	Comment
01 Pre-commissioning & Commissioning records as per Appendix B of the Installation, Operation and Maintenance Manual completed and submitted to EXHEAT Limited for acceptance no later than 21 days after completion of commissioning.				Date of commissioning Completion to be recorded below:
02 Storage Preservation Check Records as per Appendix B of the Installation, Operation and Maintenance Manual completed and submitted to EXHEAT Limited for acceptance no later than 21 days after completion of commissioning.				
03 Routine Maintenance records as required under Section 8 of the Installation, Operation and Maintenance Manual are complete and available (to be submitted to EXHEAT upon request).				
04 Any Post-Installation Preservation checks as required by EXHEAT Installation, Operation and Maintenance Manual between completion of commissioning and Start-up has been completed and recorded (to be submitted to EXHEAT upon request).				Date of Installation to be recorded below:
05 All equipment checked to ensure that all applicable Special Conditions for Safe Use have been complied with.				
06 Confirm that the correct process flow is available.				
07 Equipment ready for Start-Up				

A completed certificate is required for each piece of equipment

It is a warranty requirement that all commissioning check lists and test reports are completed by Contractor and signed off during commissioning and e-mailed to commissioning@exheat.com for acceptance.

No claim under the equipment warranty will be accepted if Commissioning & Preservation Forms and this Equipment Start-Up Certificate have not been provided and accepted by EXHEAT Ltd prior to any claim.

Verified	Commissioning / Start-Up Contractor	EXHEAT Ltd
Name		
Signature		
Date		

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ROUTINE MAINTENANCE CHECK RECORD

Electric Heater



Tag No	
Description	
PO No	
Reference No	

	Inspection Checklist	Status Codes	Name	Date	Comment
	3 Monthly Checks				
01	Check equipment for external damage				
	6 Monthly Checks (in addition to 3 Monthly Checks)				
01	Check that there is no dirt, debris, loose items or moisture within the terminal enclosure				
02	Check that all electrical connections are undamaged and tight including any spare unused terminals.				
03	Check the heater insulation resistance and record readings on form IR-H01				
04	Check that enclosure gaskets are undamaged and fit correctly				
05	Check flame paths are undamaged				
06	Check that earth conductors are correctly fitted and undamaged				
07	Check heater and instrument enclosure covers are closed and all fasteners are fitted, tight and of the correct type				
08	Check all trip devices are set and functioning correctly; record set-points on form TR-02				
	12 Monthly Checks (in addition to 3 & 6 Monthly Checks)				
01	Check heater load resistance values and record on form LR-02				
	24 Monthly Checks (in addition to 3, 6 & 12 Monthly Checks)				
01	If Equipment falls within Section 13 of the IOM, under the 'Dry' fluid process immersion Heater, please contact EXHEAT Ltd for recommended procedures for maintenance check.				

NOTE: Routine Maintenance Check Record is necessary to be completed as part of Post-Installation Preservation Check where the equipment is not put into service 3 months between from the Date of Installation and/or commissioning.

Carry out the inspection in accordance with relevant codes of practice concerning inspection and maintenance of electrical installations in non-hazardous or hazardous areas whichever is applicable.

Verified	Fabrication/ Construction	Hook-Up/ Commissioning	EXHEAT Ltd
Name			
Signature			
Date			

ROUTINE MAINTENANCE CHECK RECORD

Control Panel



Tag No	
Description	
PO No	
Reference No	

	Inspection Checklist	Status Codes	Name	Date	Comment
	3 Monthly Checks				
01	Check equipment for external damage				
	6 Monthly Checks (in addition to 3 Monthly Checks)				
02	Check that there is no dirt, debris, loose items or moisture within the control panel enclosure.				
03	Clean out dirt from filters where fitted and check correct operation of cooling fans.				
04	Check for 50% of the main electrical connections are at the specific torque value of the contract document. If any are found to be loose, then a further 100% should be checked				
05	Check the control panel insulation resistance and record readings on form IR-P01				
06	Check flame paths are undamaged.				
07	Check that enclosure gaskets are undamaged and fit correctly				
08	Check that earth conductors are correctly fitted and undamaged				
09	Check all trip devices including internal thermostats are set and functioning correctly; record set-points on form TR-02				
10	check that all external glands and connections are complete, tight and conform to the correct specification for use in a hazardous area (if applicable)				
	12th Monthly Check (In addition to 3 monthly and 6 monthly checks)				
02	Contactors to be checked for flamepath contact points				
03	Check MCCB (if applicable)				
04	ACBs Electronic Trip Unit (ETU) be tested yearly for correct function (if applicable)				

NOTE: Routine Maintenance Check Record is necessary to be completed as part of Post-Installation Preservation Check where the equipment is not put into service 3 months between from the Date of Installation and/or commissioning.

Inspection must be carried out in accordance with relevant codes of practice concerning inspection and maintenance of electrical installations in non-hazardous or hazardous areas whichever is applicable.

Verified	Fabrication/ Construction	Hook-Up/ Commissioning	EXHEAT Ltd
Name			
Signature			
Date			

Appendix C. Setting over-temperature trip devices

Scope

This procedure applies to setting over-temperature trip devices used in protection circuits of all Ex e heaters manufactured by the company.

Failure to comply with this procedure will nullify all certification supplied and issued for use of equipment in hazardous areas.

Procedure

- Ensure that all test equipment is within its calibration period prior to use.
- Ensure that all over-temperature sensors and transmitters (where fitted) are correctly located, undamaged and functional.
- Adjust the trip controller device upscale well above the required trip temperature.
- Using a sensor signal simulator/injector connected in place of the over-temperature sensor, increase the output to correspond to the required trip temperature.
- Adjust the trip controller device downscale until it just trips.
- Verify the setting by adjusting the simulator/injector output well below the trip temperature and then gradually increase the output until the trip controller device operates.
- If this trip occurs outside a tolerance band of $+5^{\circ}\text{C}$, adjust as necessary and repeat the previous step to check.
- When the verification is successful, re-connect the over-temperature sensor.
- Repeat the procedure for each over-temperature trip controller device.
- When all over-temperature trip controller devices are set, ensure that the terminal enclosure covers are re-fitted.
- Ensure that enclosures containing trip controller devices are locked using a key or special tool.



www.exheat.com/iom

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Third Edition (February 2014)

Refer to EXHEAT website for latest edition

3-B GAS ODORIZER WITH POSITIVE ACTION INDICATOR GAUGE (300 PSIG)

2014 INFORMATION MANUAL

Natpro

CRN # L3956.52

SUBMITTED BY:



TANSLEY ASSOCIATES
ENVIRONMENTAL SCIENCES

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Submitted on: September 11, 2014



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2 Safety Precautions

The Tansley Associates Environmental Sciences bypass odorizer you have purchased has been designed and built to give years of dependable service. But like many things you buy, it has to be installed with care and properly maintained. Please read and understand all of the written material shipped with this odorizer. If you have any questions, call one of our qualified staff members at 1(888) 213-5838.

SAFETY PRECAUTIONS

There are certain precautions which must be taken when dealing with any piece of equipment. These odorizers, when properly used and maintained, safeguard people and property against fires, possible asphyxiations, explosions, etc. by warning them of the presence of natural gas.

Below are precautions recommended you take to protect everyone and everything around the odorizer. If you confront a problem not mentioned below, we would appreciate immediate communication. This will allow us to help you, our valued customer.

- ❑ Is the odorizer you are installing the proper size for your service? If it is too small, it may not odorize the gas sufficiently. If it is too large, reading the amount of odorant being used may be difficult or you may over-odorize. If you are not certain, stop right now and check.
- ❑ "B" Series odorizers are used for flow rates up to eight million standard cubic feet per hour (SCFH) based on an absorption rate of 2.0 lbs of odorant per mmscf gas.
- ❑ For the "B" Series odorizers a small amount of the mainstream natural gas is bypassed though the odorizing unit. Odorant laden gas is returned to the mainstream where it then mixes with the un-odorized gas. The illustration below (odorizer installation schematic) shows that an orifice (a partially-closed gate valve, or even a slightly closed full port ball valve) installed in the gas main can provide the differential pressure required to operate the odorizer. For the average installation a maximum differential pressure of 30" to 80" of column water is sufficient to operate all "B" Series odorizers at their rated capacities. For calculating a closer estimate of the differential pressure needed versus the appropriate precision control valve setting for your particular service contact Tansley Associates. Note: precision valve control can be lost if the differential is too high or if the odorizer is too large for the application. Once the proper differential



pressure is established, the desired intensity of odor is fine tuned by adjustments of the precision control valve.

- Dual bypass odorant installations allow for continuous odorization while completing a fill or maintenance on an operating gas odorization system.
- Before installing an odorizer, or any part connected to it, read the directions. If you cannot find any directions or do not understand the directions provided, contact Tansley Associates. Comply with all of your company's safety rules along with all local, county or parish, state, provincial, national, and/or international laws which apply, such as CSA, OSHA, EPA, DOT, TC, etc.
- Before installing an odorizer or any part thereof, inspect everything involved very thoroughly to make sure all is in order and all bolts and connections are secure.
- Every precaution, including but not limited to, elevation of the in/out connections above the main pipeline, should be taken to insure that both liquids and solids are removed and prevented from entering the odorizer. Solids can restrict or plug small orifices and openings, thereby preventing odorization. Liquids can settle on top of, or below, the surface or even mix with the odorant causing "masking" and/or "blinding off", or saturation of wicks, preventing or reducing odorization of the gas. Every odorizer should be checked frequently to see if this has occurred. If it has, the odorizer must be evacuated of all liquid, new wicks installed, and the odorizer recharged with fresh odorant. A liquid knock out pot may be required if you anticipate wet gas or signs of wet gas appear during odorant audits.
- The wicks should be inspected and changed on a regular basis. If plugging of the precision control valve occurs, and it cannot be cleared or cleaned out, the precision valve should be replaced following all appropriate safety guidelines. (OSHA, EPA, CSA, etc...)
- Once the odorizer has been properly piped into the bypass line and the Positive Action Indicator has been screwed on securely following the supplied directions, a nitrogen pressure test should be performed. A thorough nitrogen purge is one way to do it. As pressure builds in the odorizer, all possible places where gas could escape should be checked using soapy water. If a leak is found, close the isolation valves connecting the odorizer to the main line. Then, vent all the gas from the bypass portion, according to proper safety procedures, via a flare specifically designed for the purpose, until there is no pressure in the odorizer. Fix the leak, or leaks, then repeat the process until no leaks can be found.
- At least once a month, each odorizer should be checked for leaks using soapy water. If any leaks are found they should be fixed immediately, following all safety rules.
- Tansley Associates Environmental Sciences' experience dictates that each odorant station be protected from tampering and vandalism. Caution or danger signs should be posted.



3 Model Specifications: 3-B Small Tap Odorizer

INCLUDED EQUIPMENT

- 3-B odorant vessel
- Positive Action Indicator level gauge

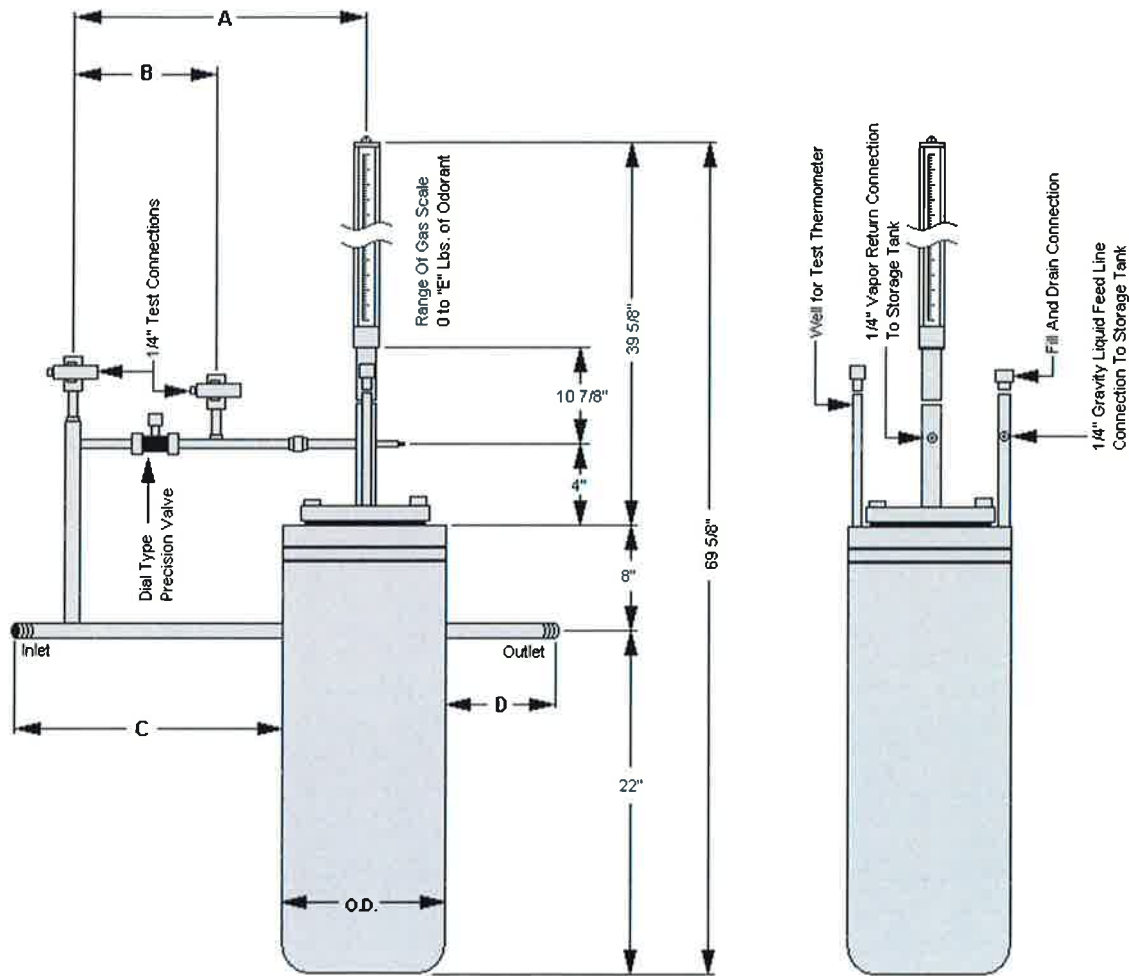
SPECIFICATIONS FOR THE 3-B ODORIZER

- ✓ Absorption by-pass odorant system
- ✓ Applicable provincial CRN included
- ✓ Design: 300 PSIG
- ✓ Maximum reservoir capacity: 95 lbs (Fill to 80% → 76 lbs Scentinel® S-20)
- ✓ Approximate shipping weight: 260 lbs
- ✓ MAWP: 300 PSI at maximum temperature 66°C
- ✓ MDMT: -49°F at 300 PSI
- ✓ Hydrotested at 450 PSI
- ✓ Two – ¼" test/vent valves
- ✓ Thermometer well for gas temperature measurements
- ✓ NPT 1" threaded fill and drain connections
- ✓ NPT 1" threaded positive action indicator connection
- ✓ NPT ¼" threaded connection for storage tank feed and drain connections
- ✓ Radiographic testing: 100% per ASME Code (both girth seams are 100% radiographed)
- ✓ Joint efficiency: 100%
- ✓ External surface prep: Commercial blast
- ✓ Prime: Self priming
- ✓ Paint: Wilko 456.12 black top water repellent coating (Siliconized asphalt coating)
- ✓ Type of gaskets used: Non asbestos composite
- ✓ Vessel body fabricated from SA-106-B
- ✓ Weld caps and ells fabricated from SA-234-WPB
- ✓ Coupling fabricated from SA-105
- ✓ Bolts and nuts from SA-193 B7
- ✓ Structural from SA-36
- ✓ Heads and pressure retaining plates from SA-516-70N
- ✓ Outer diameter: 406.4 mm
- ✓ Length of vessel without positive action indicator: 1140 cm
- ✓ Length of vessel with positive action indicator: 1768 cm



- ✓ Units come equipped with a leak-proof positive action indicator gauge (Note: This is custom to our units and is designed to prevent odorant leaks by eliminating the need for gaskets in the level gauge)
- ✓ 1" NPT threaded positive action indicator connection

4 Odorizer Dimensions



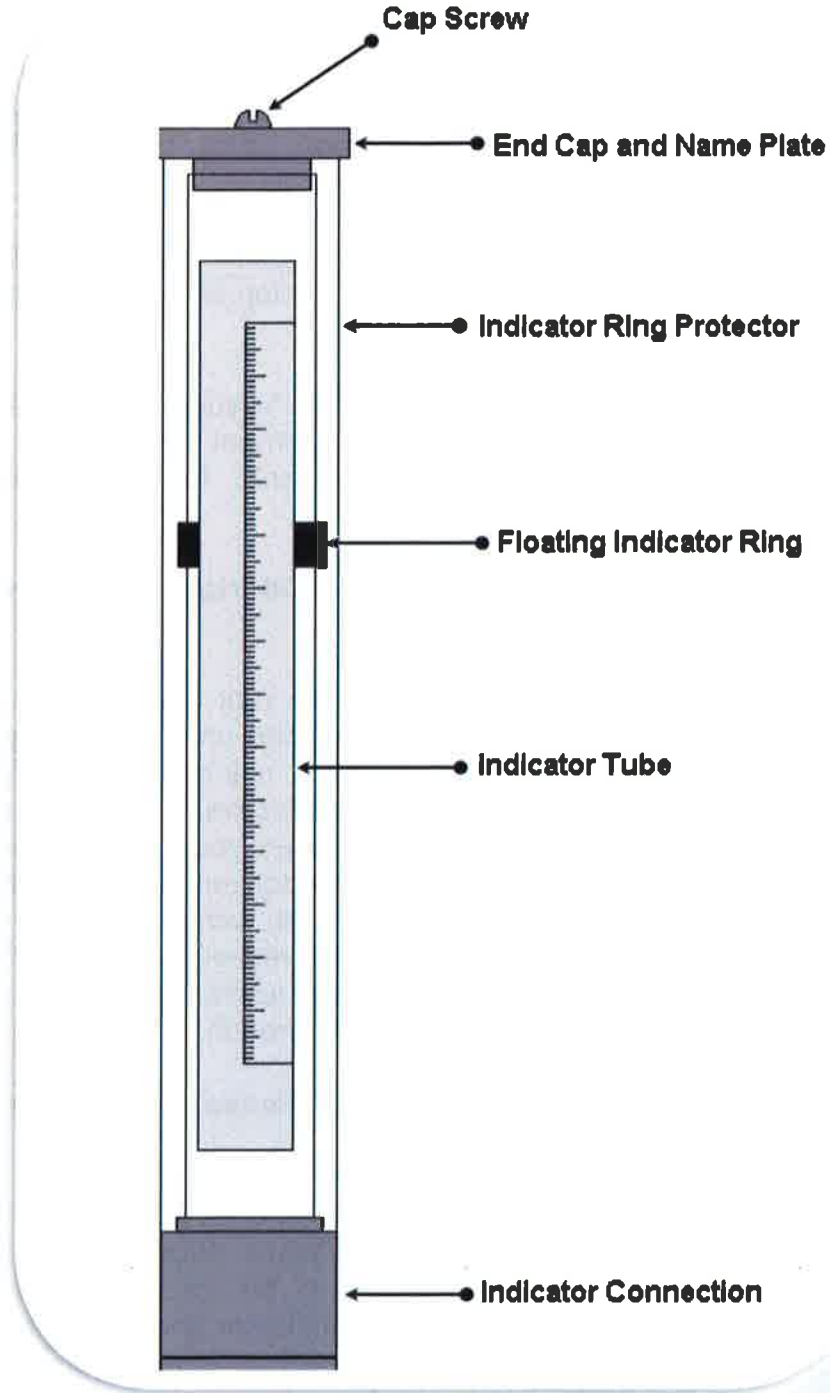
ODORIZER DIMENSIONS (See Diagram)

MODEL	3-B
O.D.	16" (40.64 cm)
A	12-1/4" (31.12 cm)
B	6" (15.24 cm)



C	4-1/2" (11.43 cm)
D	3" (7.62 cm)
E	95
INLET & OUTLET SIZE	1" NPT

5 Positive Action Indicator Schematic





6 Positive Action Indicator Installation

Tansley Associates Environmental Sciences' 'Positive Action Indicator' is a sealed unit (no leak) assembly designed and manufactured to replace the tubular glass design furnished with all "B" series odorizers and storage tanks marketed by Tansley Associates Environmental Sciences.

The only open connection on the Positive Action Indicator is the 1"-3000# NPT connection that screws directly onto the 1" NPT riser on top of the "B" series odorizers and storage tanks.

The Positive Action Indicator may have been furnished to you for installation on your new odorizer, new odorant storage tank or as a replacement assembly for installation on an existing "B" series odorizer or odorant storage tank. For installation, read the following.

Instructions for Installation on a New "B" Series Odorizer or Odorant Storage Tank

Your Positive Action Indicator was shipped to you with your new odorizer or storage tank protected inside a plastic pipe sleeve with a cap glued onto it. When you remove the Positive Action Indicator from the plastic pipe sleeve, it is now necessary for you to go to the odorizer or tank and remove the temporary protective pipe extension on the 1" riser and discard it. Upon removing this protective cover, you will find a stem $\frac{3}{16}$ " in diameter protruding above the 1" NPT pipe on the odorizer or tank. This stem is connected to a float inside the vessel which rises or drops, with a change in liquid level. Using Teflon tape, coat the 1" NPT male threads on the vessel riser. (DO NOT tape the 1" NPT female threads on the indicator assembly) Now, screw the indicator connection on the vessel connection and tighten with an 18" Stilon Wrench.

Instructions for Installation on an Existing "B" Series Odorizer or Odorant Storage Tank

Your new Positive Action Indicator was shipped to you as a replacement for an existing Level Indicator Assembly. You received the new indicator packaged inside a plastic pipe sleeve with a cap glued onto it. It is necessary for you to depressurize your existing odorizer or tank, screw off the existing level indicator and seal it in an air tight container. Now that the old level indicator is off, you will observe a stem about $\frac{3}{16}$ " in diameter protruding above the 1" NPT pipe on the odorizer or tank. This stem is connected to a float inside the vessel which rises or drops, with a change in liquid level. Using teflon tape coat the 1" NPT male threads on the vessel riser. (DO NOT tape the 1" NPT female threads on the indicator assembly) Now, screw the indicator connection on the vessel connection and tighten with an 18" Stilon Wrench.



Important**The floating indicator ring should have energized with the power capsule inside the indicator when you inserted the float stem inside the indicator body. If the vessel is new and does not have any fluids inside, the energized floating ring should be positioned about 2" above the 1" NPT indicator connection. If you are replacing an existing indicator on a vessel that is charged with some fluid, the floating ring will be at a much higher level indicating that the float inside has elevated the float stem.

If the floating indicator ring **DID NOT** energize with the power capsule inside the indicator tube, in either of the above installation procedures, then you must lift the ring with your fingers until you feel it lock into the power capsule field. This position should be approximately 2" above the bottom of the indicator tube to the top of the tube depending on the fluid level inside the vessel. Once you are satisfied the power capsule has control over the floating ring, you can re-assemble the Indicator Ring Protector, the End Cap, the Nameplate, and the Cap Screw. Once this is completed, you can read the level of the fluid inside the vessel.

This completes the Positive Action Indicator installation and you will find that as you add fluid to your odorizer storage tank, the floating indicator ring will rise as does the fluid level.

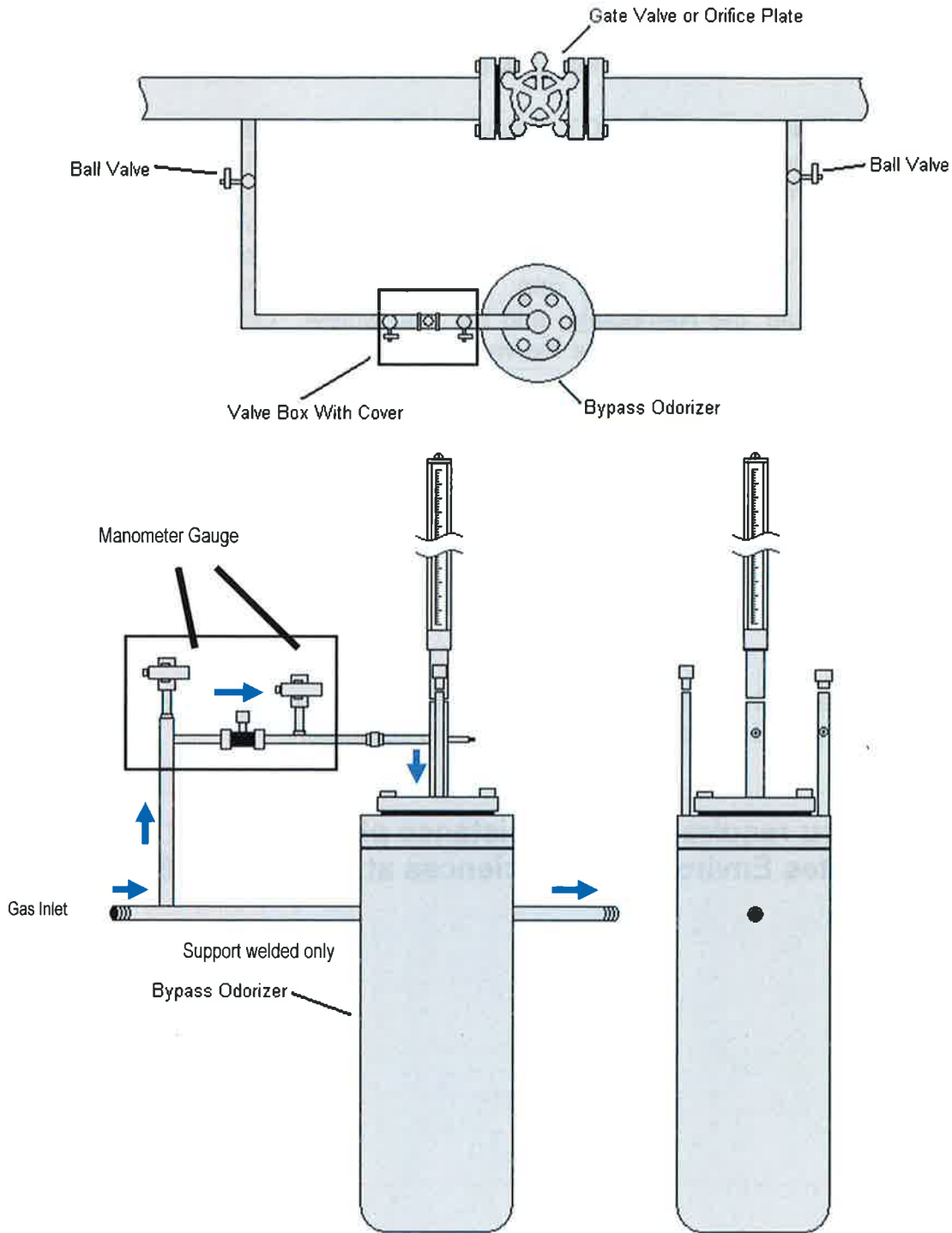
Caution** Be very careful not to overfill the odorizer tank as this will cause the odorant to spill and the odor is not easily removable. In the event that a spill does occur, contact Tansley Associates Environmental Sciences and we will assist with the cleanup.

Also, when you are finished with the installation and filling procedure, use the protective pipe with cap as an added measure of safety for this equipment.

****Should you require further assistance please contact Tansley Associates Environmental Sciences at 1(888) 213-5838.****



7 Odorizer Installation Schematic





8 References for Installation





9 Fill Procedures

- Requirements prior to site entry:**
- 1) Two technicians on deliveries.
 - 2) Masking agent on site.
 - 3) Clean hoses in good condition.

- Equipment required:**
- 1) Fire extinguisher
 - 2) Personal protective equipment
 - 3) 150lb relief valve
 - 4) Spill response equipment
 - 5) Recovery drum filled with charcoal
 - 6) Safety manual and operational procedures on-site

Specifications for Measuring:

- 1) Utilize customers vessel capacity specification charts
- 2) Dip the vessel with a tape measure
- 3) Read and record centimeters of odorant present in vessel
- 4) Calculate volume required to 80% of vessel capacity

Operational Procedures for Small Tap Fill:

- 1) Notify client of entry into site and ask that everyone is aware that an odorant fill is to occur.
- 2) Walk around site and become oriented. Inspect the required fittings for an Odorant Intensity Audit.
- 3) On-site safety meeting and safety documentation completion.
- 4) Odorant utilization is discussed with client using data from previous visits.
- 5) Back trailer into position for odorant fill.
- 6) Block tires on truck and trailer.
- 7) Check manifold for leaks and ensure that odorant supply is off.
- 8) Check Small Tap for odorant leaks. Check that it is in good repair.
- 9) Check boiler and gas supply for leaks or potential future problem areas.
- 10) Have all hoses in position prior to hook-up. Hose connections covered with a cloth that has masking agent on it to prevent odorant vapor release.
- 11) Ensure all valves from odorant supply and manifold are closed.
- 12) Isolate Odorant loop from gas stream.
- 13) Tie in bleed hose to charcoal filter from loop.
- 14) Tie in small tap to odorant fill supply via manifold.
- 15) Cover connections with Masking Agent.
- 16) Person A monitors Small Tap gauge as it fills, while Person B operates the odorant supply.
- 17) Person B slowly turns on odorant supply.
- 18) Person A notifies B when odorant level is $\frac{3}{4}$ filled and then proceeds to call out level.
- 19) Small Tap is full.
- 20) Turn off odorant supply from cylinder and manifold.
- 21) Disconnect all hoses, covering connections with Masking Agent.
- 22) Turn on bypass loop to Small Tap.



10 Long Term Storage Procedure

Odorant equipment is best stored in original shipping container. Keep all piping sealed with end caps. Do not store odorant vessel where contaminants would be allowed to get into piping or any other part of the vessel.

11 Third Person Intensity Reporting

In addition to our small tap odorant fill services, Tansley Associates Environmental Sciences also provides a third party odor intensity audit service. Our technicians travel to your site and recharge your odorant storage tank and audit your gas stream at the end point to ensure that you meet the government standards for odorization.

The government requires that fuel gas be readily detectable at 1/5 the Lower Explosive Limit (LEL). An odorant intensity audit is the key to compliance with the Gas Code regulations. Tansley Associates Environmental Sciences suggests one audit during late spring and another audit mid winter filling is done in conjunction with the audits.

See the attached CSA Odorization Standards and an Odor Intensity Audit Report Form.



12 CSA Odorization Standards

Taken From:

**CSA Standard
Z662-11
Oil and Gas Pipeline Systems**

4.17 Odorization

4.17.1

Fuel gas that is to be delivered to customers through distribution lines or service lines, or to residences associated with a compressor station, and that does not naturally possess a distinctive odor to the extent that its presence in the atmosphere is readily detectable at all gas concentrations not less than one-fifth of the lower explosive limit, shall have an odorant added to it to make it so detectable, except that odorization shall not be necessary for such gas delivered for further processing or use where the odorant would serve no useful purpose as a warning agent. Fuel gas that is to be used within compressor stations shall be so odorized, or electronic gas detectors that set off an alarm at a gas concentration of one-fifth of the lower explosive limit or less shall be used.

4.17.2

In the concentrations at which they are used, odorants shall comply with the following:

- a) Odorants shall not be deleterious to persons or pipeline systems.
- b) The products of combustion from odorants shall not be toxic, corrosive, or harmful to those materials to which the products of combustion will be exposed.
- c) The odorants shall not be soluble in water to an extent greater than 2.5 parts per 100 parts by mass.

4.17.3

Equipment for odorization shall introduce the odorants without wide variations in the level of odorant.



13 Odor Intensity Audit Report Form


Tansley Assoc. Env. Sc. Office 403-569-8566, Fax 403-207-5110 #3 1470 28th st NE Calgary, AB		Odorization Recharge & Odor Intensity Audit Report			
		PO # :			
		Date :			
Company :		Contact person :			
Site location :		Contact number :			
Site location :		Site number :			
Site Name :		Odorant Type :			
Nearest Town :		Lot Number :			
Odorizer type :		Odorizer Information :			
Odorizer CRN # :					
Odorizer Serial # :					
Max Capacity :					
80% Capacity :					
Odorizer Recharge Record		Comments :			
Equipment Condition :	<input type="checkbox"/> Good <input type="checkbox"/> Satisfactory <input type="checkbox"/> Poor				
Any Leaks Noted :	<input type="checkbox"/> Yes <input type="checkbox"/> No				
Odorizer Recharge Amounts (in pounds)					
Previous Odorizer Reading :					
Present Odorizer Reading :					
Amount used :		Comments :			
Final Odorizer Reading :					
Amount Added :					
Previous Micro Valve setting :					
New Micro Valve setting :					
Temperature (°C) :		Not Detectable :	n-d	Readily Detectable :	r-d
Odor Intensity Audit Report		Weak :	w	Strong :	s
Threshold Levels	1 st	Comments :			
Gas/Air Ratio	2 nd				
Odor Levels at	1 st				
0.5% Gas/Air Ratio	2 nd				
Odor Levels at	1 st				
1.0% Gas/Air Ratio	2 nd				
Odorization System Suggested Action Required					
Recommended Action :					
Reasons for Action Suggested :					
Changes in gas flow/usage :	<input type="checkbox"/> Yes <input type="checkbox"/> No	Manometer values :	<input type="checkbox"/> High <input type="checkbox"/> Normal <input type="checkbox"/> Low		
Possible Liquid in mercaptan :	<input type="checkbox"/> Yes <input type="checkbox"/> No				
Site Operator Comments					
Additional Comments:					
Tansley Technician :		Plant Technician :			



14 Odorant Level Tracking

An important part of ensuring that your fuel gas is odorized to the code requirements is tracking the odorant usage. Changes in temperature and usage will affect the rate at which the odorant is consumed. Regularly checking the level of your odorant will allow you to arrange for fills before you run out.

The Positive Action Indicator included with Tansley Associates Environmental Sciences odorizers makes it easy to check levels at a glance. The following is sample of a simple tracking sheet that will allow you to easily monitor your odorant levels. Checking the level takes only moments to complete, it can easily be added in to any normal inspection routines.



TANSLEY ASSOCIATES
ENVIRONMENTAL SCIENCES

Odor Intensity Audit and Recharge Record

Spring / Summer Odor Audit

	2014	2015	2016	2017
March				
April				
May				
June				
July				
August				

Fall / Winter Odor Audit

	2014	2015	2016	2017
September				
October				
November				
December				
January				
February				

Marked box indicates compliance with (CSA Z662-11-Odorization)
Fuel gas must be readily detectable in the atmosphere at
one-fifth of the lower explosive limit.
Tansley Associates Environmental Sciences Inc.
1-888-213-5838 markt@tansleyaes.com



15 Initial Adjustment of Manatrol Flocontrol Valve

Procedure for the initial adjustment of the manatrol flocontrol valve used on bypass odorizers

The first step in determining the proper setting of manatrol flocontrol valve on the odorizer is to find the maximum volume of gas to be bypassed through the unit. This is done by using the following formula.

$$Q2 = \frac{Q1R}{VE}, \text{ where:}$$

Q1 = Maximum flow through pipeline or main (cu. ft. per hour – 8 oz. pressure base)

Q2 = Quantity of gas to be passed through odorizer (cu. ft. per hour – 8 oz. pressure base)

R = Odorization rate (pounds of odorant per million cu. ft. of flowing gas)

V = Solubility of odorant at operating pressure and temperature (pounds of odorant per million cubic feet of flowing gas). See chart below for Scentinel -20 odorant

E = Efficiency factor to be determined from experience for each installation. A factor of 0.80 may be assumed for the initial adjustment

Knowing the maximum volume of gas to be by-passed (Q2), the next step is to determine the coefficient of the flo-control valve by means of the formula given below:

$$C = \frac{Q2}{\sqrt{HP}}, \text{ where:}$$

C = Coefficient of flocontrol valve

P = Operating pressure in pounds per sq. inch absolute

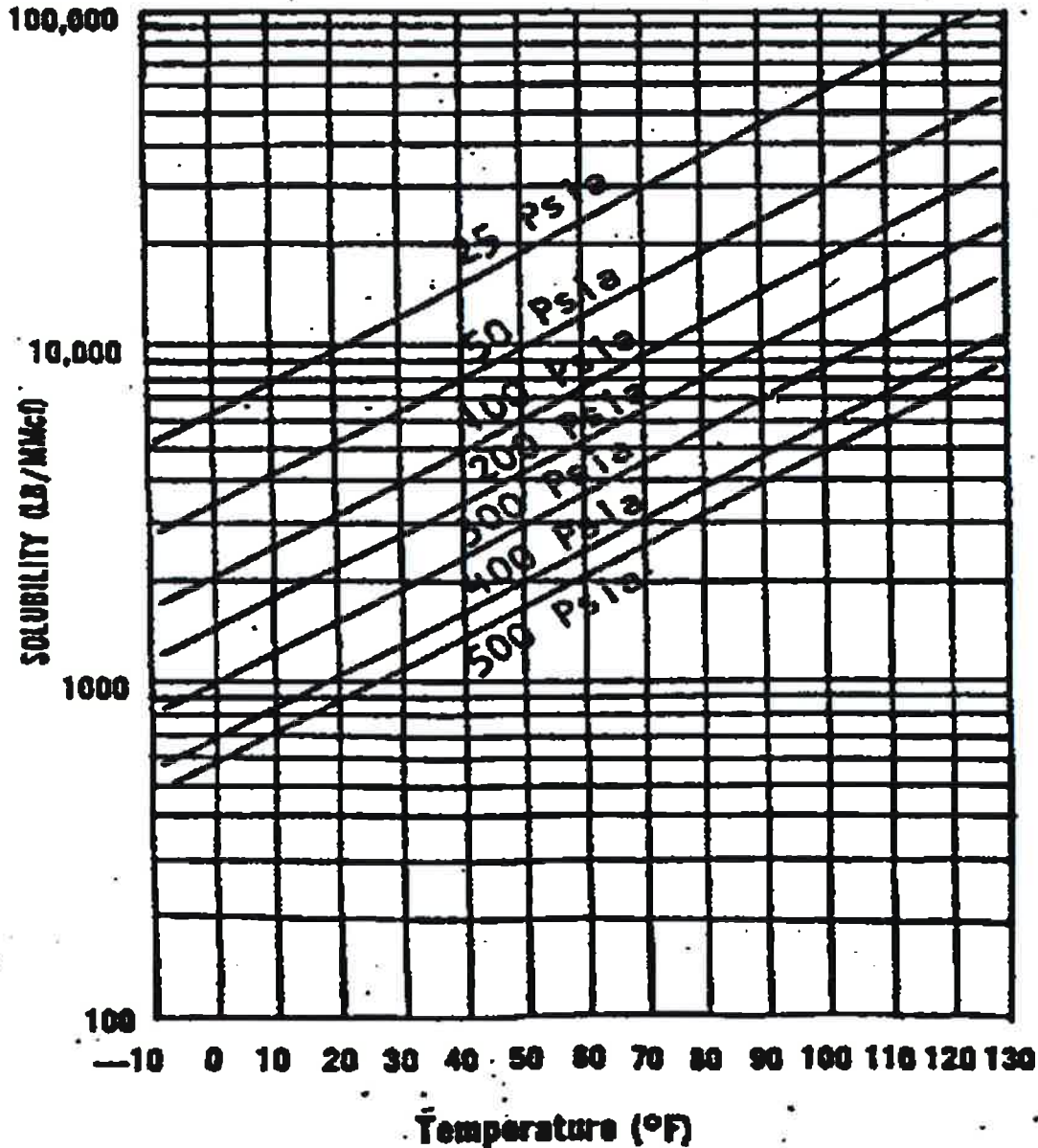
H = Differential pressure in inches of water across orifice plate or pinched valve in pipeline or main. A differential of 60" – 80" water is generally sufficient to operate all Tansley Associates bypass odorizers at their rated capacities.

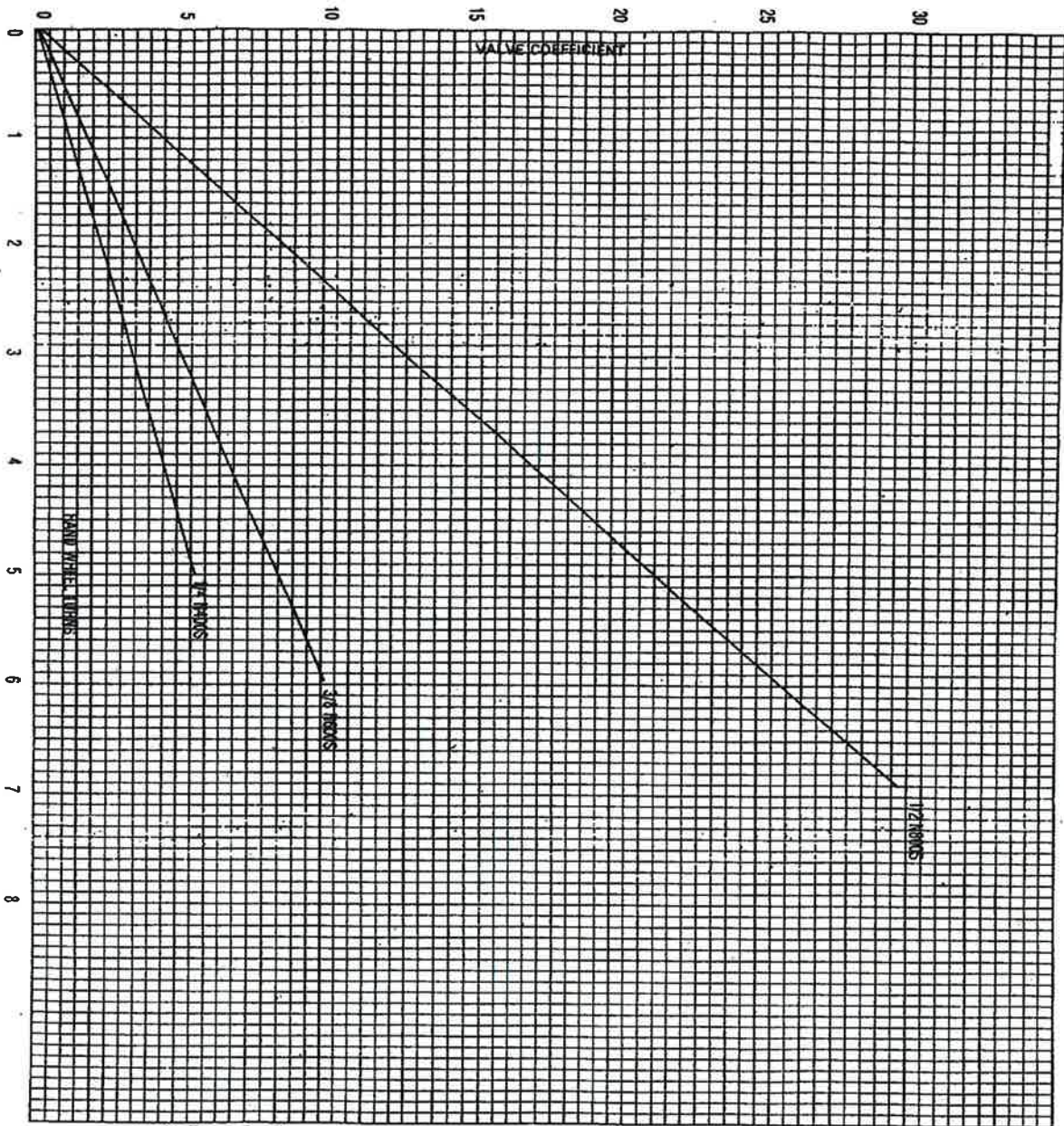
Once the coefficient is established, the proper setting of the valve is read off the chart on the back of this procedure.



IMPORTANT !

Use this method initially to find the approximate setting for the valve. After the unit has been in service for a sufficient length of time, the odorant quantity used compared to the quantity of gas flow used as well as odor audits should be the basis for making further adjustments until the desired results are obtained.







16 Manufacturer's Data Report

FORM U-1 MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS Natl. Bd. No. 14,031
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by King Tool Company, 208 South Avenue A, Longview, Texas 75604
(Name and address of Manufacturer)

2. Manufactured for Tansley Associates, #3, 1470 28th. St, NE, Calgary, AL T2A 7W6 Canada
(Name and address of Purchaser)

3. Location of installation For Export
(Name and address)

4. Type Vertical Odonizer 15,101
(Horizontal, vertical, or sphere) (Tank, separator, jkt. vessel, heat exch., etc.) (Manufacturer's serial number)
L3956.52 KTC-14567-T 14,031 2014
(CRN) (Drawing number) (National Board number) (Year built)

5. ASME Code, Section VIII, Div. 1 2013
[Edition and Addenda, if applicable (date)] (Code Case number) [Special service per UG-120(d)]

Items 6-11 incl. to be completed for single wall vessels, jackets of jacketed vessels, shell of heat exchangers, or chamber of multichamber vessels.

6. Shell: (a) Number of course(s) 1 (b) Overall length 1' 5-3/4"

Course(s)			Material	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B & C)			Heat Treatment	
No.	Diameter	Length	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time
1	16" OD	1' 5-3/4"	SA-106-B	.375	0	S			1	Full	1		

Body Flanges on Shells										Bolting			
No.	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Location	Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material	

7. Heads: (a) SA-516-70N (b) SA-516-70N
(Material spec. number, grade or type) (H.T. — time and temp.) (Material spec. number, grade or type) (H.T. — time and temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)	Bottom	.375	0			2:1					X	S		
(b)	Top	.375	0			2:1					X	S		

Body Flanges on Heads										Bolting			
	Location	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material	
(a)													
(b)													

8. Type of jacket _____ Jacket closure _____
(Describe as ogee and weld, bar, etc.)
 If bar, give dimensions _____ If bolted, describe or sketch.

9. MAWP 300 at max. temp. 150 Min. design metal temp. 49 at 300
(Internal) (External) (Internal) (External)

10. Impact test No UCS-66(b) at test temperature of _____
[Indicate yes or no and the component(s) impact tested]

11. Hydro., pneu., or comb. test pressure 450 Proof test N/A

Items 12 and 13 to be completed for tube sections.

12. Tubesheet [Stationary (material spec. no.)] [Diameter (subject to press.)] [Nominal thickness] [Corr. allow.] [Attachment (welded or bolted)]

[Floating (material spec. no.)] [Diameter] [Nominal thickness] [Corr. allow.] [Attachment]

13. Tubes [Material spec. no., grade or type] [O.D.] [Nominal thickness] [Number] [Type (straight or U)]

Mfg. Rep. JG
 Date 8/28/14
 Auth. Insp. Bg
 Date 8/28/14

FORM U-1 (Cont'd)

Items 14-18 incl. to be completed for inner chambers of jacketed vessels or channels of heat exchangers.

14. Shell: (a) No. of course(s) _____ (b) Overall length _____

Course(s)			Material	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B & C)			Heat Treatment	
No.	Diameter	Length	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time

Body Flanges on Shells													
No.	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Location	Bolting				
									Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material	

15. Heads: (a) _____ (Material spec. number, grade or type) (H.T. — time and temp.) (b) _____ (Material spec. number, grade or type) (H.T. — time and temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)														
(b)														

Body Flanges on Heads													
	Location	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Bolting				
									Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material	
(a)													
(b)													

16. MAWP _____ at max. temp. _____ Min. design metal temp. _____ at _____
(Internal) (External) (Internal) (External)

17. Impact test _____ at test temperature of _____
(Indicate yes or no and the component(s) impact tested)

18. Hydro., pneu., or comb. test pressure _____ Proof test _____

19. Nozzles, inspection, and safety valve openings:

Purpose (Inlet, Outlet, Drain, etc.)	No.	Diameter or Size	Type	Material		Nozzle Thickness		Reinforcement Material	Attachment Details		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
Inlet/Outlet	2	1"		SA-106-B		.18	0		UW-16.1(c)		
Fill & Drain	1	1"		SA-106-B		.18	0		UW-16.1(c)		
Handhole	1	6-5/8"		SA-516-70		1-1/4"	0		*		(b) Head
Others:	1	3/8"		SA-106-B		.13	0		UW-16.1(c)		
	3	3/4"		SA-105		6000	0		UW-16.1(y-1)		
	2	1/4"		SA-105		6000	0		UW-16.1(y-1)		

20. Supports: Skirt No Lugs 0 Legs 0 Others _____ Attached _____
(Yes or no) (Number) (Number) (Describe) (Where and how)

21. Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report (list the name of part, item number, Manufacturer's name, and identifying number):

22. Remarks _____
Safety UG-125. *Handhole complete with 6 cap bolts. Overpressure protection provided by system design per UG-140(b).
3-B 300# King Odorizer

FORM U-1 (Cont'd)

National Board No. 14,031
Mfg. Rep. 45 Date: 8/28/14
Auth. Insp. 29 Date: 8/28/14

CERTIFICATE OF SHOP COMPLIANCE

We certify that the statements in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1.

U Certificate of Authorization Number 3196 Expires 28-Feb-16
Date 8/28/14 Name King Tool Company Signed Jerry Combs
(Manufacturer) (Representative)

CERTIFICATE OF SHOP INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by The Hartford Steam Boiler Inspection and Insurance Company of Connecticut of Hartford, Connecticut

have inspected the pressure vessel described in this Manufacturer's Data Report on 8-28-14, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date 8/28/14 Signed [Signature] Commissions NB9778A, TX1136
(Authorized Inspector) (National Board (incl. endorsements))

CERTIFICATE OF FIELD ASSEMBLY COMPLIANCE

We certify that the statements in this report are correct and that the field assembly construction of all parts of this vessel conforms with the requirements of ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. U Certificate of Authorization Number _____ Expires _____

Date _____ Name _____ Signed _____
(Assembler) (Representative)

CERTIFICATE OF FIELD ASSEMBLY INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by _____

of _____, have compared the statements in this Manufacturer's Data Report with the described pressure vessel and state that parts referred to as data items _____, not included in the certificate of shop inspection, have been inspected by me and to the best of my knowledge and belief, the Manufacturer has constructed and assembled this pressure vessel in accordance with the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. The described vessel was inspected and subjected to a hydrostatic test of _____. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date _____ Signed _____ Commissions _____
(Authorized Inspector) (National Board (incl. endorsements))

14031

MANUFACTURED BY

CERTIFIED
BY

KingTool
COMPANY

R.P.

300

MT.

-49

°F @

300

NO.

15,101

DIA.

16 O.D.

BUILT:

2014

MODEL

3-R 000-1

NO.

14-567

NO.

13956.52

NOON

11

14-567
(S/N 15101)

4 Seps (9 800)
8-28-14
Zheentovsk



CHART NO. MC MP-1000-150F

Graphic Controls, Inc.

METER _____

CHART PUT ON _____

LOCATION _____

REMARKS _____

TAKEN OFF _____

10

9

8

7

6 AM

5

4

3

2

3

4

2

3

4

5



JONELL SERIES JVC GAS COALESCER INSTALLATION AND OPERATING INSTRUCTIONS

INSTALLATION AND START-UP:

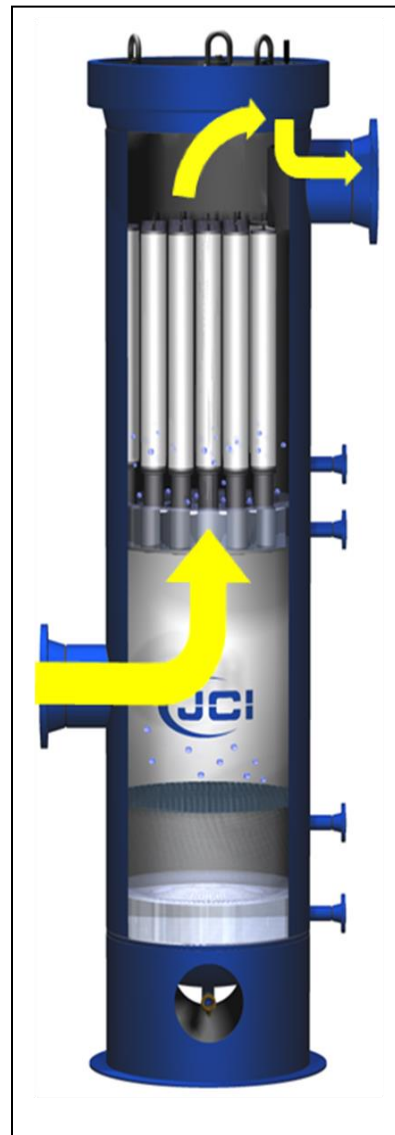
1. Check the JVC filter coalescer sketch and become well acquainted with correct flow configuration through the first and second stage.
2. Using the vessel's 'as built' general layout drawing, connect the vessel by the usual piping methods, observing proper inlet and outlet connections as marked on the drawing. Pipe all instrument connections on first and second stages independently. Level gauges, liquid level controllers, dump valves and drains should never be manifolded between first and second stages unless a check valve is used on each stage.
3. Use blind flanges or steel plugs for any openings not being used.
4. The filter vessel should be opened before start-up to ensure that all elements are installed correctly and secured using a rubber washer, metal washer and a double nut system. Ensure the nuts are tightened sufficiently but do not over-tighten.
5. Build up pressure in the vessel and check all connections for leaks.
6. Put the vessel on stream by slowly opening the inlet valve until the line pressure is reached, then slowly open the outlet.
7. Check the pressure drop across the elements to determine the initial pressure drop. Initial pressure drop should be low and typically not exceed 1 to 1.5 psi with clean and dry elements. Once the elements are wetted, depending on operating conditions, the clean pressure drop may reach 2 psi (or less).
8. Do not flow the filter coalescer in reverse. This may result in collapsing of the elements. Check with factory if any reverse flow is anticipated.
9. In normal service, the recommended element change-out interval is once every 12 months or earlier. If excessive solids are present, this may necessitate a more frequent change-out based on differential pressure of 10-12 psi.

ELEMENT CHANGE-OUT:

1. Open the vessel access closure and undo the element nuts and remove washers.

2. Remove each element from its carrier (riser) and inspect the element and carrier to ensure the bottom gasket has been removed with the element. In prolonged service, the gaskets may occasionally separate from the element and stick to the carrier.
3. Do not reuse the elements if the gasket has come unglued and obtain new Jonell coalescing elements.
4. Re-install the elements using a rubber washer, metal washer and double nut. The rubber washer should be new. Ensure element is centered on the carrier and torqued adequately.
5. Before closing vessel, inspect closure gasket or o-ring for any damage and replace as necessary.
6. Order elements and gaskets from Jonell Canada based on vessel model and serial number shown on the name plate.

Thank you for using Jonell Canada Inc.



4C GHG43 Series Control Stations

Nonmetallic or 316L Stainless Steel Corrosion Resistant

UL/cUL listed
 Cl. I, Div. 2, Groups A, B, C, D
 Cl. I, Zones 1 and 2,
 (A) Ex de IIB + H₂ T6
 Cl. II, Div. 1, Groups E, F, G (cUL)

PTB ATEX CERTIFIED 3117
 Ex de IIC, T6,
 Zones 1 and 2
 Ex de IIC, T6 Zones 21 and 22
 IP 66, NEMA 4X

Applications:

Control stations are used as a remote means of:

- Motor control
- Visual indication of equipment performance
- On-off control of circuits
- Circuit selection

Common applications include:

- Areas which are hazardous due to the presence of flammable vapors, gases or highly combustible dusts
- For installation at petroleum refineries, chemical and petrochemical plants and other process industry facilities where similar hazards exist

Features:

- NEMA 4X, IP66 enclosure with formed-in-place gasket
- Available with all operators: indicator lights, potentiometers, control switches, pushbuttons, terminal blocks and meters
- Base-mounted contact blocks
- Easy change-out components snap in place on DIN rail
- Enclosure meets UL 94-VO. Also available in anti-static Ex e materials
- Inserts for mounting DIN rails
- Available with a maximum of 2 entries - top and bottom for conduit fittings or cable glands
- Suitable for universal mounting plates on pipes, conduit, wall or channels
- Mounting dimensions data molded on back
- Captive, corrosion-resistant cover screws
- Built-in mounting slots for wall installation
- Available in 316L stainless steel

Certifications and Compliances:

- UL/cUL Listed
- Class I, Div. 2, Groups A, B, C, D
- Class II, Div. 1, Groups E, F, G (cUL)
- Class I, Zones 1 and 2, Ex de IIB + H₂, T6
- AEx de IIB + H₂, T6
- Type 3, 4, 4X; IP66
- CENELEC-PTB 00 ATEX 3117
- Ex de IIC, T6, Zones 1 and 2, IP66

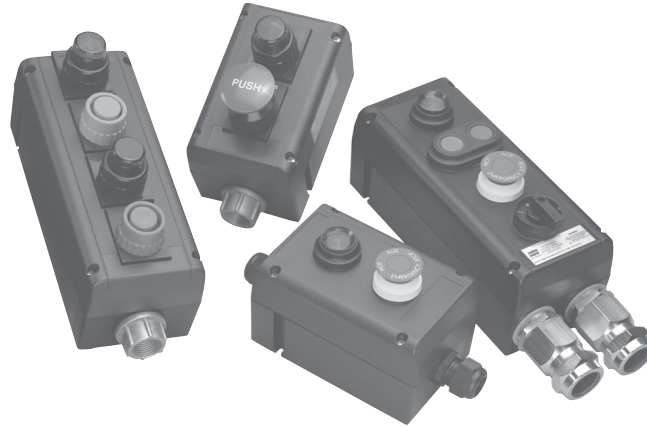
Options:

Description

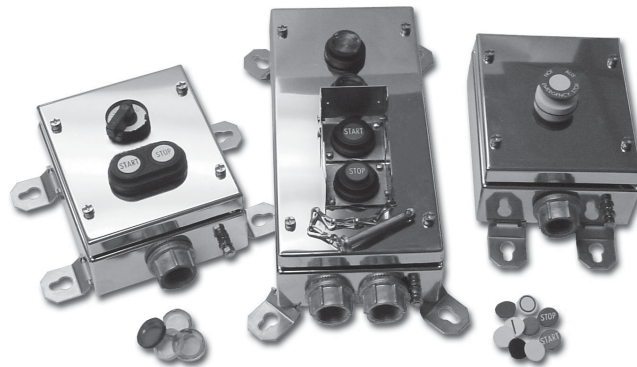
Eaton's Crouse-Hinds GHG43 Series control stations are now available with 316L stainless steel enclosures, making them ideal for corrosive and adverse locations - especially offshore platform applications

Suffix

S860



GHG43 Nonmetallic Control Stations



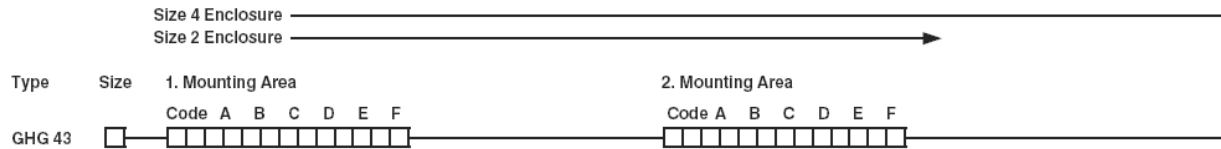
GHG43 Stainless Steel Control Stations



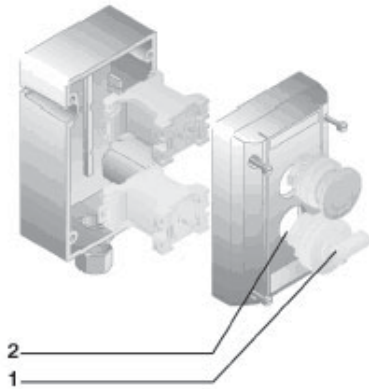
Crouse-Hinds
 by **F.T.N**

4C

Nonmetallic or 316L Stainless Steel Corrosion Resistant



GHG43 2 - Size 2 Enclosure



Mounting Area*



Pushbutton DRT

Code A B C D

Codes see page 559

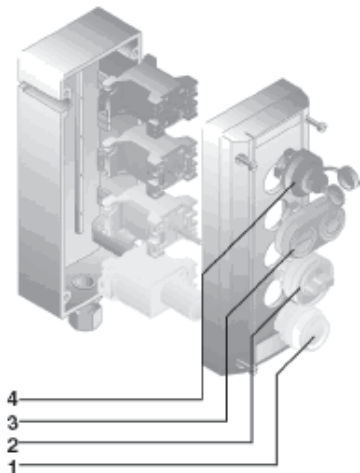


Double Pushbutton

Code A B C D E

Codes see page 559

GHG43 4 - Size 4 Enclosure



Mounting Area*



Key Operated Pushbutton

Code A B C

Codes see page 559



Mushroom-Head Pushbutton

Code A B C D E F

Codes see page 560



Signal Lamp

Code A B C

Codes see page 560

‡For a GHG43 control station with 316L stainless steel enclosure, add suffix "S860" to end of catalog number.
 *Unoccupied spaces must be filled in with KLM for correct positioning of devices.

Nonmetallic or 316L Stainless Steel Corrosion Resistant

4C



Potentiometer

Code A Code B

Codes see page 561



Measuring Instrument

Code A Code B Code C

Codes see page 562
Requires 2 spaces



Switch

Code A Code B Code C Code D

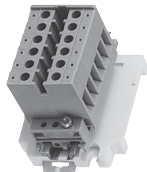
Codes see pages 563-564



Control Switch Ex 23 10A

Code A Code B Code C Code D Code E

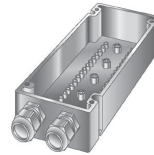
Codes see pages 563-564
Requires 2 spaces



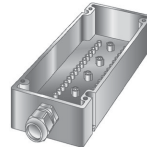
Terminals and cover blanking plug

Code A Code B

Code see page 561



Two entries



One entry

Cable Entries

NPT

No entries

2 x 1/2" Myers Hub, STGK1 Zinc Gland plate

2 x 3/4" Myers Hub, STGK2 Zinc Gland plate (Stainless Steel Control Stations only)

2 x 1/2" Myers Hub, SSTGK1 Stainless steel Gland plate

2 x 3/4" Myers Hub, SSTGK2 Stainless steel Gland plate (Stainless Steel Control Stations only)

1 x 3/4" Myers Hub, STGK2, Zone 1 Gland plate

1 x 1/2" Myers Hub, STGK1, Zone 1 Gland plate

1 x 1/2" Myers Hub, SSTGK1 Stainless st. Gland plate

1 x 3/4" Myers Hub, SSTGK2 Stainless st. Gland plate

Metric

No entries

2 x M25 Plastic Cable gland M25 Blanking plug

2 x M20 Threaded entries Gland plate

2 x M25 Threaded entries Gland plate

1 x M32 Plastic Cable gland

1 x M25 Threaded Entry, Blanking plug and Gland plate

2 x M25 Threaded Entry, 1 blanking plug and Gland plate

1 x M20 Threaded entry Blanking plug and Gland plate

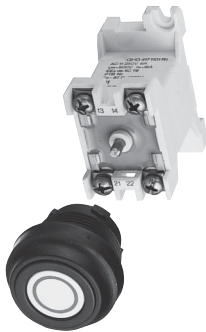
1 x 3/4" Myers Hub SSTGK2 stainless steel, Gland plate

‡For a GHG43 control station with 316L stainless steel enclosure, add suffix "S860" to end of catalog number.
*Unoccupied spaces must be filled in with KLM for correct positioning of devices.

Nonmetallic or 316L Stainless Steel Corrosion Resistant

Pushbuttons:

- Used for logic controls in hazardous areas
- Single or double units
- Used with all operators
- Base mounting



Type of Protection	Ex de IIC T6
Certificate of Conformity	PTB No. Ex-87.B.1007U
Approvals	PTB, UL, cUL
Rated Voltage	Up to 400V
Rated Current	NEC/CEC 10A IEC 16 A
Terminal Wiring	2 x 2.5mm ² / 14AWG
Mechanical and Electrical Life	>10 ⁵ Operations

See page 564 for explanation of contact symbols.

Pushbutton DRT

	D	R	T	O					
Code	A				B		C		D
Contact System									
Code B	13				14		15		
Inscription	ALL *	0	I	II	Stop	Start	Special-Text On Order †		
Code C	01	02	03	04	06	07	99		

Lockout see page 565

Code D (leave blank if no lockout required)

Double Pushbutton DDTO

	D	D	T	O						
Code	A				B		C		D	E
Contact System										
Code B	43				44		45			
Inscription	ALL *	0	I	II	Stop	Start	Special-Text on Order †			
Code C, D Left/Right	01	02	03	04	06	07	99			

Lockout see page 565

Code E (leave blank if no lockout required)

Key-Operated Pushbutton SLT

	S	L	T	O			
Code	A			B		C	
Contact System							
Code B	23			24		25	
Pushbutton	Key						
Not Depressed	Lockable	Yes	Yes	Yes	No	No	Yes
	Key Removable	Yes	Yes	No	No	Yes	Yes
Depressed	Lockable	Yes	No	Yes	Yes	Auto	Yes
	Key Removable	No	No	Yes	Yes	Yes	Yes
Code C	1	2	3	4	5	6	

* 01 - Includes the following discs - Start, stop, I, O, and red, green, yellow, white and black blank discs.
 † For Marking Guide for Pushbuttons see page 565.



**Nonmetallic or 316L Stainless Steel
Corrosion Resistant**



Mushroom-Head Pushbutton SGT

	<table border="1"><tr><td>S</td><td>G</td><td>T</td></tr></table>	S	G	T	<table border="1"><tr><td></td><td></td></tr></table>			<table border="1"><tr><td></td></tr></table>		<table border="1"><tr><td></td></tr></table>		<table border="1"><tr><td></td><td></td></tr></table>			<table border="1"><tr><td></td></tr></table>	
S	G	T														
Code	A	B	C	D	E	F										
Contact System																
Code B	53	54	55													
Color of Pushbutton	Red	Yellow	Black Actuator													
Code C	1	2	3													
Function	Spring Return	Maintained	Key Release													
Code D	1	2	3													
Inscription	Stop	Start	Black Actuator													
Code E	06	07	11													
Lockout	see page 565															
Code F	(leave blank if no lockout required)															

4C

Signal Lamp

- Used for positive feedback indication
- High intensity with special reflector and optical lens
- Accommodates most input voltages
- Base mounting



	Lamp
Type of Protection	Ex de IIC T6
Certificate of Conformity	PTB No. Ex-88.B.2106U
Approvals	PTB, UL, cUL
Lamp Life	>100,000 Hours (11.5 Years)
Rated Voltages	Up to 240VAC, 50 / 60 Hz Up to 110VDC
Rated Current	Max. 15 mA
Power Consumption	<1.2W
Terminal Wiring	2 x 2.5mm ² / 14AWG
Colors	Red, Green, Yellow, Clear & Blue

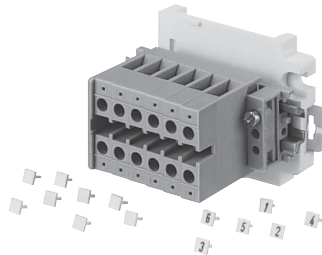
Signal Lamp SIL

	<table border="1"><tr><td>S</td><td>I</td><td>L</td></tr></table>	S	I	L	<table border="1"><tr><td></td></tr></table>		<table border="1"><tr><td></td><td></td></tr></table>		
S	I	L							
Code	A	B	C						
Colored Lens Cover	White	Yellow	Red	1 pkg white, yellow, red, green	Green	Blue			
Code B	1	2	3	4	5	6			
Voltage	20-250VAC/DC			10-33VAC/DC					
Code C	01			31					

Nonmetallic or 316L Stainless Steel Corrosion Resistant

Terminal Blocks

- Terminal block for easy field connections
- Base mounting



Terminal Blocks	
Type of Protection	Ex e II
Certificate of Conformity	PTB No. Ex-88.B.3112U
Rated Voltages	Up to 400V
Rated Current	23A
Conductor Size	4mm ² / 12AWG

Terminals and Cover Plugs KLM



Code A B

	6 Terminals 2 x 4 mm ²	Undrilled Cover (No Terminals)
Code B	61	00

Potentiometers

- Used to adjust resistance to vary motor speed or light levels
- Scale 0 to 100%
- Base mounting



Potentiometers	
Type of Protection	Ex de IIC T6
Certificate of Conformity	PTB No. Ex-87.B.1007U
Approvals	PTB, UL, cUL
Rated Voltages	>250V
Power Consumption	1.0W
Resistance	100-10,000W
Angle of Rotation	270°
Scale	0-100%
Connection Terminals	2 x 2.5mm ² / 14AWG

Potentiometer POT



Code A B

	1W			
Resistance W	1,000	2,200	4,700	10,000
Code B	4	7	5	6

4C

**Nonmetallic or 316L Stainless Steel
Corrosion Resistant**

Ammeters

- Used to measure motor current draw for efficiencies and maintenance
- Slide in scales to accommodate any amperage range
- Red indicator for quick visual indication to compare set points and actual values

4C



Ammeters	
Type of Protection	Ex e II T6
Certificate of Conformity	PTB No. Ex-87.B.2016U
Approvals	PTB, UL, cUL
Movement	Moving iron (core)
Accuracy	2.5% of range (class 2.5)
Measuring Range	0-16A direct, C.T. n/1 A
Operating Position	Vertical
Scale	Interchangeable for C.T. n/1 A
Zero Adjustment	At instrument
Terminal Wiring	2 x 2.5 mm ² / 14 AWG
Rated Current Marking	Red indicator

**Ammeter Measuring
Instrument AM 72***



Code A B C

Movement	Direct	n/1 A	0 - 2 mA	4-20 mA
Code B	1	2	3	6

Movements 0-20 mA and 4-20 mA are only available with 0 - 100 / 120% scale

Direct Measurement		Interchangeable Scale for C.T. n/1A					
Code C	Scale	Code C	Scale	Code C	Scale	Code C	Scale
02	0 - 1/1.5A	02	0 - 1/1.5A	09	0 - 30/45A	16	0 - 200/300A
03	0 - 2.5/3.75A	03	0 - 2.5/3.75A	10	0 - 40/60A	17	0 - 250/375A
04	0 - 5/7.5A	04	0 - 5/7.5A	11	0 - 50/75A	18	0 - 300/450A
05	0 - 10/15A	05	0 - 10/15A	12	0 - 60/90A	19	0 - 400/600A
07	0 - 16/24A	06	0 - 15/22.5A	13	0 - 75/112.5A	20	0 - 500/750A
		08	0 - 20/30A	14	0 - 100/150A	21	0 - 600/900A
				15	0 - 150/225A	22	0 - 100/150A

* Requires 2 spaces.

Nonmetallic or 316L Stainless Steel Corrosion Resistant

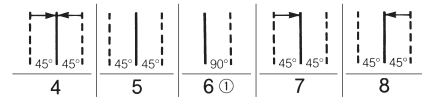
Rotary Control Switches

- Used for selectable operations (i.e. Hand-Off-Auto)
- 2 independent contacts
- Available in any contact configuration
- Spring return or maintained position
- Available with lockout positions



	SCT	Ex 23
Type of Protection	Ex de IIC T6	Ex de IIC T6
Certificate of Conformity	Ex.87.B.1007U	PTB no. Ex-88.B.1047U
Approvals	PTB, UL, cUL	PTB, UL, cUL
Rated Voltage	400 V	Up to 500 V
Rated Current	NEC 10 A IEC 16 A	NEC 10 A IEC 16 A
Terminal Wiring	2 x 2.5mm ² / 14 AWG	2 x 2.5mm ² / 14 AWG
Mechanical Life	>10 ⁵ Operations	>10 ⁵ Operations
Electrical Life	>10 ⁵ Operations	>10 ⁵ Operations
Switching Capacity	AC II: 20V/6A 400V/4A DC II: 24V/6A 60V/0.8A 110V/.5A 220V/.2A	AC I: 500G/10A AC II: 230V/6A 500V/6A DC II: 24V/6A 48V/4A 60V/0.8A 110V/0.5A 220V/0.4A

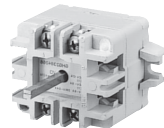
Rotary Control Switch SCT



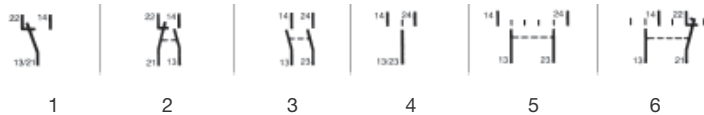
Switch Mechanism

Code B	Inscription	Code C	Inscription			
01	0	I	07	I	0	II
03	STOP	START	13	LOCAL	REMOTE	AUTO
04	HAND	AUTO	14	STOP	0	START
06	REMOTE	LOCAL	15	HAND	0	AUTO
29	OFF	ON	99	Special – text to be given on order		

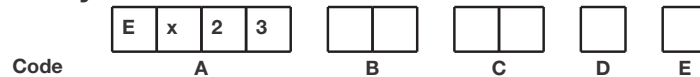
Same as SCT above except up to 4 independent contacts



Contact System



Rotary Control Switch Ex 23*



Code B	Inscription
01	0
03	STOP
04	HAND
06	remote
07	I
13	LOCAL
14	STOP
23	OFF
24	HAND
27	START
29	OFF
32	ON
99	Special – text to be given on order
	I
	START
	AUTO
	local
	0
	REMOTE
	0
	0
	OFF
	STOP
	ON
	OFF
	AUTO
	AUTO

* Requires 2 spaces in cover.

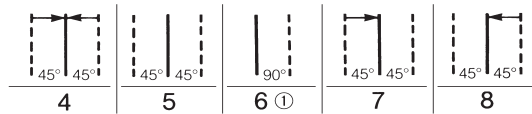
4C

**Nonmetallic or 316L Stainless Steel
Corrosion Resistant**

4C

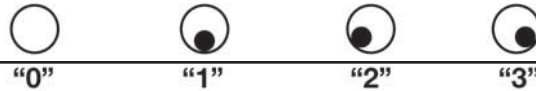
Code C	Contact System	Type	Code C	Contact System	Type
00		2 Position	09		3 Position
01		2 Position	10		3 Position
02		2 Position	12		3 Position
03		Single Pole Changeover	13		2 Position
05		HOA	14		2 Position
07		3 Position Single Level	15		3 Position Double Pole Changeover

**Switched Mechanism
Code D**



Padlocking Facility

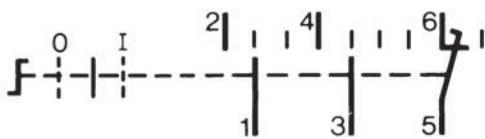
Code E



Contact Configurations

Normally Closed			Normally Open
Normally Closed Extended Over 2 Positions			Normally Open Early Make/Late Break
Change-Over Break Before Make			Change-Over Make Before Break

Example of Switch Type 10



This example is the switch type 10 Stop-Run-Stop. The switch has 3 positions – the normal position is center and can be switched left or right. An arrow (→←) indicates spring return. (See codes for switch mechanism). Contacts 1–2 only close in the Stop position. Contacts 3–4 close only in the Start position. Contacts 5–6 are normally closed and remain closed when switched to the Start position and open when switched to the Stop position.

Nonmetallic or 316L Stainless Steel Corrosion Resistant

Lockouts for DRTO Pushbuttons



X
Code D
Shroud Cover For
Pushbutton
Y-Lockout with bolt and chain



Z
Code D
Padlocking Fire Alarm
Cover For Pushbutton

Lockouts for DDTO Double Pushbuttons



X
Code ED
Padlocking Cover For
Double Pushbutton
Without Hole



Z
Code E
Padlocking Cover For
Double Pushbutton
With Hole

Lockouts for SGT Mushroom-Head Pushbuttons



X
Code F
Padlocking Cover For
Emergency Stop Pushbutton



Z
Code F
Padlocking Cover For
Emergency Stop Pushbutton
With Bolt & Chain
Not permitted in IEC hazardous
locations.

Marking Guide For Pushbuttons

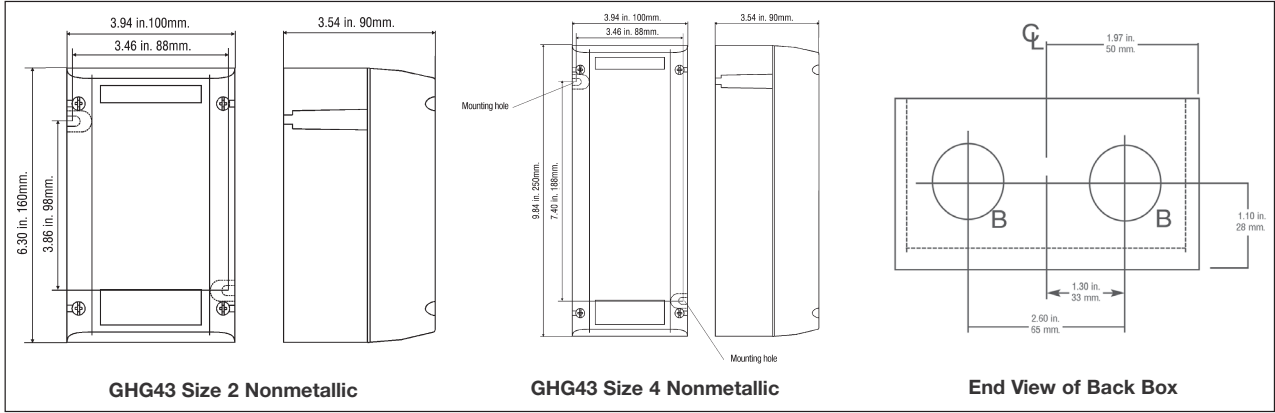
Special Text

Marking Required	Standard Abbreviation	Actual Marking on Disc
Acknowledge	AK	ACK
Alarm	AM	ALARM
Automatic	AU	AUTO
Close	CL	CLOSE
Down	DN	DOWN
Fast	FS	FAST
Forward	FW	FWD
Hand	HN	HAND
High	HI	HIGH
In	IN	IN
Jog	JG	JOG
Local	LC	LOCAL
Lower	LO	LOWER
Maintain	MT	MAINT
Manual	MN	MANUAL
Normal	NR	NORMAL
Off	OF	OFF
On	ON	ON
Open	OP	OPEN
Out	OT	OUT
Raise	RA	RAISE
Remote	RM	REMOTE
Reset	RS	RESET
Reverse	RV	REV
Run	RN	RUN
Slow	SL	SLOW
Test	TT	TEST
Trip	TP	TRIP
Up	UP	UP

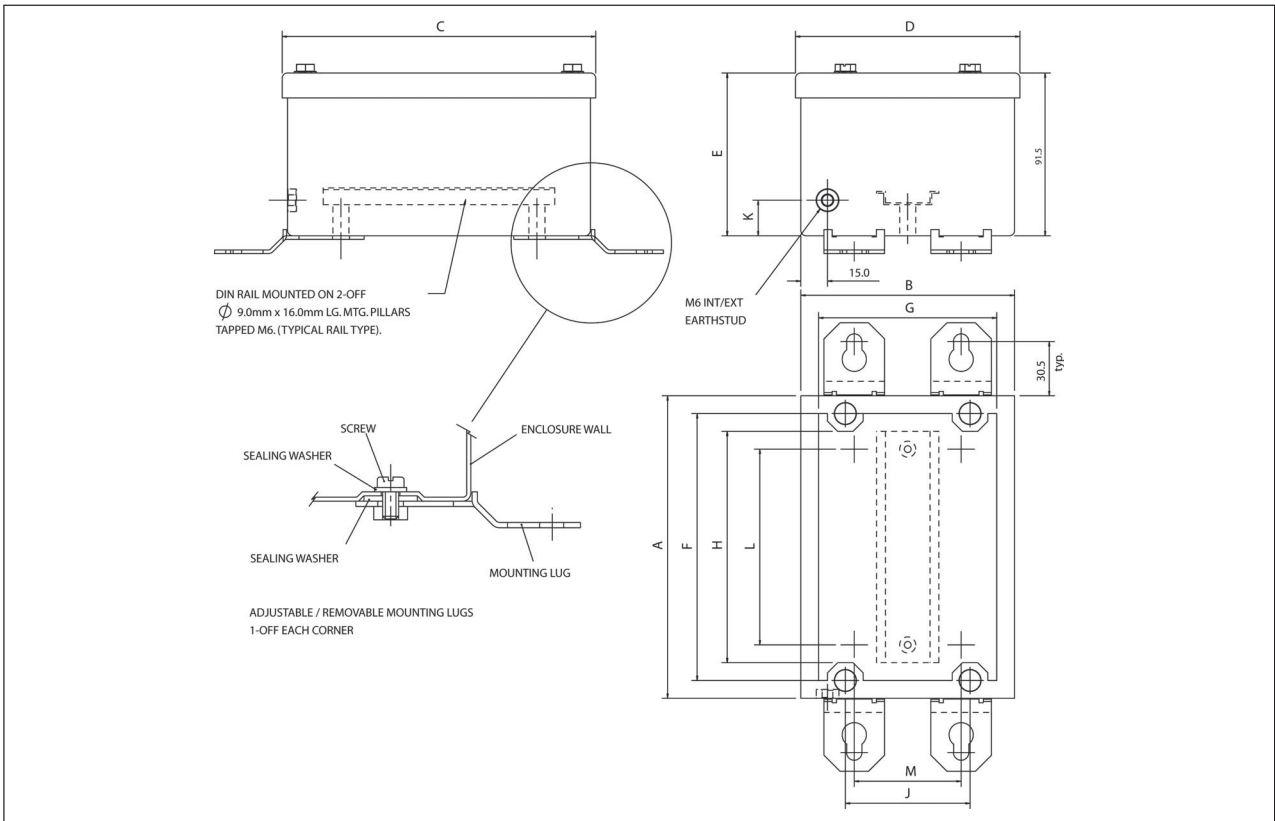
4C

Nonmetallic or 316L Stainless Steel
Corrosion Resistant

GHG43 Nonmetallic Control Stations



GHG43 Stainless Steel Control Stations



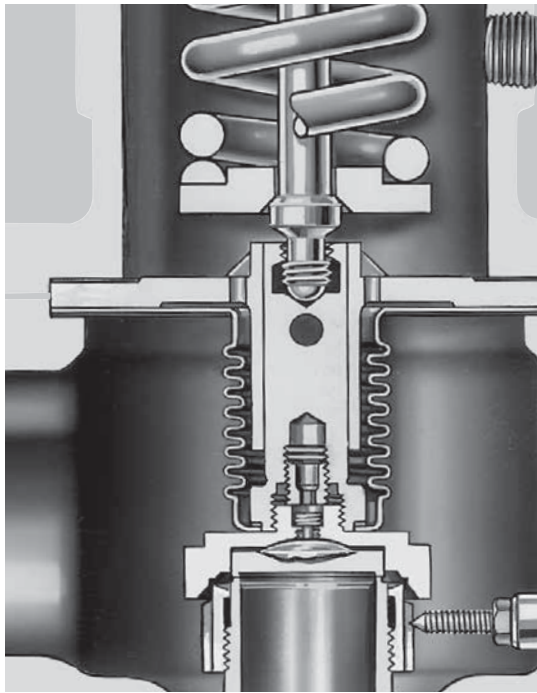
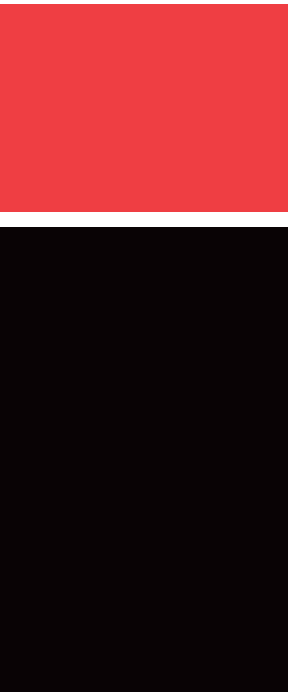
Box Type

Dimension (inches)

	A	B	C	D	E	F	G	H	J	K	L	M
1 Operator Control Station	4.72	4.72	4.96	4.96	3.60	3.94	3.94	3.15	2.76	0.79	2.36	2.36
2 Operator Control Station	6.69	4.72	6.93	4.96	3.60	5.90	3.94	5.12	2.76	0.79	4.33	2.36
3 Operator Control Station	8.66	4.72	8.90	4.96	3.60	7.87	3.94	7.09	2.76	0.79	6.30	2.36
4 Operator Control Station	10.63	4.72	10.87	4.96	3.60	9.84	3.94	9.06	2.76	0.79	8.27	2.36

Series 2600

Maintenance Manual





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1. Introduction

This maintenance manual is provided because you have Farris Engineering 2600 Series pressure relief valves protecting equipment and personnel in your plant. We trust that you will find this manual useful, as it is intended to clearly present all the essential information you will need in order to keep your Farris valves in perfect operating condition.

Any maintenance and repair work or testing performed on Farris pressure relief valves should be done in strict accordance with the requirements of all applicable Codes and Standards. Persons performing the work should maintain proper authorization through applicable governing authorities.

To ensure reliable and safe operation, installation, testing, maintenance, adjustment, and repair of Farris valves, these activities shall only be performed by qualified personnel having the required skills and training. No repair, assembly, adjustment or testing performed by individuals other than Farris-authorized representatives shall be covered by the warranty extended by Farris to its customers. All applicable regulations, directives, codes and standards shall be adhered to when performing these activities. Failure to follow proper test procedures or failure to use proper test equipment will lead to incorrect test results, damage to the valve and will invalidate the warranty.

Farris Engineering provides programs which coordinate classroom and hands-on training. It is recommended that individuals performing pressure relief valve maintenance receive training specific to those valve series they expect to repair and set. Only this type of training will ensure the proper application of these instructions. The National Board of Boiler and Pressure Vessel Inspectors conducts training programs on valve repair in conjunction with their VR program. This is a broad-based program and is recommended to supplement training received from specific manufacturers.

These instructions do not cover all details or variations in equipment, nor do they provide for every possible contingency to be met in regards to installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, please contact Farris Engineering.

2. Safety Warning and Instruction System

You will find safety warnings and instruction labels throughout this manual. These have been included to ensure your safety and must be followed. Safety labels are vertically oriented rectangles as shown in the samples below. These labels consist of three panels inside a border. Each safety label will communicate the following three key pieces of information. This information is communicated using narrative and pictorials.

- The nature and severity of the hazard
- The consequence of the hazard, if not avoided
- The precautions and measures required to avoid the hazard.

The top panel of the safety label illustrates the signal word (DANGER, WARNING, or CAUTION) which communicates the severity of the hazard, per the above explanations. The center panel contains a pictorial which communicates the nature of the hazard, and the possible consequence of hazard, if not avoided. In some cases, the pictorial may depict the precautions or measures required to avoid the hazard. The bottom panel will then contain the remaining narrative information needed to ensure all three key pieces of information have been conveyed.



DANGER:
Indicates hazards which, if not avoided, will result in death or serious injury.

WARNING:
Indicates hazards which, if not avoided, could result in death or serious injury.

CAUTION:
Indicates hazards which, if not avoided, could result in minor or moderate injury.

NOTICE:
“NOTICE” is reserved for instructions given to prevent property, product, or environmental harm.

SAFETY INSTRUCTIONS:
“SAFETY INSTRUCTIONS” indicates processes or procedures recommended to ensure safety.

General Safety Instructions

The maintenance manual is provided by Farris Engineering, a business unit of Curtiss-Wright Flow Control Company, to its customers as general guidance for the repair and maintenance of Farris valves described herein. Pressure relief/safety valves are critical components in pressurized systems to ensure the safety of people, the environment, and property. Always follow all manufacturer and industry standard recommendations relating to proper installation, testing, maintenance, and reconditioning.

This manual should not be considered an exhaustive manual. Certain configurations, applications, and usages may not be covered. If there is specific information needed which is not covered in this manual, the customer is advised to contact Farris using the contact information on the back of this manual. All information presented in this manual is subject to change without notice. The purchaser should contact Farris regarding any possible changes in information or specifications.

To ensure reliable and safe operation, installation, testing, maintenance, adjustment, and repair of Farris valves, these activities shall only be performed by qualified personnel having the required skills and training.

No repair, assembly, adjustment or testing performed by individuals other than Farris-authorized representatives shall be covered by the warranty extended by Farris to its customers. All applicable regulations, directives, codes and standards shall be adhered to when performing these activities. Failure to follow proper test procedures or failure to use proper test equipment will lead to incorrect test results, damage to the valve and will invalidate the warranty.

Likewise, use of parts in any maintenance or repair activity other than factory-supplied OEM parts will invalidate the warranty extended by Farris to its customers. Incorrect selection or application of Farris valves on the part of the customer is not covered by the warranty extended by Farris to its customers.

These general safety instructions have been provided not only to protect the product and warranty but also are provided for an individual's personal safety in handling Farris pressure relief valves. Failure to follow these procedures could result in severe bodily harm or even death.

- All possible hazards may not be identified in this manual. Conduct your own safety risk assessment given your specific system, environment, and configuration, and ensure proper control procedures are in place to prevent personal injury or illness and property, product or environmental harm.

DANGER

- When the valve is under pressure, do not place any part of your body near or in the path of the outlet of the main valve or other discharge areas. Doing so will result in serious injury or death upon release.
- If a test gag is provided with the valve, it must be removed prior to service installation. Failure to do so will result in equipment failure, serious injury or death in the instance of an overpressure event.

WARNING

- In certain applications it may be impossible to remove the valve from service. Never attempt to remove, adjust, maintain, or repair a pressure relief valve either while it is installed in a pressurized system or on a test stand, unless you have been properly trained to do so. Doing so may result in serious injury or death. Ensure the proper isolation of energy sources and residual pressures by complying with all local, state and country-specific regulations/directives applying to energy control procedures and “lockout/tagout.”
- Ensure that the pressure relief valve and system is at an ambient temperature before inspecting, servicing, or repairing. The valve, system, and contents may be extremely hot or cold. Failure do so may result in serious injury.
- The exhaust from the main valve outlet or any other ports that could exhaust, should be vented to a safe location to eliminate the potential for serious injury or damage during relief operation.

- Prior to valve disassembly, ensure that proper controls are implemented to address potential exposures to hazardous substances, including gases, liquids, or process byproducts contained in or contaminating the valve. Consult applicable material safety data sheets (MSDSs) and established exposure limits for the substances expected to be present to ensure proper exposure controls are implemented. Failure to do so could result in serious injury or illness.
- Ensure the valve is operable at all times and free of potential obstructions due to the conditions of use, or process fluid obstructions resulting from solidifications, byproducts, polymerization or other obstructions. Failure to do so could render the valve inoperable, leading to serious injuries or damage in the event of system over-pressurization.
- Use extreme caution when inspecting a pressure relief valve for leakage. Never use body parts to inspect for flow leaks. Doing so could result in serious injection, burn, or chemical injuries.
- Use all appropriate personal protective equipment to protect against process hazards, including but not limited to, pressurization, temperature extremes, noise, and chemical hazards. Failure to do so could result in serious injury or death.

CAUTION

- Always use the appropriate tools, and in the correct manner, for adjustment or servicing of valves. Failure to do so could result in injury.

SAFETY INSTRUCTIONS

- It is the responsibility of the customer and user of Farris valves to properly train their personnel on all required safety standards and procedures to prevent injuries and illnesses.

3. Serial and Type Numbering Systems

Familiarity with Farris valve type and serial numbering systems will greatly benefit anyone using this manual or any other Farris literature. The ability to recognize certain valve types and construction features along with identifying serial numbers will assist correct maintenance procedures and spare part selection/ordering. All Farris valve nameplates contain a specific valve type number and serial number unique to that particular valve. See Figure 1.2 on page 6 for an example of a typical 2600 Series nameplate.

Serial Numbering System

Each Farris pressure relief valve is assigned a unique serial number. This serial number is assigned by the factory and remains part of the factory records. Providing this serial number to the factory will assist in the identification of the construction and metallurgy of the valve in question. The following outline will give general guidelines on the serial numbering system used on 2600 Series valves.

Serial Suffix Summary For 2600 Maintenance Manual			
Serial # Suffix	Valve Type	Description	Production Dates
-A15/H	2600L BalanSeal "O" Ring Seat Design (Liquid Service)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
-A14/H	2600L Conventional "O" Ring Seat Design (Liquid Service)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
-A15/G	2600L BalanSeal Metal Seat Design (Liquid Service)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
-A14/G	2600L Conventional Metal Seat Design (Liquid Service)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
-A15/M	2600L BalanSeal Design - "O" Ring (air, steam, vapor & liquid services)	Modified "D" through "K" orifice "O" ring seat design that replaced original A14 & A15 "O" ring seat design. Starts at Serial #'s above 300000.	July 1993 - present
-A14/M	2600L Conventional Design - "O" Ring (air, steam, vapor & liquid services)		
-A15	2600L BalanSeal Design (air, steam, vapor & liquid services)	Full nozzle valves conforming to API Standard 526 with ASME Section VIII certification for liquid service. Air & steam certification added in 2005.	1985 - present
-A14	2600L Conventional Design (air, steam, vapor & liquid services)		
-A13	2600 & 2600L BalanSeal Piston Design - All design variations and Services	2600 & 2600L Balanced Piston version of standard 2600 BalanSeal Design. Use of serial suffix changed from A12 to A13 for consistency of numbering system.	Nov. 1997 - present
-A12			1978 - Nov. 1997
-A11/R	2600 BalanSeal Design - "O" Ring (air, steam, & vapor services)	Modified "D" through "K" orifice "O" ring seat design that replaced the modified A10/M & A11/M "O" ring seat design. Starts at Serial #'s above 312123.	August 1996 - present
-A10/R	2600 Conventional Design - "O" Ring (air, steam, & vapor services)		
A11/N	2600 & 2600L BalanSeal Design (air, steam, vapor & liquid services)	Special version of 2600 series built to military specifications with MIL Spec. flanges and semi-nozzle construction	2000 - present
A10/N	2600 & 2600L Conventional Design (air, steam, vapor & liquid services)		2000 - present
A11/H	2600 BalanSeal "O" Ring Seat Design (air, steam, & vapor services)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
A10/H	2600 Conventional "O" Ring Seat Design (air, steam, & vapor services)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
A11/G	2600 BalanSeal Metal Seat Design (air, steam, & vapor services)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
A10/G	2600 Conventional Metal Seat Design (air, steam, & vapor services)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
-A11/M	2600 BalanSeal Design - "O" Ring (air, steam, & vapor services)	Modified "D" through "K" orifice "O" ring seat design that replaced original A10 & A11 "O" ring seat design. Starts at Serial #'s above 300000.	July 1993 - July 1996
-A10/M	2600 Conventional Design - "O" Ring (air, steam, & vapor services)		July 1993 - July 1996
-A11	2600 BalanSeal Design (air, steam, & vapor services)	Full nozzle valves conforming to API Standard 526 with nozzles revised to incorporate ASME 0.9 capacity reduction factor.	1976 - present
-A10	2600 Conventional Design (air, steam, & vapor services)		
-A9	BalanSeal Bellows Design	Full nozzle valves conforming to API Standard 526.	1959 - 1976
-A8	Conventional Design		
-A3, A5, & A7	BalanSeal Bellows Design	Includes both 2605 & 2675 Series	1955 - 1967
-A2, A4, & A6	Conventional Design		
-A	Full nozzle valves, conventional and BalanSeal bellows types.	Serial suffix covers all types of construction including Conventional, FarriSeal, BalanSeal, enclosed and exposed spring designs.	1943 - 1955

Note: Valves covered by serial number suffixes in RED are for obsolete designs.



Type Numbering System

Our type numbering system simplifies the selection and specifying of Farris pressure relief valves because the digits that comprise a specific type number have a distinct significance. The digits describe the basic valve series, orifice, seat and internal construction, inlet temperature range, body, bonnet and spring material, inlet flange class and Code liquid design.

Prefix (if applicable)		26	D				A	1			
		Series Number	Orifice Areas				Construction	Temperatures & Materials			
H* Set Pressure Above API 526 SJ Steam Jacket HTF Heat Transfer Fluid	26	Orifice Letter	Area, Sq. In.		Area, Sq. mm		A Conventional construction	Designation	Inlet Temperature Range °F	Material	
			API	Actual	API	Actual				Body & Bonnet	Spring
		D	0.110	0.150	71	97	B BalanSeal construction	1	-20 to 800	Carbon Steel	Chrome Alloy
		E	0.196	0.225	126	145	C Conventional with O-ring seat pressure seal				
		F	0.307	0.371	198	239	D BalanSeal with O-ring seat pressure seal				
		G	0.503	0.559	325	361	E BalanSeal with auxiliary balancing piston	2**	451 to 800	Carbon Steel	Chrome Alloy
		H	0.785	0.873	506	563	F BalanSeal with auxiliary balancing piston and O-ring seat pressure seal				
		J	1.287	1.430	830	923	T Teflon seat, conventional	3	801 to 1000	Chrome Moly Steel	High Temp. Alloy
		K	1.838	2.042	1186	1317	U Teflon seat, BalanSeal				
		L	2.853	3.170	1841	2045		4*	1001 to 1200	—	—
		M	3.60	4.000	2323	2581					
		N	4.34	4.822	2800	3111		5*	1201 to 1500	Austenitic St. St.	Inconel Alloy
		P	6.38	7.087	4116	4572					
		Q	11.05	12.27	7129	7916		1	-21 to -75	Use "S3" Trim Options	
		R	16.0	17.78	10323	11471					
		T	26.0	28.94	16774	18671		1	-76 to -450	Use "S4" Trim Options	
		U	—	31.5	—	203.2*					
		V	—	49.4	—	318.6*		6	-21 to -75	3-1/2% Nickel Steel	Carbon Steel
		W	—	63.6	—	410.2*					
		W2	—	104.0	—	670.8*		7	-76 to -150	3-1/2% Nickel Steel	Austenitic St. St.
		X	—	113.1	—	729.5*					
		Y	—	143.1	—	923.0*		8	-151 to -451	Austenitic St. St.	Austenitic St. St.
		Z	—	176.7	—	1139.7*					

*Available Only on Q, R, T and U Orifices

*The U – Z orifices are not API standard sizes. U – Z metric areas = cm².

This manual only covers maintenance for D – U orifices. For larger orifices, please consult the factory.

* Temperature ranges 4 and 5 are beyond the scope of this catalog. Consult the Factory.

** Temperature range 2 is no longer used as the standard range valve handles temperatures to 800°F.

Note: Items listed in **RED** are for non-current nomenclature designations or options no longer offered.

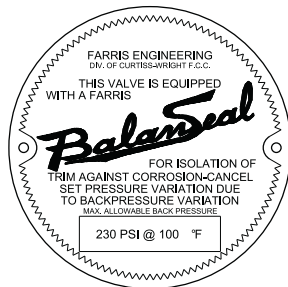


Figure 1.1 – BalanSeal Identification Plate

FARRIS ENGINEERING DIV. OF CURTISS-WRIGHT F.C.C. BRECKSVILLE, OHIO USA			
TYPE	26FB10-120		
SIZE AND ORIFICE	1-1/2 F 2	SET PRESS.	110 PSIG
BACK PRESSURE	10 PSIG	NB	
	COLD DIFF. TEST PRESS.		
CAPACITY AT 10% OVER PRESSURE	791 SCFM		
SERIAL	21310-A11	TAG	PSV-13469A
26906			

Figure 1.2 – Typical Farris Nameplate

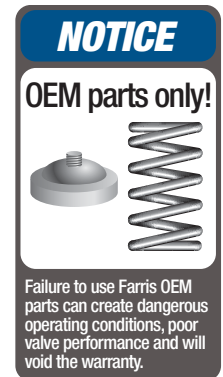
Parts Replacement

Valves – If an exact replacement valve is required, then the valve type, size and serial number must be specified to ensure proper dimensions and material being supplied. If a specific valve is obsolete, a recommendation of the current equivalent will be made if possible.

Spare Parts – When ordering parts, use part names as listed in the bills of materials. Specify valve type, size and serial number. If the serial number is not available, the original Farris factory order number will help us supply the proper part and material.

Springs – Order as an assembly to include spring with upper and lower spring buttons. Specify valve type, size, serial number, set pressure and backpressure, if any.

Note: If valve modification or set pressure changes are required, consideration must be given to correct the nameplate and other data.



2		L -	1	2	0	/S4
Inlet Class		Special Construction (if applicable)	Inlet Facing	Cap Construction	Test Gag	Special Material
Designation	ANSI Nominal Inlet Flange Class	A Expanded API sizes: air, steam and gas service* B Expanded API sizes: ASME liquid valve* C Expanded API sizes: ASME Code Section VIII exposed spring design* D Valve suitable for heat transfer service-vapor E Valve suitable for heat transfer service-liquid F Expanded API size valves suitable for heat transfer service-vapor* G Expanded API size valves suitable for heat transfer service-liquid* H Integral steam jacket expanded API Sizes – Vapor Service J Integral steam jacket Vapor Service K Integral steam jacket – Liquid Service L ASME Code certified for liquid, air and steam service S ASME Code Section VIII exposed spring design X Integral steam jacket expanded API sizes – Liquid Service	0 Special ² 1 Raised Face, ANSI Std. (125 to 160 AARH) 2 Large Female, ANSI Std. 3 Small Male, ANSI Std. 4 Small Female, ANSI Std. 5 Large Tongue, ANSI Std. 6 Large Groove, ANSI Std. 7 Small Tongue, ANSI Std. 8 Small Groove, ANSI Std. 9 Ring Joint (octagonal), ANSI Std. A 125 AARH Smooth Finish B 125 AARH (Outlet Only) C 125 to 160 AARH (Inlet & Outlet) (now indicated by a '1') H 63-83 AARH Smooth Finish RF The following designation can apply to inlet and/or outlet: J 63 to 83 AARH (outlet only) K 63 to 83 AARH (inlet & outlet) X High pressure hub style connection	2 Screwed Cap 3 Bolted Cap 4 Packed Lever 5 L Type Packed Lever 6 R Type Packed Lever 7 Open Lever 8 Remoter (with Packed Lever)	0 Without Gag 1 With Gag	See "Materials for Corrosive Service" Table below.
	0	150				
	1	300 lightweight valve				
	2	300 heavyweight valve				
	3	600				
	4	900				
	5	1500				
6	2500					
		*Letter suffixes for expanded API sizes where 2-1/2" inlet or outlet has been replaced by 3" size.				

Materials for Corrosive Service				
Designation	Body Bonnet, Cap	Special Material Description		
		Nozzle & Disc	Other	Internal Parts
				Springs & Buttons
/S1	Standard	316	316 ¹	316 buttons, Chrome Alloy or High Temperature Alloy Nickel Plated spring
/S2	Standard	316	316	316 buttons, Chrome Alloy or High Temperature Alloy Nickel Plated spring
/S3	316	316	316	316 buttons, Chrome Alloy or High Temperature Alloy Nickel Plated spring
/S4	316	316	316	316
/S5	Standard (NACE)	316	316 & Monel w/Inconel 625 bellows	Standard ²
/S6	Standard (NACE)	316	316 SAS w/standard bellows	Standard ²
/S7	Standard (NACE)	316	316 & Monel w/standard bellows	Standard ²
/H1	Standard	Hastelloy C	Standard	Standard
/H2	Standard	Hastelloy C	Hastelloy C & Monel	316 buttons, Chrome Alloy or High Temperature Alloy Nickel Plated spring
/H3	Hastelloy C [®]	Hastelloy C	Hastelloy C	316 buttons, Chrome Alloy or High Temperature Alloy Nickel Plated spring
/H4	Hastelloy C	Hastelloy C	Hastelloy C	Hastelloy C
/M1	Standard	Monel	Standard	Standard
/M2	Standard	Monel	Monel	316 buttons, Chrome Alloy or High Temperature Alloy Nickel Plated spring
/M3	Monel	Monel	Monel	316 buttons, Chrome Alloy or High Temperature Alloy Nickel Plated spring
/M4	Monel	Monel	Monel	Inconel spring, Monel buttons
/N1	Carbon Steel (NACE)	316 (NACE)	316 ¹	Standard ²
/N4	316 (NACE)	316 (NACE)	316 ¹	316 ²

1. Spring adjusting screw in standard material
 2. The springs shown assume bellows construction. For conventional construction, use Inconel X750.

4. Valve Cross-Section, Parts and Construction

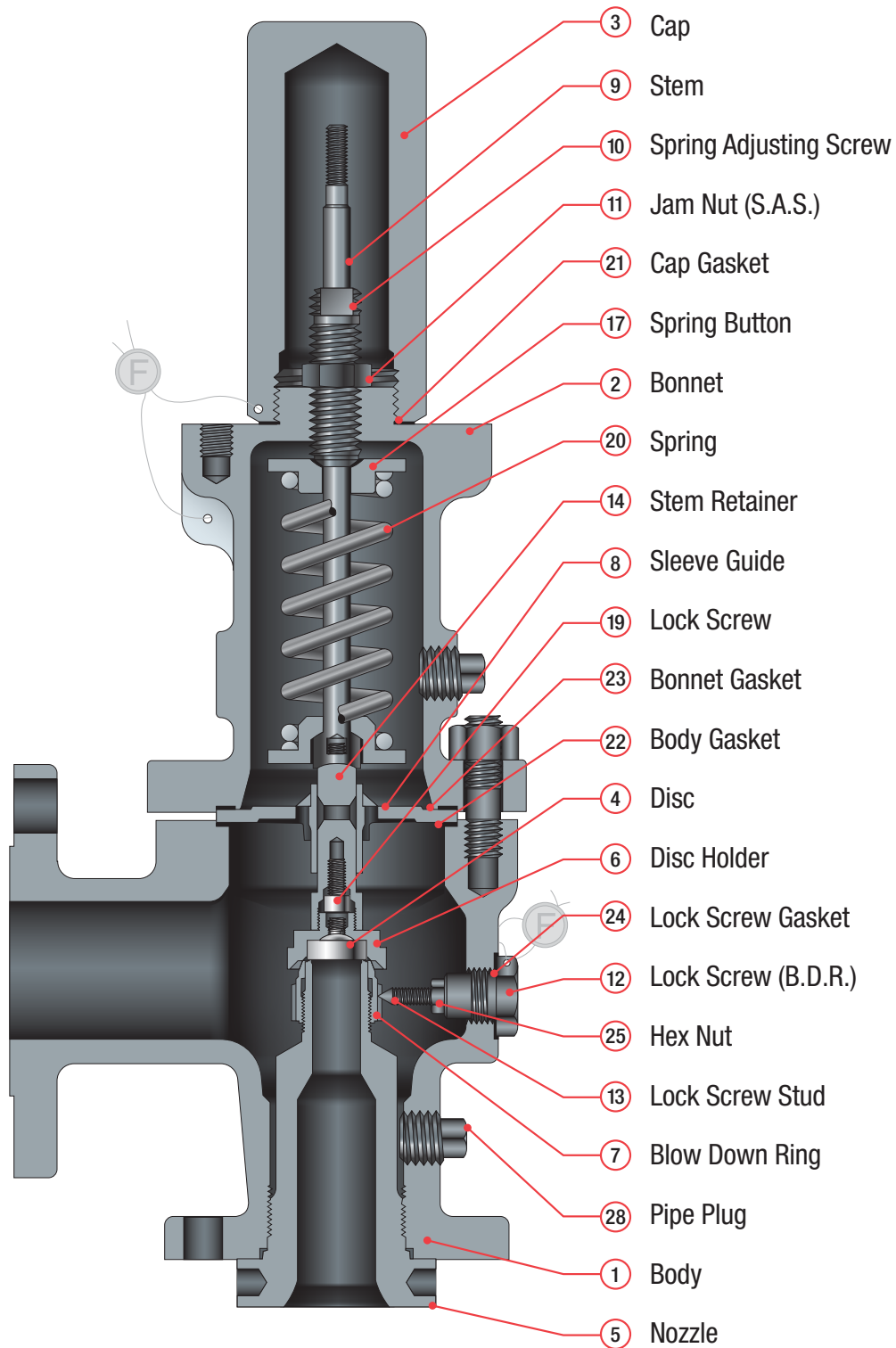


Figure 4.1

General Notes:

The safety valve cross-section illustrated is typical and actual construction details will vary depending on valve size and pressure rating. Consult the other illustrations contained elsewhere in this manual for greater detail or consult the factory for a cross-section drawing for the actual valve size and pressure rating.

Valve Bill of Materials				
Item	Part Name		Conventional (A10) Material	BalanSeal (A11) Material
1	Body	26()10 thru 26()16	SA-216 Gr. WCB, Carbon Steel	SA-216 Gr. WCB, Carbon Steel
		26()32 thru 26()36	SA-217 Gr. WC6, Chrome Moly	SA-217 Gr. WC6, Chrome Moly
2	Bonnet	26()10 thru 26()16	SA-216 Gr. WCB, Carbon Steel	SA-216 Gr. WCB, Carbon Steel
		26()32 thru 26()36	SA-217 Gr. WC6, Chrome Moly	SA-217 Gr. WC6, Chrome Moly
3	Cap		Carbon Steel	Carbon Steel
4	Disc		316 St. St.	316 St. St.
5	Nozzle		316 St. St.	316 St. St.
6	Disc Holder		316 St. St.	316 St. St.
7	Blow Down Ring		316 St. St.	316 St. St.
8	Sleeve Guide		316 St. St.	316 St. St.
9	Stem		316 St. St.	316 St. St.
10	Spring Adjusting Screw		Stainless Steel	Stainless Steel.
11	Jam Nut (S.A.S.)		316 St. St.	316 St. St.
12	Lock Screw (B.D.R.)		316 St. St.	316 St. St.
13	Lock Screw Stud		316 St. St.	316 St. St.
14	Stem Retainer		17-4 Ph. St. St.	17-4 Ph. St. St.
15	Bellows (not shown)		N/A	Inconel Composite
16	Bellows Gasket (not shown)		N/A	Non-Asbestos
17	Spring Button		Carbon Steel, Rust Proofed	Carbon Steel, Rust Proofed
18	Body Stud		ASME SA-193 Gr. B7, Alloy Steel	ASME SA-193 Gr. B7, Alloy Steel
19	Lock Screw (D.H.)		Stainless Steel	Stainless Steel
20	Spring	26()10 thru 26()16	Chrome Alloy Rust Proofed	Chrome Alloy Rust Proofed
		26()32 thru 26()36	High Temp. Alloy Rust Proofed	High Temp. Alloy Rust Proofed
21	Cap Gasket		316 St. St.	316 St. St.
22	Body Gasket		316 St. St.	316 St. St.
23	Bonnet Gasket		316 St. St.	316 St. St.
24	Lock Screw Gasket		316 St. St.	316 St. St.
25	Hex Nut (B.D.R.L.S.)		Stainless Steel	Stainless Steel
26	Hex Nut (Body)		ASME SA-194 Gr. 2H, Alloy Steel	ASME SA-194 Gr. 2H, Alloy Steel
27	Pipe Plug (Bonnet)		Steel	N/A
28	Pipe Plug (Body)		Steel	Steel

Table 4.1

General Notes:
 Parenthesis in type number indicates orifice designation and valve construction, example: 26FA10

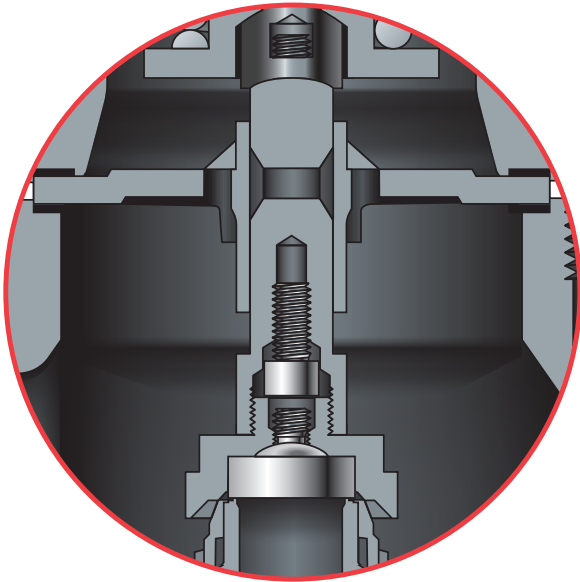


Figure 4.2
Internals for Orifice D-J

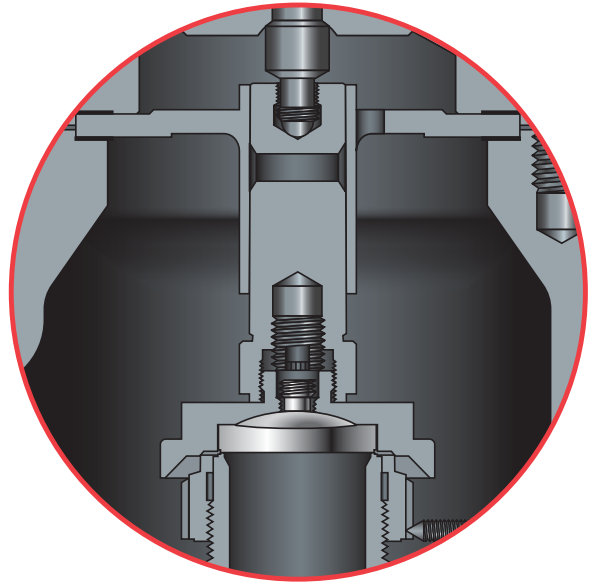


Figure 4.3
Internals for Orifice K-P

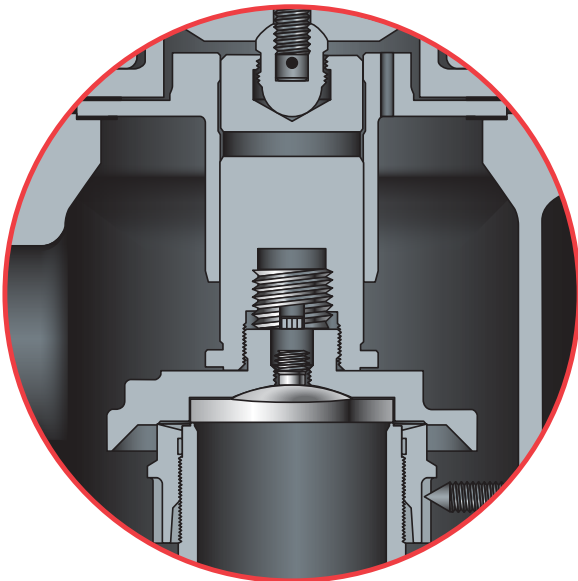


Figure 4.4
Internals for Orifice Q-U

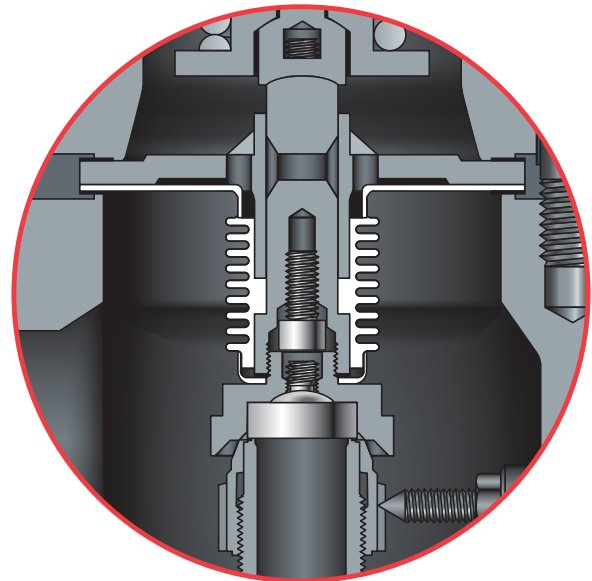


Figure 4.5
BalanSeal® Bellows Safety Valve

5. Valve Removal and Pre-Inspection

General Handling:

After the pressure relief valve is removed from the installation it should be transported to the shop for inspection, testing, maintenance, and resetting. Careful handling in transit is important, as rough handling can change the pressure setting or deform the pressure relief valve parts so they cannot be set or function properly. Flanges on the piping and flange faces on the valve should be protected so that gasket faces are not damaged. Large valves should be handled with suitable rigging equipment to avoid dropping or rough handling. Pressure relief devices should not be stocked in a careless manner and, where practical, they should be segregated and not stored with heavy pipe fittings or other types of valves. Pressure relief valves should be treated as delicate instruments because their accurate functioning is very important to safe plant operation.



Because cleanliness is essential for the satisfactory operation and tightness of a pressure relief valve, all necessary precautions should be taken to keep out foreign materials. Valves which are not installed soon after repair should be closed off properly at both inlet and outlet flanges. Particular care should be taken to keep the valve inlet and internals absolutely clean. Preferably, valves should be stored indoors or in locations where dirt and other forms of contamination are at a minimum. Valves should be handled carefully and not subjected to heavy shocks. If due consideration is not given to this point, some internal damage or misalignment can result and seat tightness may be adversely affected. Store, transport and install valves with the stem in the vertical position.

In practice, a repaired pressure relief valve including one that has been only cleaned or readjusted is called upon to provide the same degree of protection as a new valve. It follows that maintenance personnel must be trained to a level of proficiency that enables them to restore a valve to original condition and function. It is recommended that historical records be established and maintained including test reports. This will provide data to determine the frequency of inspection and repair for various services. One excellent publication for reference on pressure relieving devices is the American Petroleum Institute's (API) **Recommended Practice RP 576, Inspection of Pressure-Relieving Devices**. The use of original manufacturer's replacement parts is necessary to maintain new valve performance, capacity flow and warranty. Farris Engineering expressly voids its warranty and will not be responsible for faulty valve operation if non-factory replacement parts or methods are utilized in product repair.

Field Removal

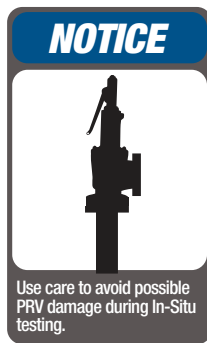
A visual inspection of pressure relief valves should be made when the valves are first removed from the system. Many types of deposits or corrosive debris may be loose and drop out from the pressure relief valve while it is being transported to the shop. When fouling is a frequent problem, it may be desirable to collect samples for further testing and to make notes regarding deposit location and appearance. Any obstructions in the valve should be noted and corrected.

Inspection of Inlet and Outlet Piping

When a pressure relief valve is removed from service, the upstream and downstream piping is often open and available for inspection. However, where it is the practice to remove pressure relief devices from equipment during operation by closing block valves, it is usually not possible to make a complete inspection of piping. Such inspection should be made when the operation equipment is out of service. Inspection of the piping at the pressure relief valve will often indicate the condition of other process piping which is not readily available for inspection. Piping should be checked for corrosion, indications of thinning and deposits which may interfere with valve operation. The characteristics of the deposits may supply clues regarding leakage from the pressure relief valve in a closed system.

In-Situ Testing

In-situ or in place testing is frequently performed as a substitute for valve removal and in-shop testing. This should not be considered as equivalent to shop maintenance; however it may be employed under controlled situations to extend the shop service frequency of particular valves. The most common method of in-situ testing employs an external power source applied to the valve to determine the valve set pressure at some lower system pressure. While this method can accurately determine the valve set pressure, valve reseal pressure cannot be determined using the method. Care must be exercised with this method to avoid possible valve damage that may go undetected during the in-situ test.



In-Shop Inspection

When a valve is first received in the shop it should be given a visual inspection to note its condition when removed from service. The results of this inspection should be noted on appropriate forms. It is generally considered important to determine the set pressure of the valve when removed from service and prior to the valve being disassembled. If the valve opens at the set pressure, the valve need not be tested further to determine the as-received relieving pressure. If the initial pop is higher than the set pressure, it is advisable to test a second time. If the valve then pops at approximately the set pressure, this indicates that the valve was probably stuck because of deposits. If the valve does not pop near the set pressure, this indicates that the valve setting was either in error originally or may have been changed during operation.

Valves which are found acceptable upon shop pre-test cannot be returned to service with a National Board "VR" stamp being applied unless they are completely disassembled and complete repairs are undertaken. Some maintenance programs may however authorize valves found acceptable on shop pretest to be returned to service based on historical records, tear-down cycles and all seals and valve identifications remaining intact.

Preparation For Maintenance

Before valve teardown is performed a review of previous maintenance records will assist in an understanding of past valve performance, settings and maintenance requirements. A complete maintenance records management system will allow proper stocking of common replacement items such as gaskets and seals and adequate stocking of major replacement parts such as nozzles, discs, and springs. Maintenance records, when properly updated, can serve to identify the need for ordering spare parts when valve servicing shows that the useful life of a particular part has been reached. Rework details and installation of new parts should be recorded to aid future service activities.

6. Disassembly Instructions

General Disassembly of Valves

After the valve is received and checked it is ready for shop inspection and repair. The valve should be carefully dismantled. If you are unfamiliar with this line of Farris valves carefully study the cross-sectional drawings in Figures 4.1 through 4.5 to familiarize yourself with part terminology and location. Proper facilities should be available for segregating parts as the valve is dismantled. At each stage in the dismantling process, all parts of the valve should be visually inspected for evidence of wear and corrosion. If parts are worn, replace them. See Appendix G for necessary tools.

The following general points will provide a brief checklist to follow during disassembly. Detailed discussion will follow for specific critical parts.

- Check for the presence of wire seals at all points of adjustment.
- Check for complete and properly identified nameplates and tags.
- Check the condition of flanges; look for evidence of pitting, roughening, deterioration of gasket surface, distortion, etc.
- Visually inspect springs for evidence of corrosion, cracking, and correct selection.
- Visually inspect bellows (if the valve is of bellows type).
- Examine o-ring condition (if applicable).
- Visually inspect inlet and outlet openings; look for evidence of deposits of foreign material and for corrosion. Note the condition of external surfaces and look for any indication of corrosion or evidence of mechanical damage.
- Check and note the body, nozzle and bonnet wall thickness, thread and stud condition.
- Verify valve components and material and check against nameplate information.



Disassembly Instructions:

Farris 2600 Series valves should be disassembled as described below. Parts identification may be found in Figure 4.1 on page 8. The parts from each valve should be properly marked and segregated to keep them separate from parts used in other valves.

1. Cut the wire seals and remove the **Cap** [3] and **Cap Gasket** [21]. For valves equipped with a lifting lever, follow the instructions in Appendix D. **(Figure 6.1)**
2. Before loosening the **Jam Nut** [11], measure the location of the **Spring Adjusting Screw (SAS)** [10] by marking the **SAS** [10] above the **Jam Nut** [11]; or by counting the number of counter clockwise revolutions of the **SAS** [10] until the **Spring** [20] is no longer compressed. This will allow the approximate set pressure to be re-established when reassembling the valve. **(Figure 6.2)**
3. Remove the **Jam Nut** [11] and **SAS** [10].



Figure 6.1

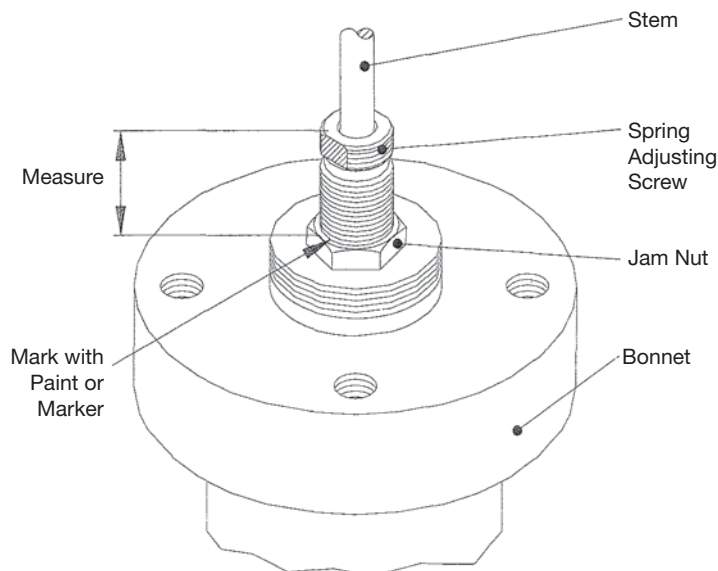
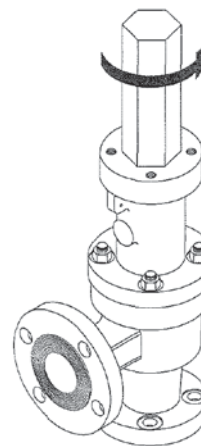


Figure 6.2

4. Remove the **Blow Down Ring Lock Screw** assembly [12,13, 25] and **Lock Screw Gasket** [24]. Record the position of the **Blow Down Ring** [7] with respect to the **Disc Holder** [6] by counting the number of notches required to raise the ring until it just touches the **Disc Holder** [6]. This information will be needed again when reassembling the valve. **(Figure 6.3)**
5. Remove the **Body Hex Nuts** [19]
6. Record the position of the bonnet drain relative to the valve outlet and remove the **Bonnet** [2].
 - a. On larger valves, the combination of bonnet weight and the height that it must be lifted to clear the **Stem** [9] requires that a hoist be used to remove the **Bonnet** [2]. During this operation, the valve **Body** [1] should be secured to prevent it from tipping over once the **Bonnet** [2] is removed.
 - b. Use care when lifting the **Bonnet** [2] as the **Spring** [20] and **Stem** [9] will be able to tip over.
7. Remove the spring assembly (**Spring** [20] and **Spring Buttons** [17]) from the **Stem** [9]. The spring assembly must be kept together. The **Spring Buttons** [17] should be tagged for later identification as the upper and lower buttons may not be identical.

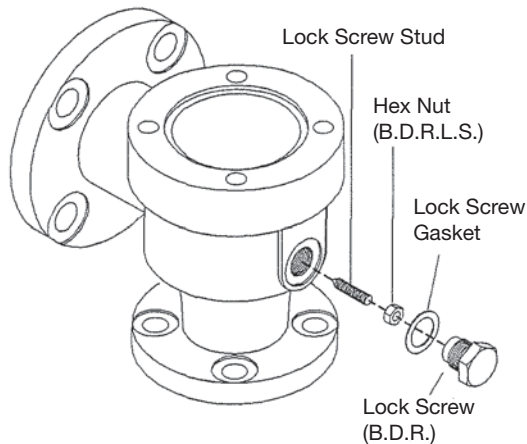


Figure 6.3

8. Using the **Stem** [9] as a handle, lift the complete internal assembly from the valve **Body** [1]. **(Figure 6.4)**
 - a. On larger valves a hoist is advisable due to the weight of the internal assembly.
 - b. An eye bolt may be attached to the stem test washer thread at the end of the **Stem** [9] to assist in lifting.
 - c. For balanced bellows valves, use care not to damage the bellows assembly.
 - d. If parts are difficult to remove due to the presence of corrosive or foreign material soaking in a suitable solvent may be required.
9. Remove the **Body Gasket** [22] and **Bonnet Gasket** [23].
10. To remove the **Stem** [9] from the **Stem Retainer** [14], lift up on the **Stem** [9] while holding the **Stem Retainer** [14] down and rotate counter-clockwise at the same time. This will engage the thread. Continue rotating until the **Stem** [9] is removed. **(Figure 6.5)**

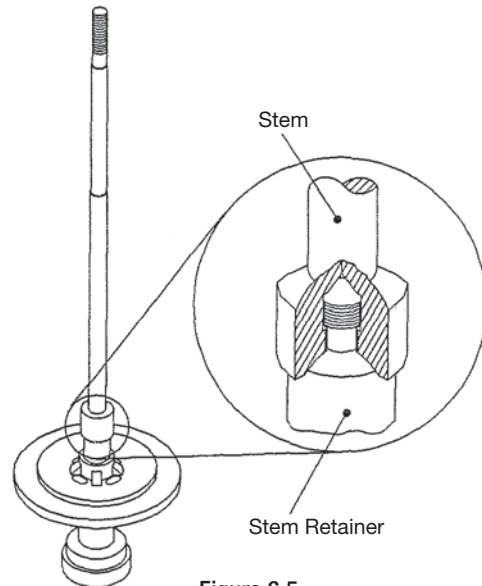


Figure 6.5

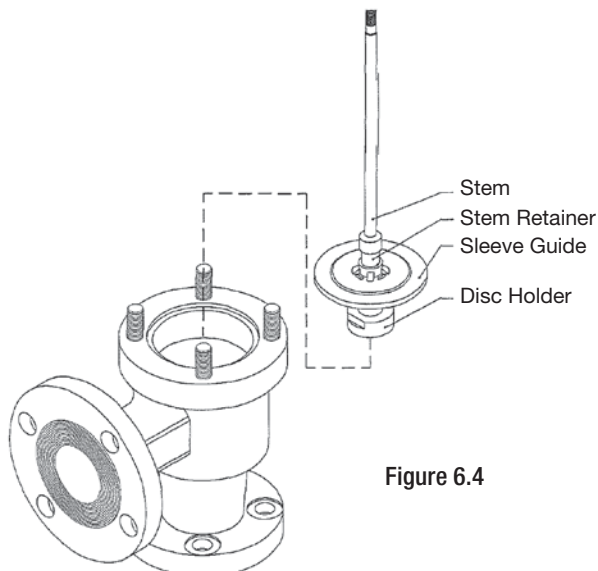


Figure 6.4

11. Remove the **Disc** [4] from the **Disc Holder** [6] (**Figure 6.6**).
 - a. Hold the assembly and rotate the **Disc** [4] with the tip of your finger.
 - b. For o-ring seat type valves, refer to Appendix C for instructions.
12. To separate the **Disc Holder** [6] from the **Stem Retainer** [14], first thread the lock screw up into the **Stem Retainer** [14] using the fixture shown in **Figure 6.7** to hold the assembly.
 - a. Except for the D & E orifice bellows (A11) designs which have a one piece stem retainer/disc holder, the **Stem Retainer** [14] and **Disc Holder** [6] are held together with a **Disc Holder Lock Screw** [26].
 - b. The **Disc Holder Lock Screw** [26] has a hex socket requiring the use of an Allen key (**Figure 6.8**).
 - c. Locking tension is relieved by threading the lock screw UP INTO the **Stem Retainer** [14].

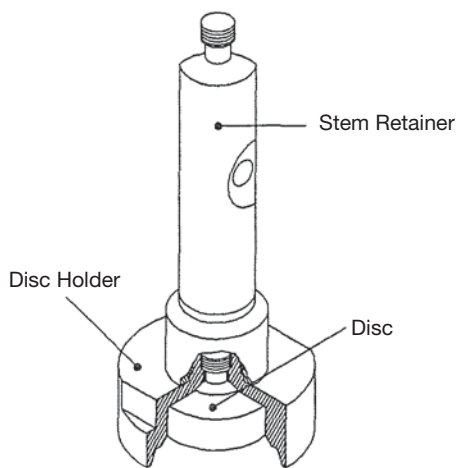


Figure 6.6

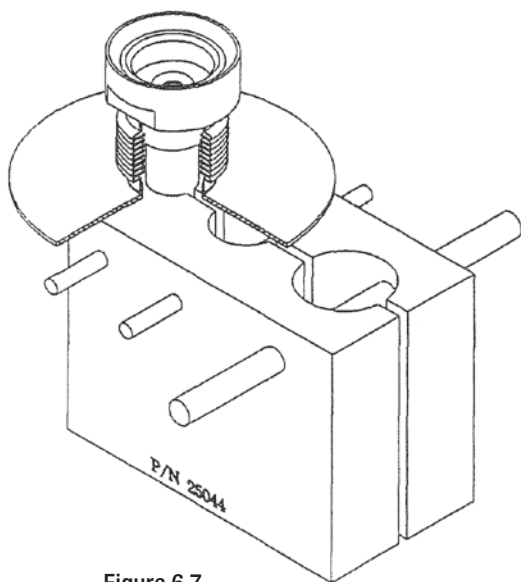


Figure 6.7

- d. Allen key wrench sizes are shown in **Table 6.1**.
 - e. Be careful not to damage the guiding surface of the **Stem Retainer** [14] during disassembly.
 - f. For bellows valves see Appendix B.
13. Remove the **Blow Down Ring** [7] from the **Nozzle** [5].
 14. Turn the valve **Body** [1] over and re-clamp to the work bench. With a spanner wrench and mallet, remove the **Nozzle** [5] from the **Body** [1].
 - a. Some valves may use wrenching flats instead of spanner holes.

NOTES:

1. For **BalanSeal Bellows construction**, please see Appendix B for disassembly instructions.
2. For **O-Ring seat construction**, please see Appendix C for disassembly instructions.
3. For **open lever, packed lever and bolted cap construction**, please see Appendix D for disassembly Instructions.

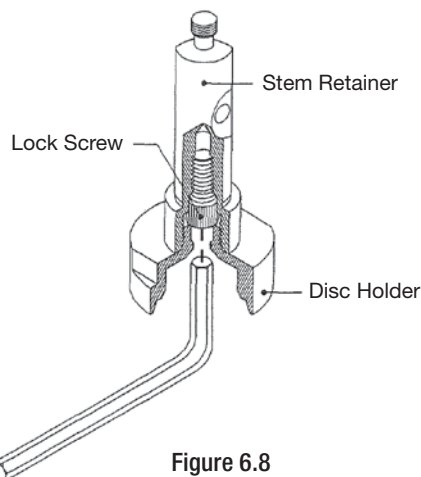


Figure 6.8

Allen Key Sizes	
Disc Holder Lock Screw	
Orifices	Allen Key Size
D thru J	3/16"
K thru P	7/32"
Q thru T	3/8"

Table 6.1

7. Cleaning and Inspection

7.1 Cleaning

Blast Cleaning

2600 Series body, bonnet and cap castings can be sand or bead blasted. When blast cleaning, exercise caution to protect internal and machined surfaces to avoid causing damage. Protect the nameplate prior to blast cleaning. It is not recommended to blast internal parts.

Brush Cleaning

Internal parts (except for guiding surfaces) and the inside of the body and bonnet castings can be cleaned with a wire brush and/or grinder until they are clean. Exercise caution when brush cleaning to avoid damaging or eroding the parts. Only clean stainless steel brushes should be used on stainless steel components.

Immersion/Washing

Castings and internal parts should be thoroughly cleaned with an appropriate solvent or cleaning solution. After immersion/washing, ensure that any residue is removed and parts are dried completely.

Polishing

Guiding surfaces on the stem, stem retainer and guide can be polished using a fine emery cloth.

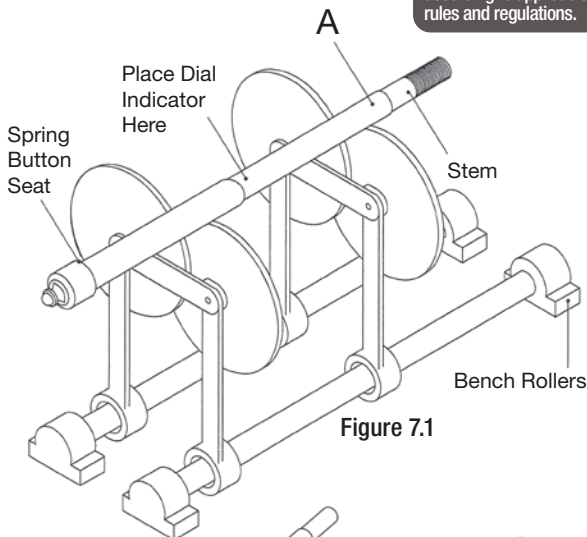


Figure 7.1

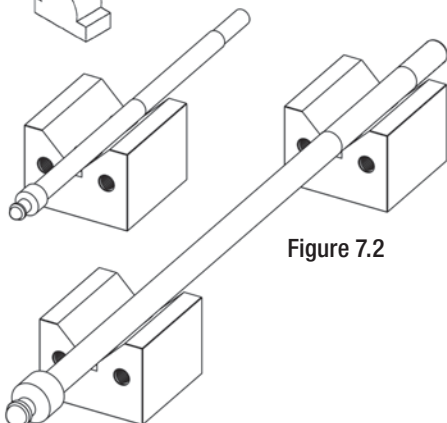
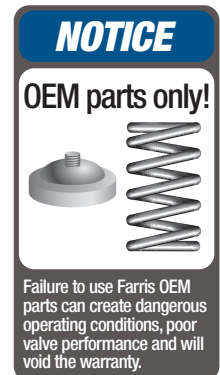


Figure 7.2

7.2 Inspection

Check all valve parts for wear and corrosion. Inspection of valve components is important to ensure proper valve performance. **Damaged valve parts must be repaired or replaced with OEM parts.**



The valve seat (nozzle and disc) must be examined to determine if they have been damaged. Typically, lapping the nozzle and/or disc is all that is needed to restore these parts to their original condition. Prior to lapping, or if machining is necessary, consult section 8 and Appendix E, Critical Dimensions.

The valve spring should be inspected for evidence of cracking, pitting, corrosion or deformation. If any of these are found, the spring should be replaced.

The guiding surfaces on the sleeve guide and stem retainer should be checked for evidence of pitting, corrosion, distortion or galling. If found, these parts should be replaced.

Stems should be inspected as follows:

1. Check the bearing point on the stem tip for a smooth surface. Lap if necessary against the mating part to improve the surface. If the spherical contact is destroyed, the stem should be replaced.
2. Check the critical stem areas for concentricity using the following procedures (Figure 7.1 and 7.2):
 - a. Using "V"-Blocks or bench rollers, check the stem at the midpoint and also at the lower spring button radius for any runout.
 - b. By applying a machinist's dial indicator and rotating the stem, the total indicator reading should not exceed 0.007 inches. Straighten if necessary.
3. The top area of the stem just below the threads serves as the valve's upper guiding surface in conjunction with the spring adjusting screw. This area is supplied from the factory with a 63 AARH finish. This area should be free from any signs of galling, corrosion, distortion or pitting. If seen, the stem should be replaced.

For BalanSeal valves, the bellows should be inspected for evidence of cracking, pitting, corrosion or deformation that might develop into a leak.

Check and inspect all gaskets for evidence of damage or corrosion. Typically, gaskets should be replaced prior to assembly.

8. Maintenance and Repair Procedures

Nozzle Refacing

1. Prior to refacing the nozzle seating area, grip the nozzle flange in a lathe chuck fitted with soft jaws (preferably with removable top jaws), and bored on each set-up to fit the nozzle flange outside diameter.
2. True up the nozzle by means of an indicator, ensuring that the nozzle bore and the machined surface between the nozzle threads and body sealing surface are concentric with each other, within 0.002" full indicator reading.
3. Machine a light cut across the seat until the damaged areas are removed, ensuring compliance with Appendix E. The seat should be machined to the smoothest possible finish. Rigidity of the cutting tool is critical.
4. Relap to the required finish.
5. Discard and replace the nozzle when the length from the seat to the flange becomes less than the minimum specified by the manufacturer. Do not reduce the nozzle flange thickness in an attempt to maintain the "L" dimension. The valve center to face dimension will be altered as a result and nozzle strength may be impaired.
6. See Appendix E for Critical Dimensions.



Lapping Compounds

The three grades of Farris Lapping Compounds are prepared especially for the requirements of pressure relief valves. These are the only compounds recommended for achieving extreme valve tightness. These compounds are available in 2 ounce tubes. Use sparingly.

Farris Lapping Compounds			
Part No.	Grade	Finish	Size
18632X1 (055)	3F	Roughing	1/2 oz. tube
18633X1 (075)	38-500	Medium	1/2 oz. tube
18634X1 (105)	38-1200	Final	1/2 oz. tube

Lapping Procedures (Manual)

1. Use a cast iron lapping block or Pyrex lapping glass which is known to have a perfectly flat face.
2. Select the appropriate lapping compound. When lapping the disc, operate with a light figure eight motion over entire block surface. In this way complete contact will be made (Figure 8.1).

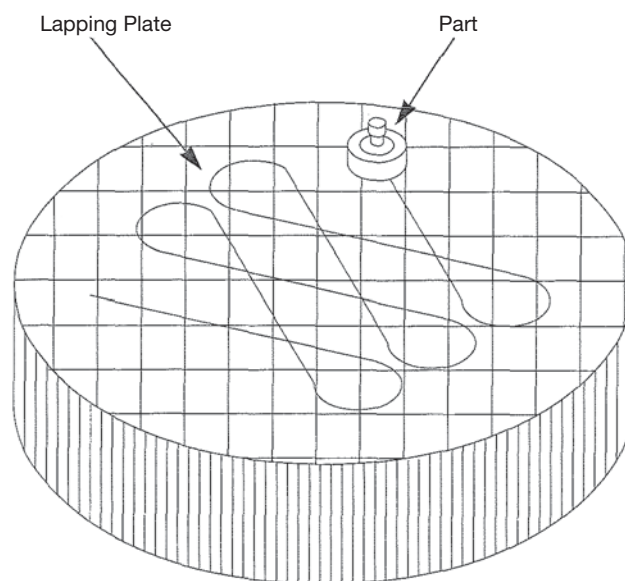


Figure 8.1

Disc Refacing

1. Prior to refacing the disc seating area, grip the disc outside diameter in a universal three-jaw lathe chuck fitted with soft jaws (preferably with removable jaws), and bored on each set-up to the disc outside diameter. Avoid excessive chucking force.
2. True up the disc by means of an indicator, ensuring that the disc outside diameter and seat face are true with each other within 0.002" full indicator reading.
3. Machine light cuts across the seat at 90° to the axis until the damaged areas are removed, facing to the smoothest possible finish. Rigidity of the cutting tool is critical.
4. Relap flat across the full width of the raised seating surface.
5. Discard and replace the disc when the thickness is less than the value in Appendix E.
6. See Appendix E for Critical Dimensions.

3. Lap the disc until all blemishes and score marks have been removed. As the figure eight motion is executed, frequently lift the disc away from the block to get a fresh bite on the compound. Most important, do not contaminate compounds with dirt. Store lapping blocks and lapping glass in a clean, dust-free area.
4. Follow the same procedure for lapping the nozzle. When lapping nozzles, the nozzle can be placed on a table and a lapping block placed on the nozzle. Be sure that the lapping block does not tip over the side of the nozzle (which would cause rounding of the edges). Use a light, rapid figure eight stroke, lifting the block from the nozzle occasionally.
5. When finished, be sure that all parts are carefully cleaned of all lapping compound using a suitable solvent. Residual compound may damage the seating surfaces during valve operation. When reassembling the parts in the valve be careful not to scratch or score the seating surfaces.
6. If the nozzle or disc is badly scored or pitted a fine machine cut should be made to reface the surfaces following instructions in the refacing section of this manual.

Lapping Procedures (Machine)

Lapping machines come in a variety of styles. There are limitations to the parts that can be lapped, which may be due to constraints of the lapping machine or the nature of the part to be lapped.

Limitations:

1. **The size of the lapping machine.**
Obviously, you will be limited by the size of the lapping plate on the machine. A part that is larger than the lapping plate capacity will have to be hand lapped.
2. **The weight of the part to be lapped.**
Some parts will be too heavy to lap on the machine, relative to the area to be lapped. These parts will have to be hand lapped.
3. **How well the part can be balanced on the lapping machine.**
Due to geometry and weight distribution of the part, the part may tend to wobble or fall over in the lapping machine. For these types of parts a holding fixture should be designed or the part should be lapped by hand.

General Operation

This is a general procedure for the use of lapping machines. ALWAYS FOLLOW THE MANUFACTURER'S OPERATING INSTRUCTIONS.

Thoroughly clean all contaminants from the seat area of the nozzle or disc to be lapped. Place the nozzle or disc seating area on the lapping plate. Turn on the machine and adjust the flow of lapping fluid which should be enough to keep the lapping plate covered with a thin film. The lapping plate should be neither dry nor overly lubricated.

The duration of time that the nozzle or disc should be lapped is dependent on the weight of the part, the hardness of the material, and the area to be lapped. A combination of a heavy part with a small area to be lapped made from a soft material will take the shortest time to lap. A combination of a light part with a large area to be lapped made from a hard material will take the longest time to lap.

Once the lapping is complete, remove the nozzle or disc from the lapping plate and remove the lapping fluid with soft tissue and suitable solvent. Protect the seating areas with soft tissue covered by a plastic cap.

Lapping Machine Maintenance and Seat Inspection

Seat flatness is critical to achieving leak tight seats. As the width of most pressure relief valve seats is quite narrow, it is difficult to check seat flatness directly with a monochromatic light. Instead, a standard test block should be kept on the lapping machine that can be periodically checked to determine the condition of the lapping plate. If the test block "reads" flat then all parts lapped on the machine will also be flat. Since the lapped surface needs to be reflective in order to "read" the surface flatness using a monochromatic light source and optical flat, a polishing stand is a needed accessory. Remove the test block from the lapping machine and clean off all lapping fluid. Rub the test block on the polishing stand as if you were hand lapping the test block. Only a few strokes will be necessary to make the surface reflective enough to allow reading the lines produced by the monochromatic light. For full details on how to read these lines and the subsequent adjustments of the machine consult the lapping machine manufacturer.

The quality of the lapped surface produced by the lapping machine can only be as good as the level of maintenance of the machine itself.

9. Assembly Instructions

Lubrication and Sealant:

Threaded parts should be lubricated to prevent galling, especially parts made of similar materials. In addition, guides and pivot points should contain lubricant which is compatible with the service conditions. Sealant should also be applied to prevent fluid from escaping valve boundaries, especially if back pressure is present. The adjacent table lists the suggested lubricant and sealant for air, steam, and liquid service. Service conditions may dictate that other lubricant or sealant be used.



Item	Thread Lubrication	Air	Steam	Liquid
1	Pipe Plug/Body	A	A	A
2	Lock Screw (BDR) Body	A	A	A
3	Blowdown Ring/Nozzle	D	D	D
4	Lock Screw Stud/Jam Nut (BDRLS)	A	A	A
5	Disc/Disc Holder	A	A	A
6	Stem Retainer/Disc Holder (if Applicable)	A	A	A
7	Lock Screw (DH)/Stem Retainer	A	A	A
8	Stem Retainer/Stem	A	A	A
9	Pipe Plug/Bonnet (if applicable)	A	A	A
10	Spring Adjusting Screw/Bonnet/Jam Nut	A	A	A
11	Plain Cap/Bonnet (if applicable)	A	A	A
12	Body Stud/Body/Hex Nut	A	A	A
Guiding and Pivot Lubrication				
13	Disc/Disc Holder	A	A	A
14	Sleeve Guide/Stem Retainer	D	D	D
15	Stem Retainer/Stem	A	A	A
16	Spring Button/Stem	A	A	A
17	Spring Button/Spring Adjusting Screw	A	A	A
Sealant				
18	Body/Nozzle	A	A	A
19	Body/Bonnet/Sleeve Guide/Gaskets	A	A	A
20	Bonnet/Gasket/Cap (if applicable)	A	A	A
21	Bellows Gasket	B	B	B

Code for Above Recommended Lubrication and Sealant

A = Bostic Never Seez

B = Molykote 3452

D = No Lubrication

* Service conditions may require an alternate lubricant or sealant

Assembly Instructions

Farris 2600 Series valves should be assembled as described below. Parts identification may be found in Figure 4.1 on page 8.

For torque requirements, please refer to Appendix H.

1. Thread the **Nozzle** [5] into the **Body** [1].
2. Thread the **Pipe Plug** [28] into the **Body** [1].
3. Thread the **Blow Down Ring** [7] onto the **Nozzle** [5].
4. Thread the **Hex Nut** [25] onto the **Lock Screw Stud** [13]. Thread the **Lock Screw Stud** [13] into the **Lock Screw** (BDR) [12].
5. Thread the **Lock Screw Assembly** into the **Body** [1] including the **Lock Screw Gasket** [24]. Adjust the position of the **Lock Screw Stud** [13] so that it prevents rotation of the **Blow Down Ring** [7] yet does not bind it. Use the position noted during disassembly. (**Figure 9.1**)
6. Thread the **Body Studs** into the **Body** [1].
7. Place the **Body Gasket** [22] in the **Body** [1] counter-bore.
8. Thread the **Lock Screw** [19] into the **Stem Retainer** [14]. (**Figure 9.2**)

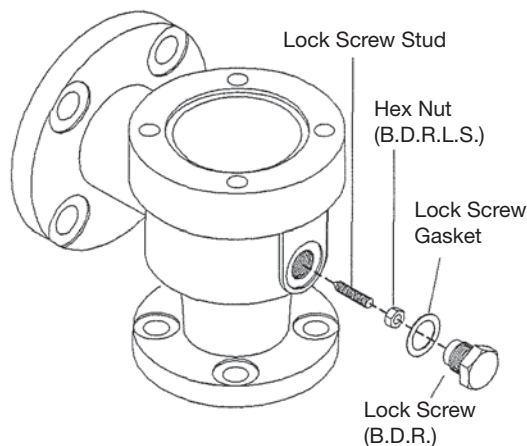


Figure 9.1

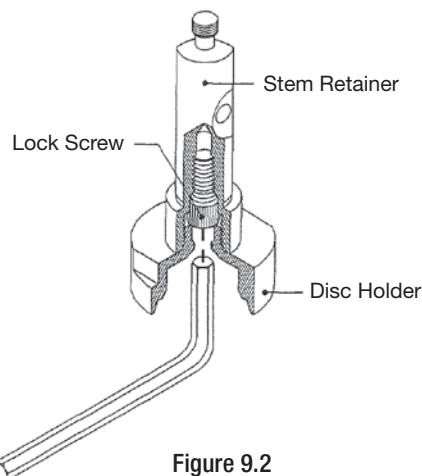


Figure 9.2

9. Thread the **Disc Holder** [6] onto the **Stem Retainer** [14] using a special assembly block (see **Figure 9.3**). Do not attempt to hold the **Stem Retainer** [14] on the guiding surface. Thread the **Lock Screw** [19] counter clockwise until contact is made with the **Disc Holder** [6]. Tighten to lock the assembly together.
10. Thread the **Disc** [4] into the **Disc Holder** [6]. Be sure the **Disc** [4] is free-floating. (**Figure 9.4**)
11. Place the **Sleeve Guide** [8] over the **Stem Retainer** [14] with the long lift stop facing down. Be sure that the guiding motion is smooth.

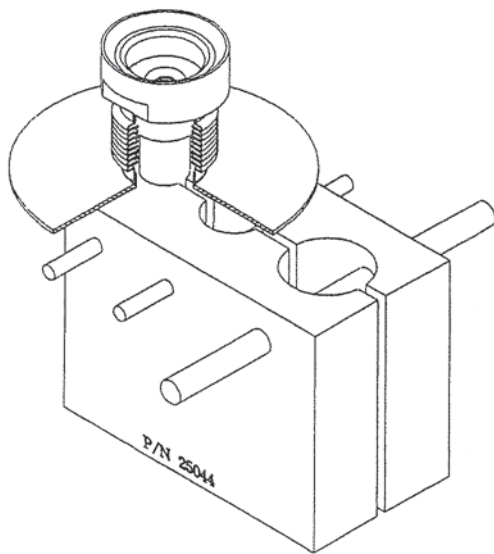


Figure 9.3

12. Thread the **Stem** [9] and **Stem Retainer** [14] together. Be sure this connection is free-floating. (**Figure 9.5**)
13. Lower the **Assembly (Stem** [9], **Sleeve Guide** [8], and **Disc Holder** [6]) into the **Body** [1] counter-bore. (**Figure 9.6**)
14. Place the **Bonnet Gasket** [23] on the **Sleeve Guide** [8], or secure with sealant in the **Bonnet** [2] counter-bore.
15. Place the lower **Spring Button** [17] on the **Stem** [9]. **Caution** – in some valve sizes the upper and lower **Spring Buttons** [17] are different.
16. Place the **Spring** [20] on the lower **Spring Button** [17].

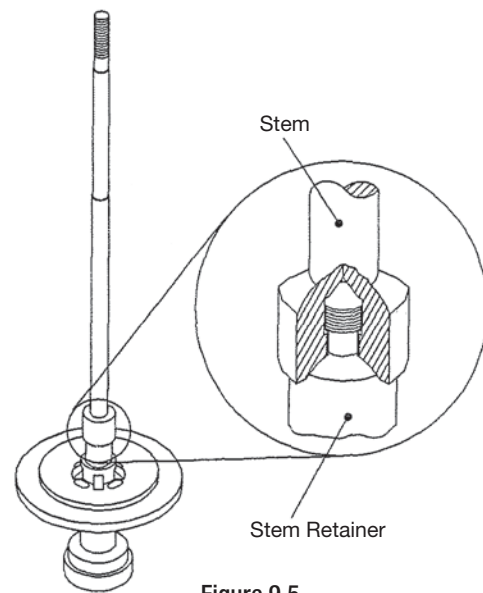


Figure 9.5

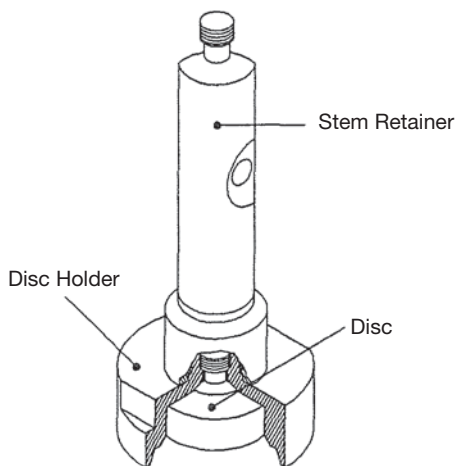


Figure 9.4

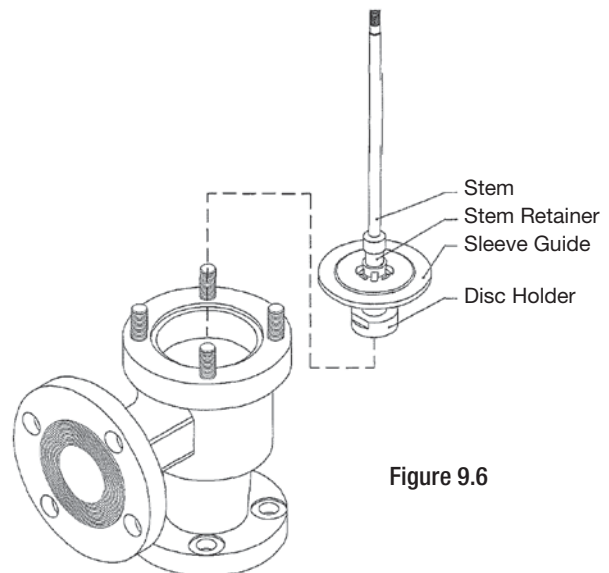


Figure 9.6

17. Place the upper **Spring Button** [17] on the **Spring** [20].
18. Thread the **Pipe Plug** [27] into the **Bonnet** [2]. Skip this step for Bellows Construction.
19. Place the **Bonnet** [2] onto the **Body** [1], making sure to align the **Pipe Plug** [27] to the position indicated in disassembly notes. Normal convention is to position the **Pipe Plug** [27] opposite of the valve outlet.
20. Thread the Hex Nuts (Body) onto Body Studs and tighten. Ensure that the **Body Gasket** [22] and **Bonnet Gasket** [23] are properly positioned in the respective counter-bores.
21. Thread the **Jam Nut (SAS)** [11] onto the **Spring Adjusting Screw (SAS)** [10].
22. Thread the **SAS** [10] into the **Bonnet** [2] to the position indicated in disassembly notes.
23. Valve should now be ready for testing, final assembly and sealing.
24. Following testing, place the **Cap Gasket** [21] on the **Bonnet** [2].
25. Thread the **Cap** [3] onto the **Bonnet** [2] and wire-seal.

NOTES:

1. **For Balanseal Bellows construction** please see Appendix B for assembly instructions.
2. **For O-Ring seat construction** please see Appendix C for assembly instructions.
3. **For open lever, packed lever and bolted cap construction** please see Appendix D for assembly Instructions.

10. Setting, Testing and Adjustments

Equipment

Air testing is the usual method of testing and setting pressure relief valves; however, valves should be set and tested using the approved media according to applicable codes and standards. A pressure source supplies air to a test drum usually 1-1/2 cubic feet internal volume. The air pressure to the test drum is controlled by a quick opening valve (approximately 1 inch). The valve being tested is mounted directly on the test drum without restrictions. If considerable numbers of valves are tested, it is advisable to provide an air receiver between the compressor and the quick opening valve. This arrangement allows a small-volume high-pressure compressor to store air during off-hours.



Adjustments & Performance

The use of the correct spring is a matter of critical importance. Attempting to employ a spring below its rated pressure range may result in a loss of lift with resulting loss of capacity and a generally sluggish valve action. Using a spring above or below its rated temperature range may cause a change in spring characteristics and possibly failure of the spring itself. Before changing the set pressure of any valve verify that the new pressure is within the range of the spring and valve construction. When raising the set pressure, check the applicable design code and the design pressure of the protected equipment to ensure compliance with equipment design and local requirements. Before reducing the set pressure, make certain that the capacity at the reduced pressure is sufficient for the protection of your equipment. Valves which are properly installed on steam, gas, or vapor services will relieve with a pronounced pop when opening. After the excess pressure has been relieved, the valve will generally reseal at approximately 5% to 7% below the set pressure. Actual blowdown will vary with each valve and installation. There is generally no distinct pop with liquid service relief valves as the opening will generally be proportional to the rise in pressure. It is important for blowdown rings to be adjusted carefully and accurately in accordance with the table values.

Procedure

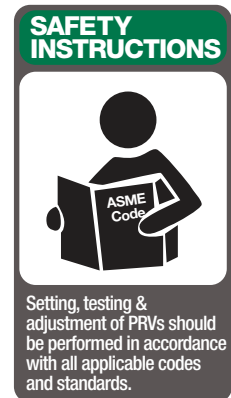
To properly test a valve, the test drum pressure is brought up to about 90% of the set pressure of the valve. The quick opening valve is now opened sufficiently to cause the test drum pressure to continue to increase 2 psi/sec until the valve pops. A test gauge connected to the test drum in a static pressure zone will indicate the pressure the valve pops. Further spring setting adjustments may be necessary to achieve the desired set pressure of the valve. The tightness of a pressure relief valve on gas or vapor service is closely connected with the operation of the valve i.e. unless a valve opens and closes sharply, it may leak. The action of such a valve depends upon the expansive and reactive forces of the flowing medium (gas or vapor only) which in turn depends upon the location of the blowdown ring. Since the capacity of the test stand is considerably less than the actual valve capacity, it is essential that the blowdown ring be adjusted for good test stand operation. The lowest ring position that can be tolerated for a given size test drum depends upon the valve size and its set pressure relative to the test drum size. Raising the nozzle ring to within two notches from touching the disc holder will obtain the maximum reaction from the smallest amount of the test fluid. However, this position may produce excessive impact and seat damage to small valves set at high pressures. Using a test gag while testing valves can reduce the damage to the seating surfaces.

Adjusting Valve to Required Set Pressure

After the valve has been reconditioned and reassembled minus the cap and/or lever assembly, it is ready for a final spring adjustment to the required set pressure. If a new set pressure is required, the limits for adjustment of the spring must be observed. It may be necessary to provide a different spring. After the jam nut is tightened, the valve should be popped at least once more to prove the accuracy of the setting.

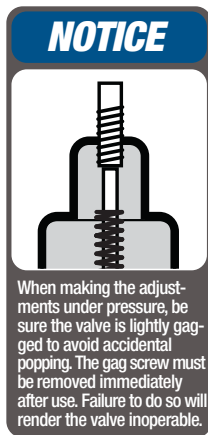
Air Test Stand Settings

For spring adjustment or checking set point on air test stands, raise the ring to a position 2 notches down from contact with the disc holder. Return ring to tabulated field setting or setting established through in-place testing before installation. Be sure to include temperature compensation of set pressure where applicable.



Liquid Service

Liquid service valves must be set on water with set pressure indicated as the first steady stream of water perpendicular to the outlet of the valve. Intermittent opening and closing indicates leakage. The reduction in inlet pressure required to reseal the valve depends on the rate of flow and operator manipulation. Set the blow down ring to the position indicated in Table 10.3. Do not attempt to adjust the blow down ring without gagging the valve first (or reducing inlet pressure to zero). Remove the gag. When the valve is first mounted there will be some air under the disc of the valve. This may cause the valve to pop open suddenly. To remove the air, lift up on the stem to let the air slowly seep out, if possible. Pressure may need to be added under the valve to assist in lifting the stem. Next, raise the pressure to the desired set point. When the pressure is within 90% of the set pressure, raise the pressure at a rate of 1 psig per 2 seconds. Adjust the spring adjusting screw until the desired set pressure is reached. We define set pressure for a liquid valve as the first continuous flow which is flowing 90 degrees from the outlet. Confirm that you have the set pressure correct by raising the pressure to where the first steady stream is evident. Then, lower the pressure until the valve re-seats. Repeat this procedure until the valve shows a consistent opening pressure.



Securing The Blowdown Ring

The adjusted position of the ring is maintained by a blow down ring lock screw which threads into the valve body from the outside and engages notches (like gear teeth) on the outside diameter of the blowdown ring. To make an adjustment, loosen and remove the blow down ring lock screw assembly. Insert a screw driver and rotate the nearest notch toward the left to lower the ring or toward the right to raise it, counting the notches as they are moved. Reinstall the lock screw assembly, ensuring that it intercepts a notch without exerting side-pressure on the ring.

Seat Tightness Testing (Figure 10.1)

After the valve is satisfactorily checked for set pressure, it is necessary to check the valve for seat leakage. It is important to minimize leakage from pressure relief valves. Excessive leakage could lead to fouled and inoperable valves, serious product loss and could also be hazardous to personnel and equipment. The valve can be tested for tightness on the test stand by increasing the pressure on the valve to 90 percent or more of the set pressure and observing the discharge side of the valve for evidence of leakage. Methods of determining leakage are covered by applicable standards and specific user requirements.

API Standard 527 is a widely accepted standard for the procedure and acceptance criteria for assessing the seat tightness of pressure relief valves. The user should be familiar with this standard, in addition to any information presented therein. The following seat tightness methods and requirements are in general compliance with API Standard 527.

Air Testing

All openings from the secondary pressure zone shall be closed before counting the bubble rate. This includes such items as caps, drain holes, vents and outlets. A soap solution or equivalent test shall be applied to secondary joints to detect escape of air other than that being measured. Seat tightness tests are normally conducted with pressure at the pressure relief valve inlet held at 90 percent of the set pressure immediately after popping. For valves set at 50 psig or below, the pressure shall be held a 5 psig below the set pressure immediately after popping. Before starting the bubble count, the test pressure shall be applied for a minimum of: 1 minute for valves of inlet sizes 2 inches and smaller; 2 minutes for sizes 2-1/2, 3, and 4 inches; 5 minutes for sizes 6 inches and larger.

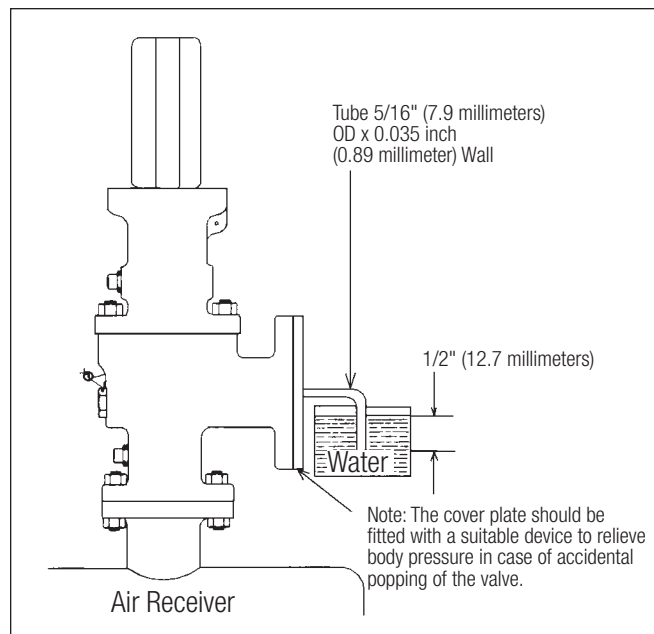


Figure 10.1



Air at ambient temperature shall be used as the pressure medium. The valve shall be observed for leakage for at least 1 minute. The leakage rate in bubbles per minutes shall not exceed the numbers listed in Table 10.1. For an O-ring seated valve, there shall be no leakage for 1 minute (Zero bubbles per minute @ 95% of set pressure). (Figure 10.1)

Maximum Seat Leakage Rates for Metal-Seated Pressure Relief Valves		
Set Pressure psig	Leakage Rate (Bubbles per Minute)	
	F Orifice and Smaller	G Orifice and Larger
15-1000	40	20
1500	60	30
2000	80	40
2500	100	50
3000	100	60
4000	100	80
5000	100	100
6000	100	100

Table 10.1

Steam Testing

Steam service pressure relief valves which are set and adjusted on steam shall be leak-tested on steam visually using a black background. There shall be no visible leakage from the valve outlet when the inlet pressure is held at 90% of the set pressure after popping and reseating. For set pressure below 50 psig this test shall be conducted at 5 psig below set pressure. The valve shall be observed for leakage for at least 1 minute. This criteria applies to both metal and o-ring seated valves.

Liquid Testing

Liquid service pressure relief valves are set and adjusted on water shall be leak-tested on water at near ambient conditions. Before starting the seat tightness test, the set pressure shall be verified, and the outlet body bowl shall be filled with water, which shall be allowed to stabilize with no visible flow from the valve outlet. The inlet pressure shall be increased to the test pressure. The valve shall be observed for 1 minute at the test pressure. For valves set at 50 psig or below, the pressure shall be held at 5 psig below the set pressure. Above 50 psig set pressure hold the pressure at 90% of the set pressure.

Blow Down Ring Settings: Air, Gas, and Vapor Applications									
Orifice	Set Pressure Range, psig								
	15 - 100	101 - 200	201 - 300	301 - 400	401 - 500	501 - 600	601 - 800	801 - 1000	1001 & Up
D ₁	3	4	6	7	7	9	9	9	10
	2	2	3	4	4	5	5	6	7
E ₁	5	9	12	15	15	18	18	19	20
	2	2	3	4	4	5	5	6	7
F	2	3	4	5	5	7	8	9	10
G	3	4	5	6	6	8	9	10	11
H	3	4	5	6	6	8	9	10	11
J	3	5	5	6	6	8	9	10	11
K	4	5	6	7	7	9	10	11	12
L	4	6	9	9	9	10	10	11	12
M	4	6	12	12	12	12	12	12	12
N	5	10	15	15	15	15	15	15	15
P	6	16	20	20	20	20	20	20	20
Q	6	16	20	20	20	20	20	20	–
R	4	16	20	20	–	–	–	–	–
T	4	16	20	–	–	–	–	–	–
U	4	16	20	–	–	–	–	–	–

Blow Down Ring Settings: Steam Applications									
Orifice	Set Pressure Range, psig								
	15 - 100	101 - 200	201 - 300	301 - 400	401 - 500	501 - 600	601 - 800	801 - 1000	1001 & Up
D ₁	3	4	6	7	7	9	9	9	10
	2	3	4	5	6	7	8	9	10
E ₁	5	3	12	15	15	18	18	19	20
	2	2	4	5	6	7	8	9	10
F	2	4	5	6	7	8	9	10	12
G	3	5	6	7	8	9	10	11	13
H	3	5	6	7	8	9	10	11	13
J	3	6	6	7	8	9	10	11	13
K	4	6	7	8	9	10	11	12	14
L	4	7	7	8	9	10	11	12	14
M	4	7	7	8	9	10	11	12	14
N	4	7	7	8	9	10	11	12	14
P	4	7	7	8	11	10	11	12	14
Q	4	8	9	10	11	12	13	15	–
R	4	8	9	10	–	–	–	–	–
T	4	8	9	–	–	–	–	–	–
U	4	8	9	–	–	–	–	–	–

Table 10.2

Note 1: Use the second row only for "D" & "E" orifice valves purchased before July 1, 1993

For both metal and O-Ring seated valves in liquid service, Farris' standard acceptance criteria is no visible leakage at 90% of set pressure for valves with a set pressure of 50 psig and higher. For valves with a set pressure below 50 psig, the test is performed at a 5 psig differential. API Standard 527, Seat Tightness of Pressure Relief Valves, does allow for a more liberal leakage acceptance criteria of 10 cubic centimeters per hour per inch of inlet size. Ultimately, the acceptance criteria selected and the amount of leakage that can be tolerated is the responsibility of the end user based on his experience with the specific application.

Blowdown Ring Setting

Tables 10.2 and 10.3 give blow down ring settings in the number of notches down from disc holder contact. The higher the ring, the sharper the pop and longer the blowdown. The lower the ring, the poorer the pop, the shorter the blowdown.

The 2600L series is now ASME Code Section VIII Certified for use in air, steam and vapor service. Regardless of the service, 2600L Series valves should be adjusted using the liquid service blowdown ring settings in Table 10.3.

Liquid Service Applications	
Orifice	Notches
D/E	2
F	3
G/H/J	4
K/L	8
M/N/P	12
Q/R/T/U	20

Table 10.3

Field Settings

The above settings are final average field settings for good performance under actual operating conditions on the installation. Use recommended number of notches, or maximum adjustment possible if less than table. Finer adjustments may be desirable or necessary because of individual piping and service differences. On applications where the valve will operate at substantially reduced flow, fewer notches may help eliminate chatter and ensure seat tightness.

Compensation for Temperature

Any increase in temperature causes a reduction in set pressure of a safety-relief valve. The primary factors are the linear expansion of the body and top works, which reduces the spring loading, and the direct effect of temperature on the spring itself.

It is customary to compensate for this effect by increasing the setting when a valve is set at ambient conditions on a test stand and the valve is intended for a higher operating temperature in service. Although the adjustment is approximate and may be outweighed by other differences caused by variations in media and blowdown ring adjustments, compensation for temperature as an independent variable improves the accuracy of the setting. It is not recommended to reduce a spring setting for valves intended for sub-zero service. (Table 10.4)

CDTP Temperature Compensation		
Normal Operating Temperature		% Increase in Set Pressure at Atmospheric Temp.
°F	°C	
-400 to 300	-240 to 149	none
301 to 600	150 to 316	1%
601 to 900	317 to 482	2%
901 to 1200	483 to 649	3%

Table 10.4

COLD DIFFERENTIAL TEST PRESSURE (CDTP) is the inlet pressure at which the valve is adjusted to open on a test stand at ambient temperature conditions, discharging to atmosphere. Computation includes compensation for constant back pressure (if required) and inlet operation temperature. Cold Differential Test Pressure is the sum of the Spring Selection and the Increase in Setting to compensate for temperature. The abbreviation is Cold Set. (Table 10.4)

Compensation for Backpressure

Back Pressure is the pressure existing at the valve outlet and in the valve outlet and in the downstream portion of the valve body. It may be superimposed, built-up, constant, or variable. The spring setting should be compensated for constant and superimposed back pressure, except for BalanSeal valves. For these type valves, variable back pressure is not compensated for, but the maximum pressure limit of the bellows is stamped on BalanSeal tag (Figure 1.1).

Operating Differentials

The variety of service conditions which a pressure relief valve is subjected to precludes a rigid set of rules. Operating difficulties can be minimized by providing as much differential as possible for known conditions on a particular application. Table 10.5 lists the suggested minimum differentials.

Final Notes

Once your valve has been assembled and tested make sure that you have completed all necessary records before placing it back in service. These records are important for the effective future use of the valve. They will provide some guidance as to when to retire valves and replace components as well as providing the historical record of the conditions and services under which the valve operated. A sample maintenance record appears in Appendix F which can be photocopied and used for this purpose.

The valve should be properly installed in service or prepared for storage. If the valve is to be stored the inlet and outlet of the valve should be covered to protect against any foreign matter entering the valve.

Set Pressure Tolerance And Operating Differentials: Gases, Vapors, and Liquids				
	Set Pressure psig	Set Pressure Tolerance (+) or (-)	Minimum Differential Suggested (Gases & Vapors)	Minimum Differential Suggested (Liquids)
Metal Seat Soft Seat	15 to 70	2 psi	5 psi	5 psi
Metal Seat Soft Seat	71 to 1000	3%	10%	10%
Metal Seat Soft Seat	1001 to 6000	3%	10%	10%

Table 10.5

11. Troubleshooting

Chatter

The valve is oversized for installation.

If the inlet capacity is less than 25% of the valve capacity there will be a tendency for the valve to chatter.

The inlet piping is of excessive length or the inlet pipe diameter is less than the inlet size of the valve.

Design inlet piping systems so that the pressure drop to the valve is less than 3%. The inlet pipe diameter should be at least the inlet size of the valve.

The outlet piping is of excessive length or the diameter is less than the valve flange size.

Design outlet piping so that the diameter is at least the outlet size of the valve and that pressure on the outlet does not build up causing the valve to shut.

Incorrect Set Pressure

Misreading the nameplate

Always compensate for backpressure and temperature when bench testing the safety-relief valve by following the Cold Differential Test Pressure.

The blowdown ring position changed

Check that the lock screw stud has engaged between the teeth on the blowdown ring to prevent rotation. This could also cause erratic blowdown characteristics as well as leakage.

Internals are misaligned.

See section on leakage.

Jam nut is loose.

Tighten jam nut.

Rough handling.

A safety-relief valve is a precision instrument and should be handled with care. It is also recommended that the valve be popped once or twice to realign the parts after rough handling.

Pressure surge at inlet.

Sudden impact of a fluid may cause the valve to open prematurely. Pressure build-up should be gradual.

The valve contains a bellows and the bonnet is not vented.

Remove bonnet pipe plug so that the bonnet is exposed to atmospheric pressure.

Leakage

The seats are damaged.

Lap the seats to remove the damage. If the scratches are deep, machining may be required. Remove any foreign particles from the system to prevent scoring the seats.

The system operating pressure is too close to the valve set pressure.

Always have at least 10% (or 5 psig, whichever is greater) differential between operating pressure vs. set pressure for metal seated and soft seated valves. See Table 10.5.

Misaligned lifting gear.

Adjust the stem test washer so that there is 1/8 inch clearance between either the cam or lever and the stem test washer. See Appendix D.

Horizontal mounting.

Safety-relief valves must be mounted with the stem in the vertical plane. If mounted horizontally the valve will experience excessive friction on the guides and will not align properly.

Lock screw stud not adjusted properly.

Adjust the length of the lock screw stud so that it does not press into the blowdown ring causing misalignment.

Misaligned internals.

Disassemble valve and check all universal ball joints, flatness of disc and nozzle seat and repair or replace.

Other.

Check for bent stem, springs with uneven ends or out of alignment. A common cause of bent stems is overgagging. Test gags are designed to be finger tightened only.

Blowdown

Blowdown is excessive/the valve is hanging up

Lower the blowdown ring until the desired blowdown is achieved. Also check for dirt or other foreign material in the seating area or on the guiding surfaces.

Blowdown is too short.

Raise the blowdown ring to lengthen the desired blowdown.

Appendix A: Valve Terminology

Safety Valve - An automatic pressure relieving device actuated by the static pressure upstream of the valve, and characterized by rapid full opening or pop action. It is used for steam, gas, or vapor service.

Relief Valve - An automatic pressure relieving device actuated by the static pressure upstream of the valve which opens in proportion to the increase in pressure over the opening pressure. It is used primarily for liquid service.

Safety Relief Valve - An automatic pressure actuated relieving device Suitable for use as either a safety or relief valve, depending on application.

Pressure Relief Valve - A pressure relief valve is a pressure relief device which is designed to reclose and prevent the further flow of fluid after normal conditions have been restored.

Set Pressure - Set pressure, in pounds per square inch gauge, is the inlet pressure at which the pressure relief valve is adjusted to open under service conditions. In a pressure or safety relief valve in gas, vapor, or steam service, the set pressure is the inlet pressure at which the valve starts to discharge under service conditions.

Differential Set Pressure - The pressure differential in pounds per square inch between the set pressure and the constant superimposed back pressure. It is applicable only when a conventional type safety relief valve is being used in service against constant superimposed back pressure.

Cold Differential Test Pressure - Cold differential test pressure, in pounds per square inch gauge, is the inlet static pressure at which the pressure relief valve is adjusted to open on the test stand. This pressure includes the corrections for service conditions of back pressure or temperature, or both.

Operating Pressure - The operating pressure of a vessel is the pressure, in pounds per square inch gauge, to which the vessel is usually subjected in service. A vessel is usually designed for a maximum allowable working pressure, in pounds per square inch gauge, which will provide a suitable margin above the operating pressure in order to prevent any undesirable operation of the relief device. (It is suggested that this margin be as great as possible consistent with economical vessel and other equipment design, system operation and the performance characteristics of the pressure relieving device.)

Maximum Allowable Working Pressure - Maximum allowable working pressure is the maximum gauge pressure permissible at the top of a completed vessel in its operating position for a designated temperature. This pressure is based on calculations for each element in a vessel using nominal thicknesses, exclusive of allowances for corrosion and thickness required for loadings other than pressure. It is the basis for the pressure setting of the pressure-relieving devices protecting the vessel. The design pressure may be used in place of the maximum allowable working pressure in cases where calculations are not made to determine the value of the latter.

Overpressure - Overpressure is a pressure increase over the set pressure of a pressure relief valve, usually expressed as a percentage of set pressure.

Accumulation - Accumulation is the pressure increase over the maximum allowable working pressure of the vessel during discharge through the pressure relief valve, expressed as a percent of that pressure or in pounds per square inch.

Blowdown - Blowdown is the difference between actual popping pressure of a pressure relief valve and actual reseating pressure expressed as a percentage of set pressure or in pressure units.

Lift - Lift is the actual travel of the disk away from closed position when a valve is relieving.

Back Pressure - Back pressure is the static pressure existing at the outlet of a pressure relief device due to pressure in the discharge system.

Superimposed Back Pressure - Superimposed back pressure is the static pressure existing at the outlet of a pressure relief device at the time the device is required to operate. It is the result of pressure in the discharge system from other sources when the valve is closed. Superimposed back pressure can be constant, variable or both:

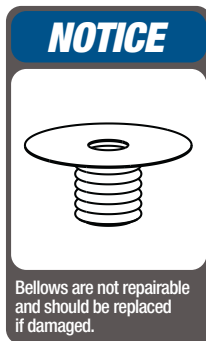
Constant Superimposed Back Pressure - Back pressure which does not change appreciably under any condition of operation whether the pressure relief valve is closed or open.

Variable Superimposed Back Pressure - The pressure existing at the outlet of a pressure relief device, which does not remain constant when the pressure relief valve is closed.

Built-Up Back Pressure - Built-up back pressure is pressure existing at the outlet of a pressure relief device occasioned by the flow through that particular device into a discharging system.

Appendix B: Bellows Construction

Bellows require very thin materials to provide the required flexibility. This results in a delicate assembly which should be carefully handled. Do not attempt to repair a bellows assembly. Any pitting or surface corrosion are sure signs of limited service life even though the bellows may be pressure tight. All bellows assemblies should be pressure tested in accordance with Figure B.1. Any leakage should be cause for bellows replacement. For BalanSeal bellows equipped valves use the assembly fixture shown in Figure B.2. Exercise care in handling the internal assembly when equipped with a bellows as any damage to the bellows in the form of a nick or dent will render the bellows unfit for service. Bellows are not repairable.



1. Place bellows/stem retainer/disc holder assembly into bellows leak test fixture with the bellows flange at the base.
2. Seal the flange of the bellows to the base of the bellows test fixture as illustrated in Figure B.1.
3. Compress the bellows approximately 1/8 inch with a securing bar so that the bellows does not elongate when pressure is applied as in Figure B.1.
4. Fill the disc holder with water. Omit this step for D & E Balanseal designs as these designs have a one piece disc holder/stem retainer.
5. Apply 30 psig pressure to the back side of the bellows.
6. Apply soapy water to bellows exterior to check for bellows integrity.
7. If bubbles appear on bellows exterior there are pin holes or a tear. Replace bellows and repeat the procedure.
8. Check to be sure the bellows/disc holder connection is leak tight. If water in disc holder bubbles or the connection bubbles, tighten the connection or replace gasket.
9. Vent pressure.
10. Release bellows assembly.
11. Air dry bellows assembly to remove soapy water.

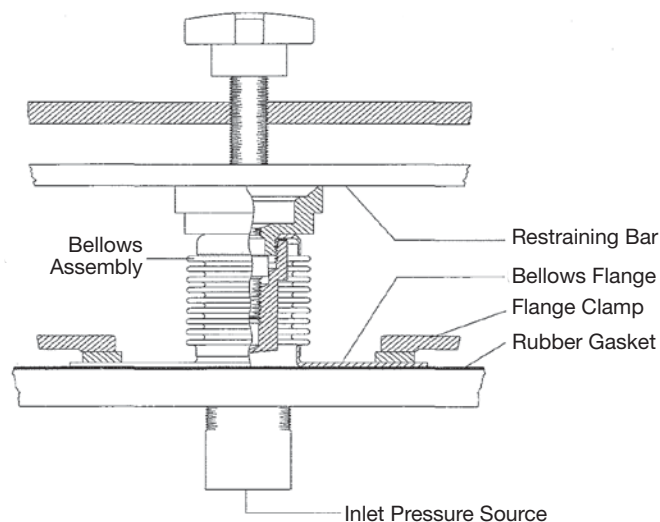


Figure B.1 Bellows Assembly Leak Test

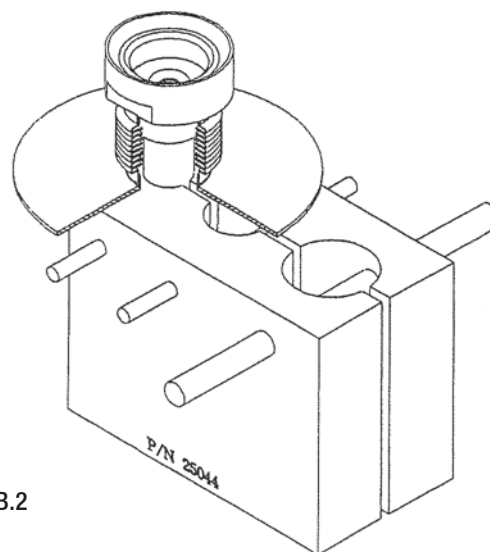


Figure B.2

BalanSeal® Bellows Construction Assembly/Disassembly Instructions

The following instructions are assembly instructions. For disassembly, reverse the order. Parts identification may be found below. Follow the same procedures as for conventional type valves except as follows:

For D and E orifice valves only (Refer to B.3 below):

1. Place the **Bellows Gasket** [16] on **Disc Holder** [6].
2. Thread the **Bellows** [15] onto the **Disc Holder** [6] and securely tighten.
3. Do not thread **Pipe Plug (Bonnet)** into **Bonnet** [2]. **Bonnet** [2] must be vented in accordance with ASME Code.

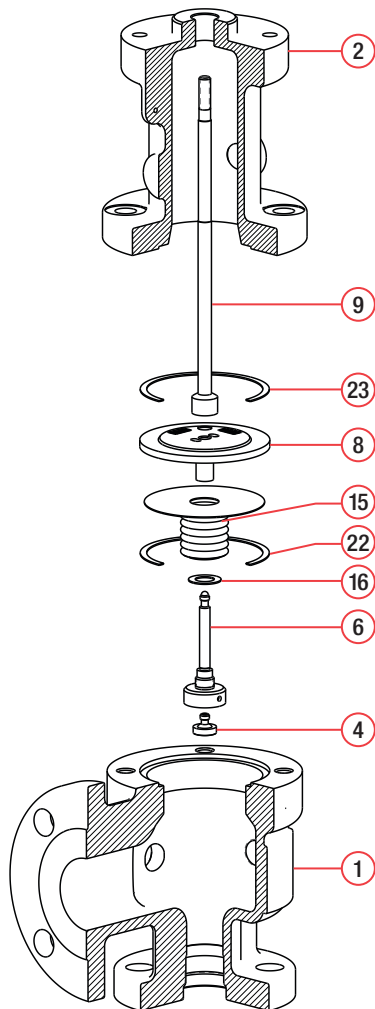


Figure B.3

For all other orifices (Refer to B.4 below):

1. Place the **Bellows Gasket** [16] on the **Stem Retainer** [14].
2. Place the **Bellows** [15] on the **Stem Retainer** [14].
3. Thread the **Disc Holder** [6] to the **Stem Retainer** [14] using the special assembly block.
4. Thread the **Lock Screw** [19] counter clockwise until contact is made with the **Disc Holder** [6]. See **Figure B.1** for bellows leak test.
5. Do not thread **Pipe Plug (Bonnet)** into **Bonnet** [2]. **Bonnet** [2] must be vented in accordance with ASME Code.

Note: For F - K orifices, O-ring seat construction only, an additional **Disc Holder Lock Screw Gasket** must be placed between the **Stem Retainer** [14] and the **Disc Holder** [6].

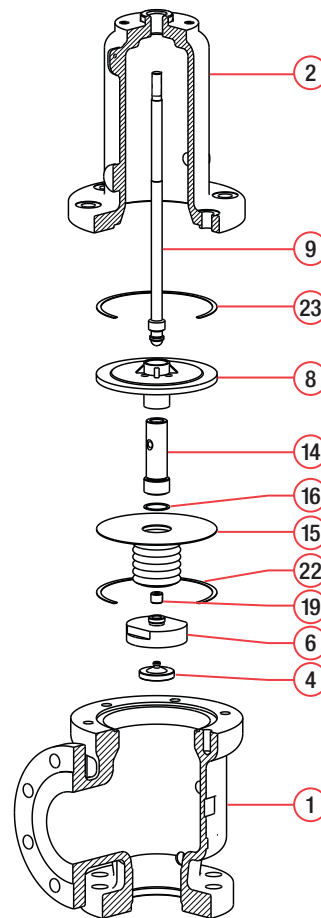


Figure B.4

Appendix C: O-Ring Construction

Due to corrosion, metal-to-metal seats can eventually leak. With the proper selection of the Farris O-ring seat pressure seal, seat tightness can be improved and maintained. Because O-rings are elastomeric, they should be handled carefully. Typically, O-rings should be replaced during your normal maintenance interval. O-rings are not repairable.

Standard seat tightness for O-ring seated valves is no leakage at 90% of set pressure for both conventional and bellows valves following Farris standard seat tightness test procedure. At set pressures of 50 psig and below, leakage test shall be made at 5 psig below set pressure.

The O-ring seat seal option is available for 2600/2600L/2600S Series valves in both conventional and bellows construction. Farris Engineering has two different O-ring designs which depend on the orifice of the pressure relief valve.

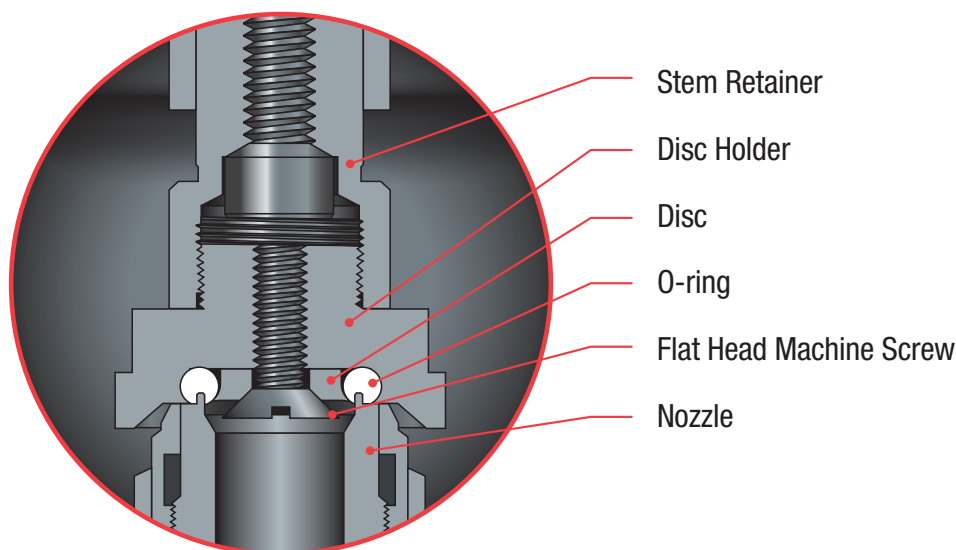


Figure C.1 – O-ring Detail D-K Orifice

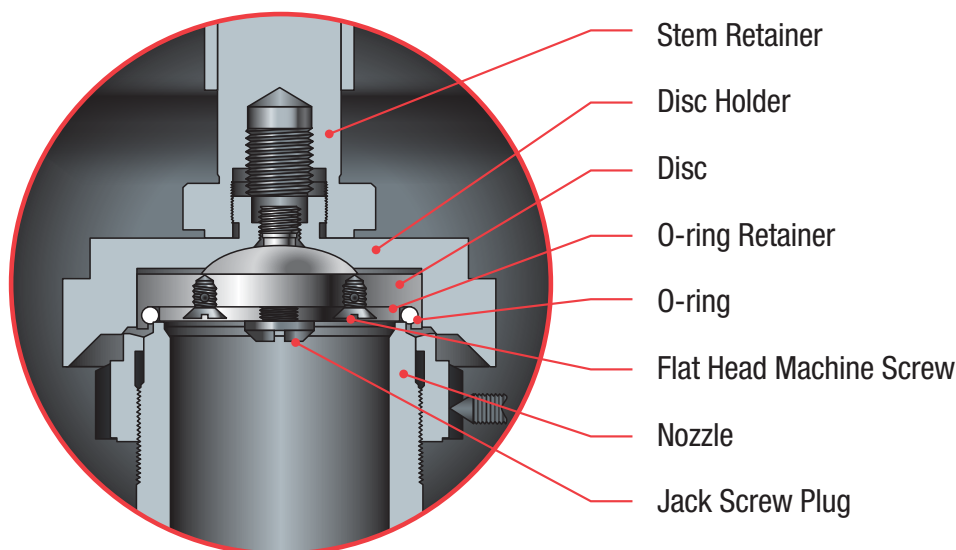


Figure C.2 – O-ring Detail L-U Orifice

O-Ring Material Selection Table					
Material	Temperature Range °F	D to K Orifice		L to T Orifice	
		Set Pressure (psig)	Durometer (Shore A)	Set Pressure (psig)	Durometer (Shore A)
Viton ⁴	-20 to 450	15 to 100	50	15 to 150	50
	-20 to 450	101 to 650	75	150 to 450	75
	-20 to 125	650 to 950	75	450 to 750	75
	125 to 450		90		90
	-20 to 450	950 to 1500	90	750 to 1500	90
Ethylene Propylene	0 to 350	15 to 100	50	15 to 150	50
	0 to 350	101 to 650	70	150 to 450	70
	0 to 125	650 to 950	70	450 to 750	70
	125 to 350		80		80
	0 to 350	950 to 1500	80	750 to 1500	80
Buna N	0 to 200	15 to 100	50	15 to 100	50
	0 to 200	101 to 650	70	100 to 450	70
	0 to 125	650 to 950	70	150 to 750	70
	125 to 200		90		90
	0 to 200	950 to 1500	90	750 to 1500	90
Silicone	-150 to 450	15 to 100	50	15 to 100	50
	-150 to 0	101 to 600	50	100 to 200	50
	0 to 450		70		70
	-150 to 450	600 to 850	70	200 to 450	70
	-150 to 125	850 to 1100	70	450 to 750	70
	125 to 450		80		80
	-150 to 450	1100 to 1500	80	750 to 1500	80
Kalrez	-20 to 550	15 to 200	65	15 to 150	65
	-20 to 550	201 to 650	80	150 to 450	80
	-20 to 200	650 to 950	80	450 to 750	80
	200 to 550		90		90
	-20 to 550	950 to 1500	90	750 to 1500	90
Neoprene	-45 to 300	50 to 750	70	50 to 750	70
	-45 to 300	751 to 1500	80	751 to 1500	80

General Notes:

- Viton and Kalrez are registered trademarks of DuPont Performance Elastomers. We reserve the right to substitute comparable fluorocarbon materials.
- PTFE seat seals available on an application basis. Consult the factory

O-Ring Seat Construction Assembly/Disassembly Instructions

The following instructions are assembly instructions. For disassembly, reverse the order. Parts identification can be found on page 31. Follow the same procedures as for conventional type valves except as follows:

To connect the **Disc Holder** to the **Stem Retainer** for O-ring valves, use the allen key sizes found in Table C.1

Allen Key Sizes	
Disc Holder Lock Screw	
Orifices	Allen Key Size
D thru K	1/8"
L thru U	See Table 6.1

Table C.1

For D and E orifice (Bellows Construction only)(See Figure C.1):

- Place the **O-ring** in the **Disc Holder** groove.
- Thread the **Disc** into the **Disc Holder/Stem Retainer**.

For orifices D and E (Conventional) through K only (See Figure C.1):

- Place the **O-ring** in the **Disc Holder** groove.
- Place the **Disc** into the **Disc Holder**.
- Thread the **Flat Head Machine Screw** through the **Disc** into the **Disc Holder**.

For orifices L through U only (See Figure C.2)

- Place **Disc** in a vice with soft jaws or in a 3-jaw chuck. Be careful not to hold too tight as the **Disc** can be damaged.
- Place the **O-ring** into the **Disc** groove.
- Place the **O-ring Retainer** on the **Disc**.
- Thread the **Flat Head Machine Screws** through the **O-ring Retainer** into the **Disc**.
- Thread the **Jack Screw Plug** into the **O-ring Retainer**.
- Thread the **Disc** into the **Disc Holder** (ensure the **Disc** is free floating).

Appendix D: Cap Construction

Section VIII of the ASME Code requires the use of a lifting device on all steam, air and hot water (over 140°F/60°C) applications. Packed levers should be used on all liquid applications or where cap tightness is a requirement. Levers should be inspected for proper operation and parts replaced as needed.

Packed Levers

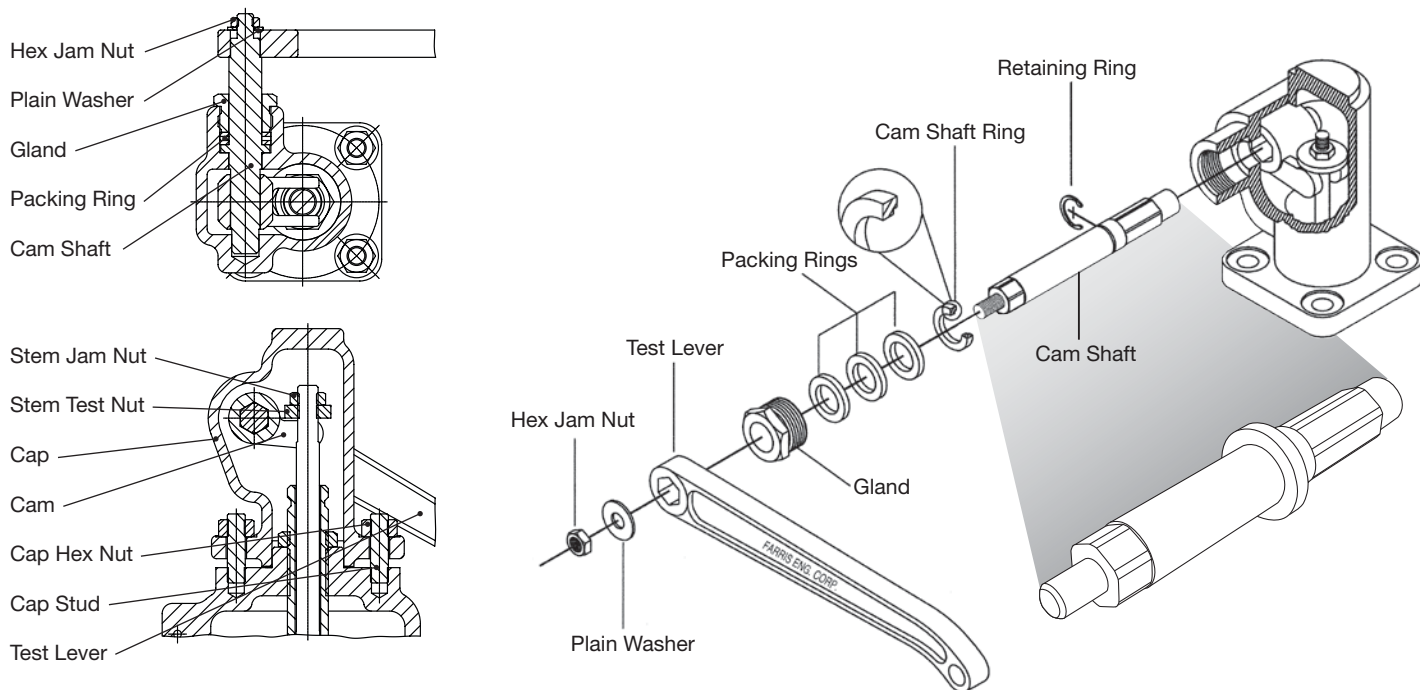


Figure D.1 – Packed Lever Cap Construction
2600 Series, All Sizes

Packed Lever Construction Assembly/Disassembly Instructions

The following instructions are assembly instructions. For disassembly, reverse the order. Parts identification may be found above. Assembly procedures for the balance of valve is identical for all cap design options: plain cap, open lever, bolted cap and packed lever.

1. Thread the **Stem Test Nut** onto the **Stem**.
2. Thread the **Stem Jam Nut** onto the **Stem**.
3. Place the **Cap Gasket** on the **Bonnet**.
4. Place the counter-bored side of the **Retaining Ring** onto the **Cam Shaft**.
5. Place the **Packing Rings** over the **Cam Shaft** and into the **Retaining Ring** cavity.
6. While holding the **Cam** in-place inside the **Cap**, slide the **Cam Shaft** through the hole in the side of the **Cap** and through the **Cam**.
7. Place the **Cap** onto the **Bonnet** ensuring that the cap protrusion is facing the valve outlet.
8. Thread the **Cap Studs** through the **Cap** into the **Bonnet** and tighten.
9. Adjust the **Stem Test Nut** until there is 1/8" clearance between **Stem Test Nut** and the **Cam**.
10. Tighten the **Stem Jam Nut**.
11. Thread the **Gland** into the **Cap**.
12. Place the **Test Lever** on the **Cam Shaft**. **Ensure that the Test Lever is oriented away from the valve outlet.**
13. Place the **Plain Washer** over the **Cam Shaft**.
14. Thread the **Lever Hex Jam Nut** onto the **Cam Shaft**.

Open Levers

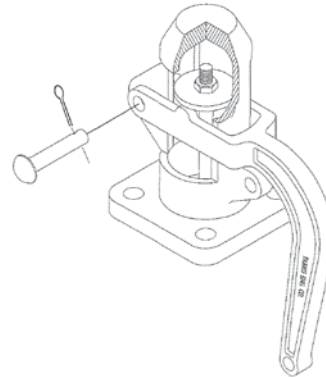
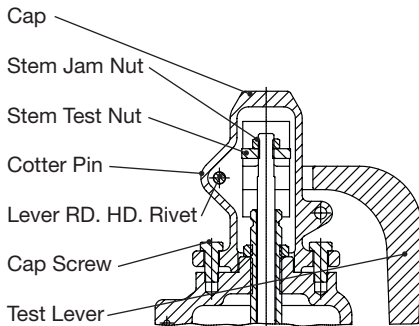


Figure D.2 – Open Lever (Single Acting)
2600 Series, Types 26()A10, A11, A20, A21, All Sizes Except 8x10

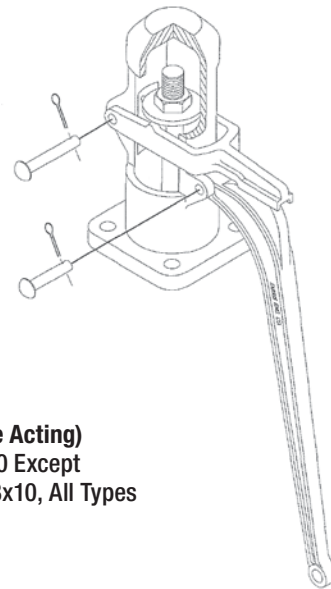
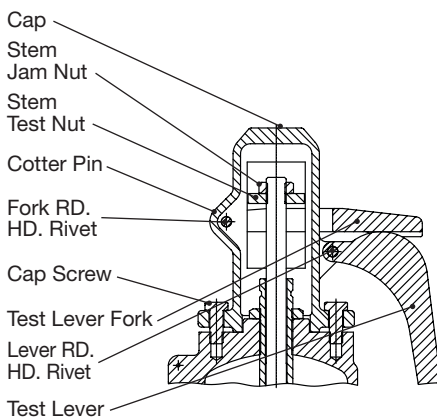


Figure D.3 – Open Lever (Double Acting)
2600 Series, Sizes 1x2 Thru 6x10 Except
Types 26()A10, A11, A20, A21, Sizes 8x10, All Types

Open Lever Cap Construction Assembly/Disassembly Instructions

The following instructions are assembly instructions. For disassembly, reverse the order. Parts identification may be found above. Assembly procedures for the balance of valve is identical for all cap design options: plain cap, open lever, bolted cap and packed lever.

For single acting lever only:

1. Thread the **Stem Test Nut** onto the **Stem**.
2. Thread the **Stem Jam Nut** onto the **Stem**.
3. Place the **Cap** onto the **Bonnet** ensuring that the cap protrusion is facing the outlet of the valve.
4. Thread the **Cap Studs** through the **Cap** into the **Bonnet** and tighten.
5. Place the **Lever Round Head Rivet** through the **Test Lever** and **Cap** hole and secure with the **Cotter Pin**.
6. Adjust the **Stem Test Nut** so there is 1/8" clearance between the **Test Lever** fulcrum and the **Stem Test Nut**.
7. Tighten the **Stem Jam Nut**.

For double acting lever only:

1. Thread the **Stem Test Nut** onto the **Stem**.
2. Thread the **Stem Jam Nut** onto the **Stem**.
3. Place the **Cap** onto the **Bonnet** ensuring that the cap protrusion is facing the outlet of the valve.
4. Thread the **Cap Studs** through the **Cap** into the **Bonnet** and tighten.
5. Place the **Fork Round Head Rivet** through the **Test Lever Fork** and **Cap** hole and secure with a **Cotter Pin**.
6. Place the **Lever Round Head Rivet** through the **Test Lever** and **Cap** hole and secure with the **Cotter Pin**.
7. Adjust the **Stem Test Nut** so there is 1/8" clearance between the **Test Lever Fork** and the **Stem Test Nut**.
8. Tighten the **Stem Jam Nut**.

Cap Constructions Standard Material & Material for Corrosive/Low Temperature Service - Stainless Steel				
Cap Description	Part Name	Std. Materials S1, N1 -20°F to 800°F	S3 -75°F to 800°F	S4 -450 °F to 450°F
Packed Lever	Cap	Carbon Steel	316 St.	316 St.
	Test Lever	Carbon Steel		
	Cam	316 St. St.		
	Cam Shaft	316 St. St.		
	Gland	316 St. St.		
	Stem Jam Nut	316 St. St.		
	Stem Test Nut	316 St. St.		
	Packing Ring	Graphite		
	Plain Washer	Steel		
	Lever Hex. Jam Nut	Steel		
	Cap Stud	Alloy Steel	Stainless Steel	Stainless Steel
	Cap Hex. Nut	Alloy Steel	Stainless Steel	Stainless Steel
Open Lever (Single or Double Acting)	Cap	Iron		
	Test Lever	Iron		
	Test Lever Fork	Iron		
	Stem Jam Nut	316 St. St.		
	Stem Test Nut	316 St. St.		
	Cap Screw	Steel, Plated		
	Fork Rd. Hd. Rivet	Steel		
	Lever Rd. Hd. Rivet	Steel		
Cotter Pin	Steel, Plated			

Table D.1



Appendix E: Critical Dimensions

These dimensions apply to 2600 Series valves with “A10” through “A15” serial numbers and supersede any dimensions provided in previous revisions to the manual.

Table E.1: Metal Seats - Serial Number Suffixes: A10 & A11 / A14 & A15													
Type	Z ¹	Nozzle Dimensions								Disc Dimensions			
		A +.010 -.000	B +.000 -.005	C +.005 -.000	D min	E min	F min	L min	Nozzle Fig.	H +.000 -.005	J +.005 -.000	N min.	Disc Fig.
26D()z	0 - 3	0.437	0.520	0.580	0.010	0.005	0.010	4.125	2, 3 ²	0.480	–	0.156	1
	4 - 6	0.437	0.520	0.614	0.005	–	0.010	4.375	1				
26E()z	0 - 3	0.535	0.585	0.645	0.010	0.005	0.010	4.062	2	0.545	0.725	0.234	2
	4 - 6	0.535	0.585	0.685	0.005	0.005	0.010	4.375	2				
26F()z ⁴	0 - 1	0.687	0.720	0.780	0.005	0.005	0.010	4.250	2				
	2 - 5	0.687	0.720	0.780	0.005	0.005	0.010	4.375	2	0.680	–	0.265	1
	6	0.687	0.720	0.820	0.005	0.005	0.010	4.375	2				
26G()z	0 - 1	0.844	0.885	0.945	0.010	–	0.010	4.093	1				
	2 - 4	0.844	0.885	0.945	0.005	–	0.010	4.234	1	0.845	–	0.296	1
	5	0.844	0.885	0.995	0.005	–	0.010	5.031	1				
	6	0.844	0.885	0.995	0.005	0.010	0.010	5.031	2				
26H()z	0 - 1	1.054	1.110	1.170	0.005	–	0.010	4.937	1				
	2	1.054	1.110	1.170	0.010	–	0.010	4.156	1				
	3 ³	1.054	1.110	1.210	0.005	–	0.010	5.031	1	1.070	–	0.296	1
	4 - 5	1.054	1.110	1.210	0.005	–	0.010	5.031	1				
26H()z33		1.054	1.110	1.170	0.010	–	0.010	4.156	1				
26J()z	0 - 1	1.350	1.416	1.476	0.005	–	0.010	4.125	1				
	2 - 3	1.350	1.416	1.496	0.005	–	0.010	5.187	1				
	4 ³	1.350	1.416	1.516	0.010	–	0.010	6.562	1	1.376	–	0.296	1
	5	1.350	1.416	1.516	0.010	–	0.010	6.562	1				
26J()z34		1.350	1.416	1.496	0.005	–	0.010	5.187	1				
26K()z	0 - 3	1.612	1.730	1.830	0.010	0.010	0.010	6.546	2				
	4 ³	1.612	1.730	1.830	0.005	0.010	0.010	7.921	2	1.570	–	0.296	1
	5	1.612	1.730	1.830	0.005	0.010	0.010	7.921	2				
26K()z34		1.612	1.730	1.830	0.010	0.010	0.010	6.546	2				
26L()z	0 - 1	2.009	2.106	2.166	0.005	0.010	0.010	6.484	2	2.056	–	0.312	1
	2 - 5	2.009	2.106	2.196	0.010	0.020	0.010	7.609	2				
26M()z	0 - 4	2.257	2.366	2.446	0.005	0.030	0.010	7.546	2	2.306	–	0.375	1
26N()z	0 - 4	2.478	2.598	2.678	0.010	0.030	0.010	7.546	2	2.538	–	0.375	1
26P()z	0 - 4	3.004	3.080	3.200	0.010	0.030	0.010	7.500	2	3.020	–	0.421	1
26Q()z	0 - 3	3.952	4.080	4.220	0.010	0.030	0.010	8.750	2	4.020	–	0.453	1
H26Q()z3		3.952	4.080	4.220	0.010	0.030	0.010	8.750	2				
26R()z	0 - 3	4.758	4.985	5.145	0.005	0.030	0.010	8.031	2	4.895	–	0.703	1
H26R()z3		4.758	4.985	5.145	0.005	0.030	0.020	8.031	2				
26T()z	0 - 2	6.070	6.366	6.546	0.005	0.030	0.010	10.406	2	6.256	–	0.953	1
H26T()z3		6.070	6.366	6.546	0.005	0.030	0.010	10.406	2				

General Notes:

1. Z column designates flange class number to be inserted in type number, example: 26D()z3 would designate any of the D orifice 2600 designs (conventional or bellows) with a 600# inlet flange.
2. For type 2600 (A10 & A11 Serials) see Figure 2. For type 2600L (A14 & A15 serials) see Figure 3.
3. Does not apply to valve type numbers designated for use at a temperature range of 801 to 1000 F.
4. For serial numbers suffixes; A10/G, A11/G, A14/G, A15/G, please consult factory for critical dimensions.



**Table E.2: O-ring Seats - Serial Number Suffixes:
A10 & A11 / A14 & A15**

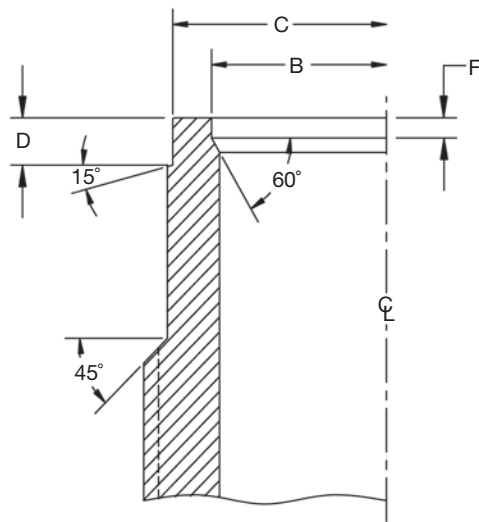
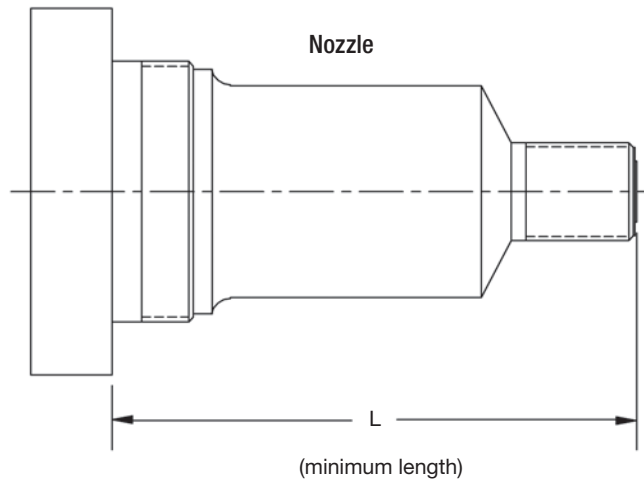
Type	Z ¹	Nozzle Dimensions					Figure
		B +.000 -.005	C +.000 -.002	D min	F min	L min	
26D()z	0 - 3	0.520	0.615	0.078	0.01	4.141	4
	4 ²					4.375	
26E()z	0 - 3	0.585	0.800	-	0.01	4.081	5
	4 ²					4.375	
26F()z ³	0	0.720	0.880	0.078	0.01	4.219	4
	2 - 3					4.344	
	4 ²					4.344	
26G()z	0	0.885	1.052	-	0.01	4.063	5
	2 - 3					4.203	
	4 ²					4.203	
26H()z	0	1.110	1.255	0.078	0.01	4.906	4
	2					4.125	
	3					5.000	
	4 ²					5.000	
26J()z	0	1.416	1.568	0.094	0.01	4.094	4
	2 - 3					5.156	
	4 ²					6.531	
26K()z	0 - 3	1.730	1.937	0.094	0.01	6.516	4
	4 ²					7.891	
26L()z	0	2.106	2.312	0.094	0.01	6.438	4
	2 - 3					7.563	
	4 ²					7.563	
26M()z	0 - 3	2.366	2.566	0.094	0.01	7.531	4
	4 ²						
26N()z	0 - 3	2.598	2.824	0.094	0.01	7.531	4
	4 ²						
26P()z	0 - 3	3.080	3.317	0.094	0.01	7.516	4
	4 ²						
26Q()z	0 - 3	4.045	4.191	0.094	0.01	8.734	4
26R()z	0 - 3	4.985	5.191	0.094	0.02	8.016	4
26T()z	0 - 2	6.366	6.581	0.094	0.01	10.375	4

General Notes:

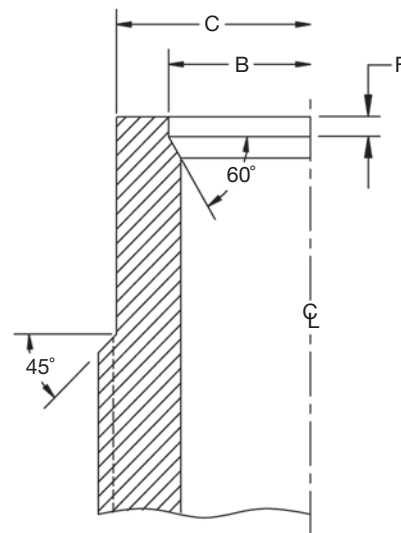
1. Z column designates flange class number to be inserted in type number, example: 26D()3 would designate any of the "D" orifice 2600 designs (conventional or bellows) with a 600# inlet flange.
2. Applies to valves with the A10 & A11 serial number suffix only. All others apply to both the A10 & A11 as well as the A14 & A15 Serial numbers.
3. For serial numbers suffixes; A10/H, A11/H, A14/H, A15/H, please consult factory for critical dimensions.

O-ring Seats A10, A11, A14, A15 Critical Dimensions

Refer to table E.2



Nozzle Figure 4



Nozzle Figure 5

**Table E.3: O Ring Seats - Serial Number Suffixes:
A10/M, A11/M, A14/M, A15/M, A10/R and A11/R**

Type	Z ¹	Nozzle Dimensions					
		/M ³			/R ³		
		B +.000 -.003	C +.003 -.000	L min	B +.000 -.003	C +.003 -.000	L min
26D()z	0 - 3 4 ²	0.520	0.564	4.145 4.390	0.520	0.560	4.145 4.390
26E()z	0 - 3 4 ²	0.585	0.635	4.081 4.390	0.585	0.625	4.081 4.390
26F()z ⁴	0 2 - 3 4 ²	0.720	0.828	4.260 4.390 4.390	0.720	0.760	4.294 4.294 4.294
26G()z	0 2 - 3 4 ²	0.885	0.985	4.100 4.260 4.260	0.885	0.925	4.100 4.260 4.260
26H()z	0 2 3 4 ²	1.110	1.204	4.950 4.170 5.040 5.040	1.110	1.150	4.950 4.170 5.040 5.040
26J()z	0 2, 3 4 ²	1.416	1.536	4.170 5.230 6.600	1.416	1.456	4.170 5.230 6.600
26K()z	0 - 3 4 ²	1.730	1.877	6.590 7.960	1.730	1.770	6.590 7.960

General Notes:

1. Z column designates flange class number to be inserted in type number, example: 26D()3 would designate any of the D orifice 2600 designs (conventional or bellows) with a 600# inlet flange.
2. Applies to valves with the A10 & A11 serial number suffix only. All others apply to both the A10 & A11 as well as the A14 & A15 Serial numbers.
3. For valves with serial number suffix "/M" use figure "M". Use figure "R" for valves with serial number suffix "/R".
4. For serial numbers suffixes; A10/H, A11/H, A14/H, A15/H, please consult factory for critical dimensions.

O Ring Seats A10/M, A11/M, A14/M, A15/M, A10/R and A11/R Critical Dimensions

Refer to table E.3

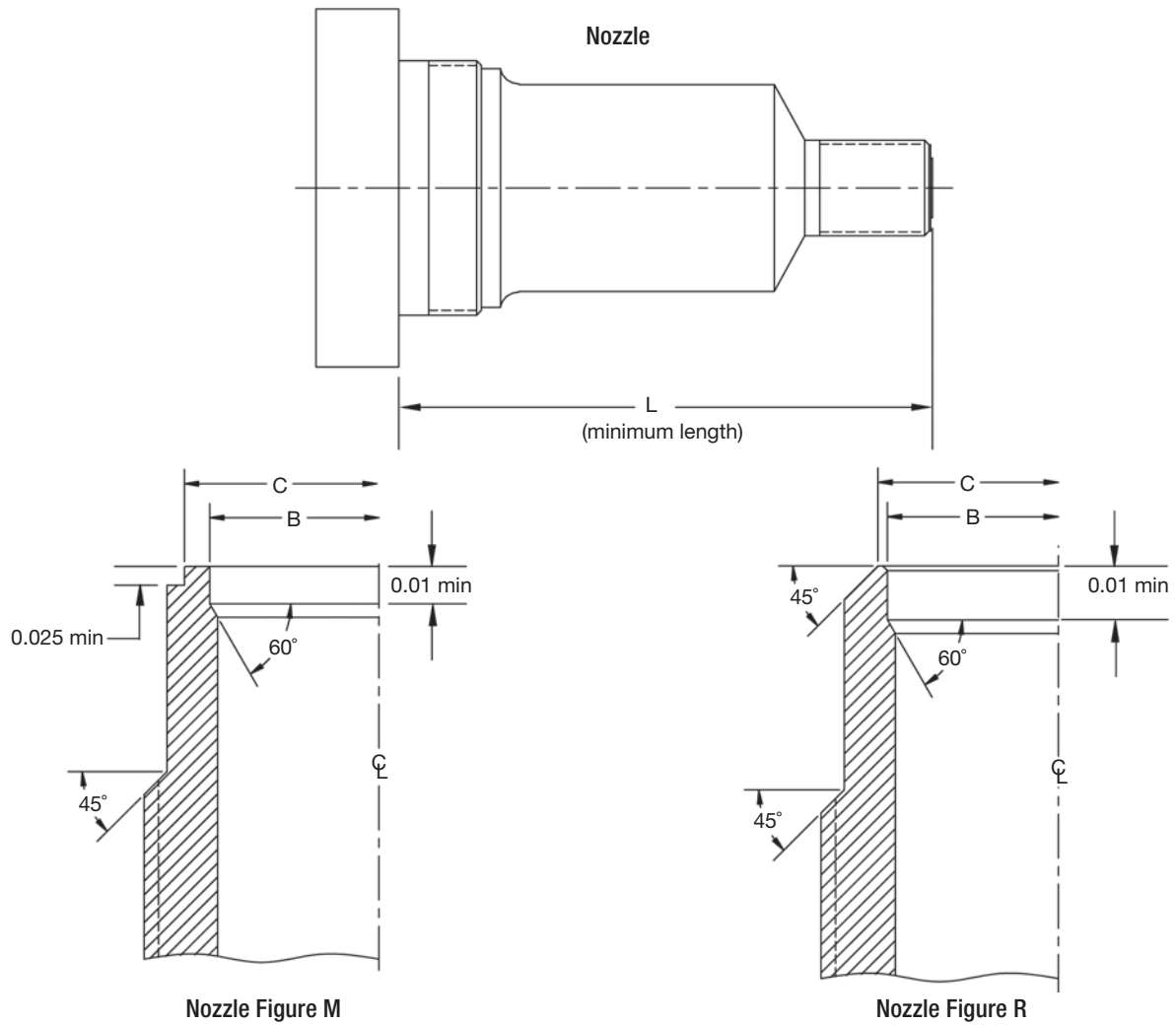




Table E.4: Metal Seats - Serial Number Suffixes: A10 & A11 Interim

Type	Nozzle Dimensions								Disc Dimensions			
	A +.010 -.000	B +.000 -.005	C +.005 -.000	D min	E +.005 -.005	F min	L min	Nozzle Fig.	H +.000 -.005	J +.005 -.000	N min.	Disc Fig.
26D()0	0.437	0.520	0.580	0.005	–	.010	4.125	1	0.480	0.653*	0.156	1, 2 ¹
26D()1	0.437	0.520	0.580	0.005	–	.010	4.125	1	0.480	0.653*	0.156	1, 2 ¹
26D()2	0.437	0.520	0.580	0.005	–	.010	4.125	1	0.480	0.653*	0.156	1, 2 ¹
26D()3	0.437	0.520	0.580	0.005	–	.010	4.125	1	0.480	0.653*	0.156	1, 2 ¹
26D()4	0.437	0.520	0.613	0.005	0.015	.010	4.375	2	0.480	–	0.156	2
26D()5	0.437	0.520	0.613	0.005	0.015	.010	4.375	2	0.480	–	0.156	2
26D()6	0.437	0.520	0.613	0.005	0.015	.010	4.375	2	0.480	–	0.156	2
26E()0	0.535	0.585	0.645	0.005	–	.010	4.062	1	0.545	0.725	0.234	1
26E()1	0.535	0.585	0.645	0.005	–	.010	4.062	1	0.545	0.725	0.234	1
26E()2	0.535	0.585	0.645	0.005	–	.010	4.062	1	0.545	0.725	0.234	1
26E()3	0.535	0.585	0.645	0.005	–	.010	4.062	1	0.545	0.725	0.234	1
26E()4	0.535	0.585	0.685	0.005	0.015	.010	4.375	2	0.545	0.725	0.234	1
26E()5	0.535	0.585	0.685	0.005	0.015	.010	4.375	2	0.545	0.725	0.234	1
26E()6	0.535	0.585	0.685	0.005	0.015	.010	4.375	2	0.545	0.725	0.234	1

General Notes:

1. Only bellows valves use Disc Figure 2 and the 0.653 inch dimension. Conventional valves use Disc Figure 1.

These dimensions only apply to “D” and “E” orifice valves as follows:

United States

A10 serial numbers below 30000.

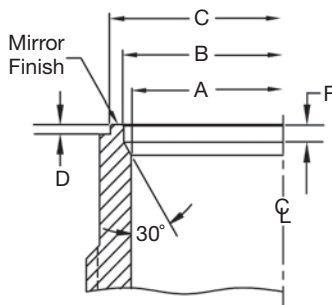
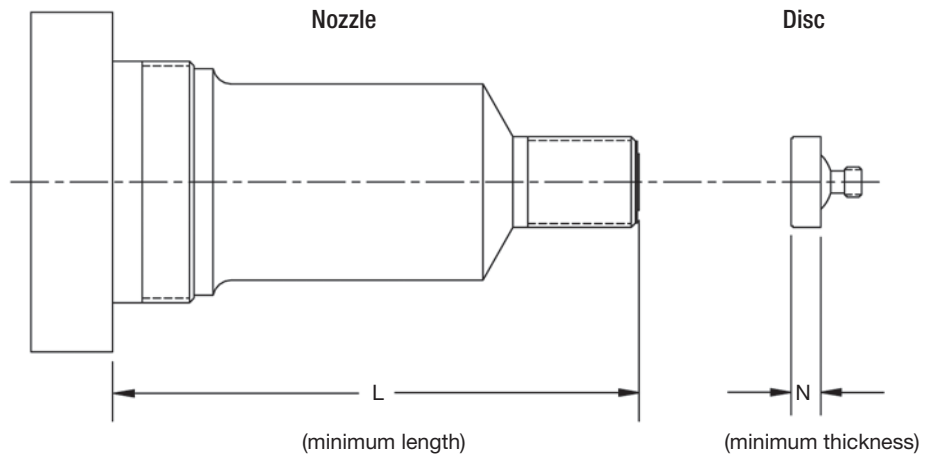
A11 serial numbers below 4000.

Canada

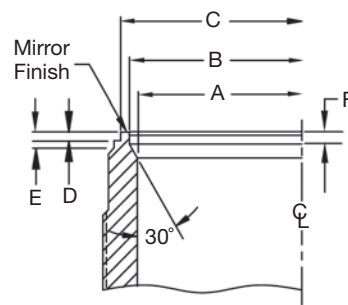
A10 & A11 serial numbers C12001 and above.

Metal Seats A10, A11 Interim Critical Dimensions

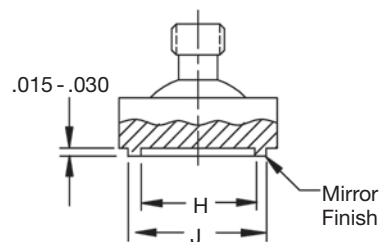
Refer to Table E.4



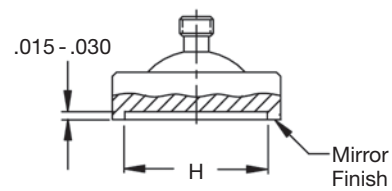
Nozzle Figure 1



Nozzle Figure 2



Disc Figure 1



Disc Figure 2



Appendix F: Maintenance & Inspection Specification Record

The information in the below form is typical of the data that should be recorded for all valves. This information should be compiled for new valves

as well as valves removed from service for maintenance. This form should be photocopied and used as part of any repair shops' proper record keeping system on maintenance of valves.

Valve Type	S/N:
Manufacturer:	Relieving Pressure:
Body and Bonnet Material:	Remarks:
Nozzle and Disc Material:	
Trim Material:	
Spring Material	Spring No.
Carbon Steel:	
Alloy:	
Inlet:	
Orifice:	
Back Pressure:	Maintenance Engineers Phone:
Spring Set Pressure	

No	Unit	Location

Historical Record						
Date Tested	Popped	Reseat	Disposition	Condition	Repairs	Remarks

Appendix G: Required Tools

Required Tools	Orifice													
	D	E	F	G	H	J	K	L	M	N	P	Q	R	T
Open End Wrenches														
7/16"	•	•	•	•	•	•	•	•	•	•	•	•	•	•
9/16"	•	•	•	•	•	•	•	•	•	•	•	•	•	•
3/4"	•	•	•	•	•	•	•	•	•	•	•			
13/16"	•	•	•	•	•	•	•	•	•	•	•			
7/8"	•	•	•	•	•	•	•	•	•	•	•	•	•	•
1"	•	•	•	•	•	•	•	•	•	•	•	•	•	•
1-1/16"	•	•	•	•	•	•	•	•	•	•	•	•	•	
1-1/8"								•	•	•	•	•	•	•
1-1/4"			•	•	•	•	•	•	•	•	•	•	•	•
1-3/8"	•	•	•	•	•									
1-1/2"				•										
1-5/8"					•									
1-3/4"						•	•	•	•	•	•			
2"								•	•	•	•	•	•	•
2-1/4"	•	•	•	•	•	•	•	•	•	•	•			
2-3/4"							•							
3-1/4"						•	•	•	•	•	•	•	•	•
3-1/2"								•	•					
3-11/16"				•	•									
3-3/4"										•				
5"							•			•				
5-1/4"						•								
5-3/4"												•		
6"													•	
6-3/16"							•	•	•	•	•	•	•	•
Allen Wrenches														
3/16"	•	•	•	•	•	•								
7/32"							•	•	•	•	•			
3/8"												•	•	•
Adjustable Pin Spanners														
1-1/4" to 3"	•	•	•		•									
2" to 4-3/4"				•	•	•								
4-1/2" to 6-1/4"							•	•	•	•	•	•	•	
8-1/2"												•	•	
10-5/8"														•
Adjustable Hook Spanners														
2" to 4-3/4"								•	•	•				
4-1/2" to 6-1/4"										•				
6-1/8" to 8-3/4"												•	•	
9-1/4"														•
Adjustable Wrenches	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Flat Head Screw Drivers	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Wire Cutters	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Super Joint Pliers	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Pipe Wrench	•	•												
O-Ring Pick	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Flashlight	•	•	•	•	•	•	•	•	•	•	•	•	•	•

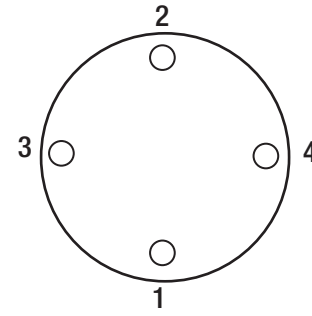
Appendix H: Torque Requirements

This appendix contains the minimum torquing requirements for body/bonnet and bolted/packed cap for Farris pressure relief valves.

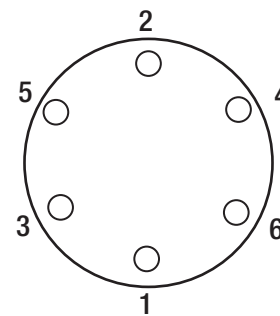
Valve: Body/Bonnet - Bolted/Packed Cap Procedure

(See figures to the right):

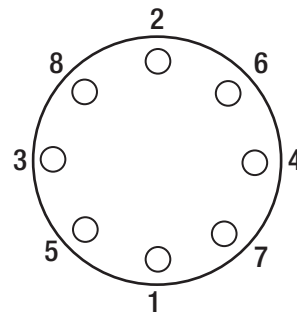
1. Valve studs, nuts and bolts shall be visually inspected to ensure they are free of rust, dirt, or physical damage.
2. Install nuts on the studs finger-tight.
3. Tighten the nuts per the sequence shown in the diagram to the right to approximately one-half the torque value shown in Table H.1. Repeat the same sequence of tightening to the torque value shown in Table H.1. Then starting with the Nut Number 1, tighten each nut in order in a clockwise or counterclockwise direction to the value shown in Table H.1. (16 stud pattern, similar to 12 stud pattern).
4. Bolting torque tolerance: $\pm 10\%$. **Measure torque with a calibrated torque wrench or torque device.**



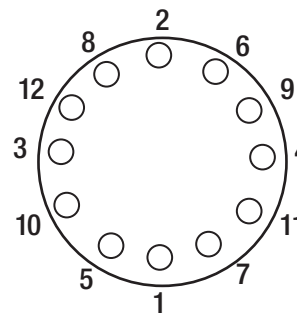
4 Studs



6 Studs



8 Studs



12 Studs

Torque Values			
Stud Thread	Torque (Ft. Lbs.) to Produce Stress in Stud Bolts		
	30 Ksi Stress (B8M, B8MA)	45 Ksi Stress (B7M)	60 Ksi Stress (B7)
	Material Codes 069, 269, D53, D59	Material Codes 235, 551	Material Codes 114
7/16 - 20	20	30	40
1/2 - 13	30	45	60
5/8 - 11	60	90	120
3/4 - 10	100	150	200
7/8 - 9	160	240	320
1 - 8	240	370	500
1 1/8 - 8	355	533	710

Table H.1

Valve Component Bolting Procedure:

1. **Blow down Ring Lock screw:**
Lubricate lock screw with Bostik Never-Seez, except in oxygen service where Holocarbon 25-5s or equivalent is used. Torque lock screw to: 80-100 Ft. Lbs.
2. **1/2"-14 NPT Pipe Plug (P/N: 5098):**
Lubricate threads with: Bostic Never-Seez. Torque pipe plug to: 18-22 Ft. Lbs.
3. **SAS Jam Nut to Bonnet:**
Lubricate threads with Bostik Never-Seez, except in oxygen service where Holocarbon 25-5s or equivalent is used. Torque jam nut to: 25-30 Ft. Lbs.

Farris Aftermarket Services

Real Value Behind Every Valve.

Farris Engineering's aftermarket department and global FAST Center Network adds value to every Farris valve. At Farris, our work is never done. Once we sell you a valve, our FAST Team is there to keep your valves in service and your plant safe. Our FAST Centers are:

Responsive. Farris Engineering and its FAST Centers understand the need to quickly and efficiently respond to customer needs.

- **Global Access** - FAST Centers work with and in our extensive representative network, providing support to all global regions.
- **24/7 Valve Service and Replacement** - FAST Centers offer quick, localized testing and repair of valves, or the prompt installation of new Farris ASME certified valves.
- **Mobile Repair Units** - Available at select FAST Centers.

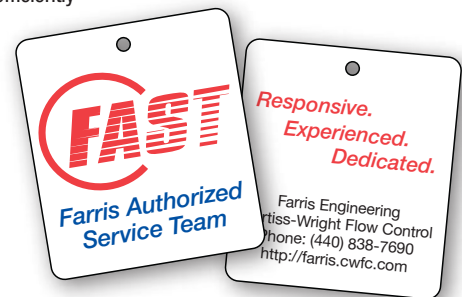
Experienced. Farris Engineering recognizes the value of having pressure relief valve experts as close to the customer as possible. This is accomplished through comprehensive training offered at the factory or on-site. FAST Center sales personnel and technicians are able to provide valuable experience to their customers.

- **Valve Expertise** - Every FAST Center is technically supported by Farris Engineering, a leader in valve design.
- **Factory Trained Technicians** - FAST technicians go through mandatory training consisting of classroom lecture and hands-on practical instruction on Farris Engineering pressure relief valves, repair procedures and applicable codes and standards. The result is a team of highly skilled technicians capable of handling both routine and complex pressure relief valve requirements around the world.
- **OEM parts** - FAST Centers use only OEM parts, restoring valves to OEM specifications. All valves are assembled and tested to ASME standards.



Dedicated. FAST Centers have committed to large investments in inventory, equipment and certifications to better support the customers in their territory.

- **Local Inventory** - Every FAST Center carries a large inventory of new pressure relief valves and spare parts, backed by a web-based global inventory to draw from.
- **ASME Certification** - FAST Centers carry all the required certifications to assemble, set and test Farris valves.
- **VR Certification** - FAST Centers have VR certification issued by The National Board of Boiler and Pressure Vessel Inspectors to effectively and efficiently repair all pressure relief valves where applicable.



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Offices Worldwide: For a listing of our global sales network, visit our website at <http://farris.cwfc.com>.

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May 2013

627 Series Pressure Reducing Regulators

WARNING

Failure to follow these instructions or to properly install and maintain this equipment could result in an explosion and/or fire causing property damage and personal injury or death.

Fisher® regulators must be installed, operated, and maintained in accordance with federal, state, and local codes, rules and regulations, and Emerson Process Management Regulator Technologies, Inc. (Regulator Technologies) instructions.

If the regulator vents gas or a leak develops in the system, service to the unit may be required. Failure to correct trouble could result in a hazardous condition.

Call a gas service person to service the unit. Only a qualified person must install or service the regulator.



W4793

Figure 1. Typical 627 Direct-Operated Pressure Reducing Regulator

Introduction

Scope of the Manual

This manual provides instructions for the installation, adjustment, maintenance, and parts ordering information for the 627 Series regulators. These regulators are usually shipped separate for line installation, although sometimes they are shipped installed on other equipment. Refer to the Instruction Manual of the other equipment for installation and operating instructions.

Description

The 627 Series direct-operated pressure reducing regulators (Figure 1) are for high and low pressure systems. These regulators can be used with natural gas, air, or a variety of other gases. Performance characteristics vary according to construction.

WARNING

Personal injury, property damage, equipment damage, or leakage due to escaping gas or bursting of pressure-containing parts may result if this regulator is overpressured or is installed where service conditions could exceed the limits given in the Specifications section, Tables 1, 2, 3, and 4, or where conditions exceed any ratings of the adjacent piping or piping connections.

To avoid such injury or damage, provide pressure-relieving or pressure-limiting devices (as required by the appropriate code, regulation, or standard) to prevent service conditions from exceeding



627 Series

Specifications

The Specifications section gives some general specifications for the 627 Series regulators. The nameplates give detailed information for a particular regulator as it comes from the factory.

Available Constructions

Type 627: Direct-operated pressure reducing regulator equipped with a pitot tube for greater regulated capacities (Figure 7).

Type 627R: Type 627 with internal relief and with an open throat (Figure 8).

Type 627LR: Type 627R with light rate relief spring (Figure 9).

Type 627M: Type 627 with a stem seal between the body outlet pressure and diaphragm case. Pressure is measured under the diaphragm through the 1/4 NPT downstream control line connection (Figure 10).

Type 627MR: Type 627M with internal relief (Figure 11).

Type 627H: Type 627 with a diaphragm limiter to deliver a higher outlet pressure (Figure 12).

Type 627HM: Type 627H with a stem seal between the body outlet pressure and diaphragm case. Pressure is measured under the diaphragm through the 1/4 NPT downstream control line connection (Figure 13).

Body Sizes and End Connection Styles

BODY SIZE		END CONNECTION STYLE	CONSTRUCTION AVAILABLE
NPS	DN		
3/4	----	NPT	All
1	25	NPT, CL150 RF, CL300 RF, CL600 RF, and Long Body	
2	50	NPT, CL150 RF, CL300 RF, CL600 RF, and Long Body	

Maximum Inlet Pressure⁽¹⁾ (Body Rating)

NPT Stainless Steel: 2000 psig / 138 bar

Flanged Stainless Steel: 1440 psig / 99.3 bar

NPT Steel: 2000 psig / 138 bar

Flanged Steel: 1500 psig / 103 bar

Ductile Iron: 1000 psig / 69.0 bar

Maximum Valve Disk Inlet Pressure Rating⁽¹⁾

Nylon (PA) Disk: 2000 psig / 138 bar

Nitrile (NBR) Disk: 1000 psig / 69.0 bar

Fluorocarbon (FKM) Disk: 300 psig / 20.7 bar

Maximum Operating Inlet Pressure, Pressure Differential, and Outlet Pressure Ranges⁽¹⁾

See Table 1 for pressures by orifice size and spring range

Maximum Spring and Diaphragm Casing Pressure⁽¹⁾

See Table 2

Maximum Body Outlet Pressure⁽¹⁾⁽²⁾

(Types 627M, 627MR, and 627HM Only)

NPT Steel: 2000 psig / 138 bar

Flanged Steel: 1500 psig / 103 bar

Ductile Iron: 1000 psig / 69.0 bar

Orifice Sizes

See Table 1

Internal Relief Performance

Type 627R: See Table 3

Type 627LR: See Table 4

Type 627MR: Limited by field-installed control line piping

Elastomer Temperature Capabilities⁽¹⁾⁽³⁾

MATERIAL	DISK/ DIAPHRAGM	TEMPERATURE	
		°F	°C
Nitrile (NBR)	Disk	-40 to 180	-40 to 82
	Diaphragm		
Fluorocarbon (FKM)	Disk	0 to 180	-18 to 82
	Diaphragm		
Nylon (PA)	Disk	-40 to 180	-40 to 82
Neoprene (CR) for Types 627H and 627HM only	Diaphragm	-40 to 180	-40 to 82

Flow Coefficients

See Table 5

IEC Sizing Coefficients

See Table 6

Pressure Registration

Type 627, 627H, 627R, or 627LR: Internal

Type 627M, 627HM, or 627MR: External through 1/4 NPT control line connection in the diaphragm casing

De-Icer System

See Figure 3 and Type 627M Regulator De-Icer System Application section

Relief Indicator

For Types 627R, 627LR, and 627MR (see Figures 8, 9, and 11)

Spring Case Vent Connection

3/4 NPT with removable screened vent assembly

Approximate Weights

Ductile Iron, Steel, or Stainless Steel Casings: 10 pounds / 4 kg

Aluminum Casings: 6.3 pounds / 3 kg

1. The pressure/temperature limits in this Instruction Manual or any applicable standard limitation should not be exceeded.

2. Types 627, 627H, 627R, and 627LR are limited by maximum diaphragm casing pressure.

3. Stainless steel body is rated to -40°F / -40°C. Steel and Ductile Iron bodies are rated to -20°F / -29°C.

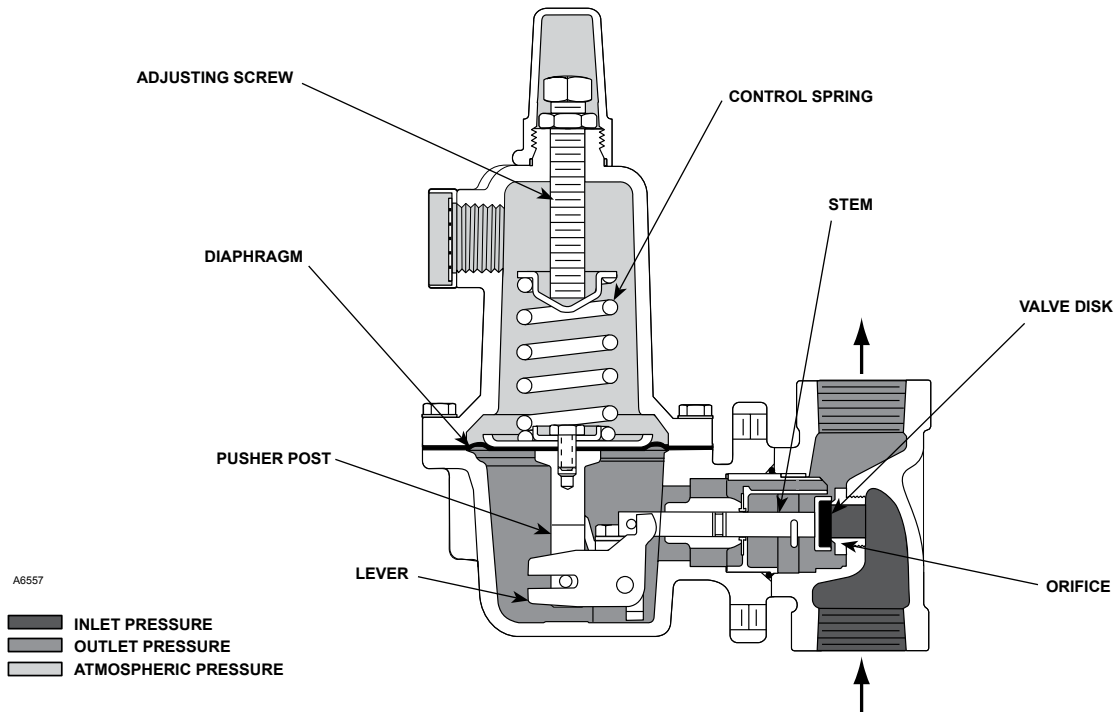


Figure 2. Type 627 Operational Schematic

those limits. The Type 627R, 627LR, or 627MR regulator with internal relief will provide downstream overpressure protection within the limits given in the Specifications section, Tables 1, 2, 3, and 4. If these limits are exceeded, additional downstream overpressure protection must be provided by the user.

Additionally, physical damage to the regulator could cause personal injury or property damage due to escaping gas. To avoid such injury or damage, install the regulator in a safe location.

Principle of Operation

Refer to Figure 2. When downstream demand decreases, the pressure under the diaphragm increases. This pressure overcomes the regulator setting (which is set by a spring). Through the action of the pusher post assembly, lever, and valve stem the valve disk moves closer to the orifice and reduces gas flow. If demand downstream increases, pressure under the diaphragm decreases. Spring force pushes the pusher post assembly downward and the valve disk moves away from the orifice.

Product Description

Types 627 and 627H Direct-Operated Pressure Reducing Regulators—The Types 627 and 627H regulators provide economical pressure reducing control for a variety of residential, commercial, and industrial applications. The regulator pitot tube located in a high velocity stream provides dynamic boost that compensates for outlet pressure drop.

Type 627 Long Body—The Type 627 Long Body regulator can be used as a drop-in replacement for existing Type 630 installations without the need to modify piping.

Internal Relief for Type 627R, 627LR, or 627MR Regulator—The Type 627R internal relief performance values were obtained **by removing the disk assembly** from the regulator. For the Type 627R, 627LR, or 627MR regulator, the internal relief across the diaphragm provides overpressure protection in many applications. As outlet pressures build up above the start-to-discharge point, the diaphragm moves off the relief valve seat allowing the excess pressure to bleed out through the screened vent.

For extra protection, should failure conditions exist which would prevent normal operation of the regulator

627 Series

Table 1. Maximum Inlet Pressures and Outlet Pressure Ranges

TYPE	OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR CODE	ORIFICE SIZE		MAXIMUM INLET PRESSURE ⁽¹⁾					
				Nylon (PA) Disk		Nitrile (NBR) Disk		Fluorocarbon (FKM) Disk	
		Inches	mm	psig	bar	psig	bar	psig	bar
627 and 627M ⁽³⁾	5 ⁽²⁾ to 20 psig / 0.34 to 1.4 bar 10B3076X012 Yellow	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	1000	69.0	1000	69.0	300	20.7
		3/16	4.8	750	51.7	750	51.7	300	20.7
		1/4	6.4	500	34.5	500	34.5	300	20.7
		3/8	9.5	300	20.7	300	20.7	300	20.7
		1/2	13	250	17.2	250	17.2	250	17.2
	15 to 40 psig / 1.0 to 2.8 bar 10B3077X012 Green	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	1500	103	1000	69.0	300	20.7
		3/16	4.8	1000	69.0	1000	69.0	300	20.7
		1/4	6.4	750	51.7	750	51.7	300	20.7
		3/8	9.5	500	34.5	500	34.5	300	20.7
		1/2	13	300	20.7	300	20.7	300	20.7
	35 to 80 psig / 2.4 to 5.5 bar 10B3078X012 Blue	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	2000	138	1000	69.0	300	20.7
		3/16	4.8	1750	121	1000	69.0	300	20.7
		1/4	6.4	1500	103	1000	69.0	300	20.7
		3/8	9.5	1000	69.0	1000	69.0	300	20.7
		1/2	13	750	51.7	750	51.7	300	20.7
	70 to 150 psig / 4.8 to 10.3 bar 10B3079X012 Red	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	2000	138	1000	69.0	300	20.7
3/16		4.8	2000	138	1000	69.0	300	20.7	
1/4		6.4	1750	121	1000	69.0	300	20.7	
3/8		9.5	1250	86.2	1000	69.0	300	20.7	
1/2		13	750	51.7	750	51.7	300	20.7	
627R and 627MR	5 ⁽²⁾ to 20 psig / 0.34 to 1.4 bar 10B3076X012 Yellow	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	1000	69.0	1000	69.0	300	20.7
		3/16	4.8	750	51.7	750	51.7	300	20.7
		1/4	6.4	500	34.5	500	34.5	300	20.7
		3/8	9.5	300	20.7	300	20.7	300	20.7
		1/2	13	200	13.8	200	13.8	200	13.8
	15 to 40 psig / 1.0 to 2.8 bar 10B3077X012 Green	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	1500	103	1000	69.0	300	20.7
		3/16	4.8	1000	69.0	1000	69.0	300	20.7
		1/4	6.4	750	51.7	750	51.7	300	20.7
		3/8	9.5	300	20.7	300	20.7	300	20.7
		1/2	13	200	13.8	200	13.8	200	13.8
	35 to 80 psig / 2.4 to 5.5 bar 10B3078X012 Blue	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	1750	121	1000	69.0	300	20.7
		3/16	4.8	1000	69.0	1000	69.0	300	20.7
		1/4	6.4	750	51.7	750	51.7	300	20.7
		3/8	9.5	300	20.7	300	20.7	300	20.7
		1/2	13	200	13.8	200	13.8	200	13.8
	70 to 150 psig / 4.8 to 10.3 bar 10B3079X012 Red	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	1000	69.0	1000	69.0	300	20.7
3/16		4.8	500	34.5	500	34.5	300	20.7	
1/4		6.4	300	20.7	300	20.7	300	20.7	
3/8		9.5	200	13.8	200	13.8	200	13.8	
1/2		13	200	13.8	200	13.8	200	13.8	
627LR	15 to 40 psig / 1.0 to 2.8 bar 10B3077X012 Green	3/32	2.4			1000	69.0	300	20.7
		1/8	3.2			1000	69.0	300	20.7
		3/16	4.8			750	51.7	300	20.7
		1/4	6.4			500	34.5	300	20.7
627H and 627HM ⁽³⁾	140 to 250 psig / 9.7 to 17.2 bar 10B3078X012 Blue	3/32	2.4	2000	138	1000	69.0		
		1/8	3.2	2000	138	1000	69.0		
		3/16	4.8	1750	121	1000	69.0		
		1/4	6.4	1500	103	1000	69.0		
		3/8	9.5	1000	69.0	750	51.7		
		1/2	13	750	51.7	500	34.5		
	240 to 500 psig / 16.5 to 34.5 bar 10B3079X012 Red	3/32	2.4	2000	138	1000	69.0		
		1/8	3.2	2000	138	1000	69.0		
		3/16	4.8	1750	121	1000	69.0		
		1/4	6.4	1500	103	1000	69.0		

1. For inlet pressure in excess of 1000 psig / 69.0 bar, refer to the maximum body and disk pressure ratings in the Specifications section.
 2. For pressure settings under 10 psig / 0.69 bar, inlet pressure should be limited to approximately 100 psig / 6.9 bar so the setpoint adjustment can be obtained.
 3. The unbalance forces change from the wide-open monitor mode to an active regulator mode such that the Type 627M or 627HM should have a 3/8 inch / 9.5 mm or larger orifice.
 [Shaded] - Shaded areas indicate that Fluorocarbon (FKM) and Nylon (PA) disk material are not available.

Table 2. Maximum Spring and Diaphragm Casing Pressure⁽¹⁾

MAXIMUM PRESSURE DESCRIPTION	DIAPHRAGM CASING MATERIAL	TYPE 627		TYPES 627R AND 627LR		TYPE 627M		TYPE 627MR		TYPES 627H AND 627HM			
		psig	bar	psig	bar	psig	bar	psig	bar	psig	bar		
Maximum pressure to spring and diaphragm casings to prevent leak to atmosphere other than relief action (internal parts damage may occur)	Die cast aluminum	250	17.2	250	17.2	Not Available		Not Available		Not Available			
	Ductile iron					250	17.2	Not Available		Not Available		Not Available	
	Steel or Stainless steel							250	17.2	250	17.2	800	55.2
Maximum pressure to spring and diaphragm casings to prevent burst of casings during abnormal operation (leak to atmosphere and internal parts damage may occur)	Die cast aluminum	375	25.9	375	25.9	Not Available		Not Available		Not Available			
	Ductile iron	465	32.1	465	32.1	465	32.1	465	32.1	Not Available			
	Steel or Stainless steel	1500	103	1500	103	1500	103	1500	103	1500	103		
Maximum diaphragm casing overpressure (above setpoint) to prevent damage to internal parts	All materials	60	4.1	120	8.3	60	4.1	120	8.3	120	8.3		

1. If the spring case is pressurized, a metal adjusting screw cap is required. Contact your local Sales Office for details.

(for example, disk broken off or disk erosion), the pusher post contacts the lever retainer causing the relief valve assembly to open. Since the diaphragm continues to rise as downstream pressure builds, it opens the relief valve; thereby, opening the valve. This internal relief may be adequate for the application.

Downstream Control Line for Type 627M, 627HM, or 627MR Regulator—A Type 627M, 627HM, or 627MR regulator has a blocking throat stem seal with O-rings and a 1/4 NPT control line connection in the diaphragm case. A regulator with a downstream control line is used for monitoring applications or other applications where other equipment is installed between the regulator and the pressure control point. The stem seal separates the body outlet pressure from the diaphragm case.

Installation

Regulator operation within ratings does not preclude the possibility of damage from debris in the lines or from external sources. A regulator should be inspected for damage periodically and after any overpressure condition. Key numbers referenced in this section are shown in Figures 7 through 13. Ensure that the operating temperature capabilities listed in Specifications section are not exceeded.

Note

If the regulator is shipped mounted on another unit, install that unit according to the appropriate Instruction Manual.

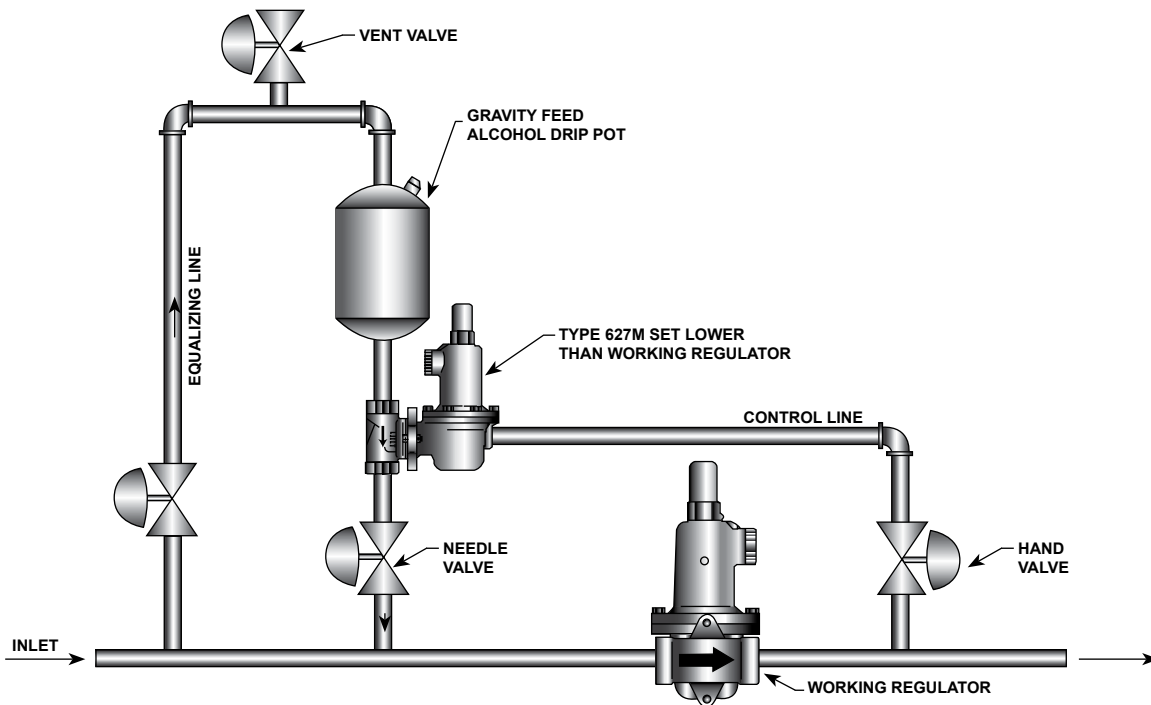
Perform steps 1 through 6 for all types of regulators:

1. Only personnel qualified through training and experience should install, operate, or maintain this regulator.
2. For a regulator that is shipped separately, make sure that there is no damage to or foreign material in the regulator.
3. Ensure that all tubing and piping have been blown free of foreign debris.
4. The regulator may be installed in any position as long as the flow through the body is in the direction indicated by the arrow cast on the body.
5. If continuous operation is required during inspection or maintenance, install a three-valve bypass around the regulator.



A regulator may vent some gas to the atmosphere. In hazardous or flammable gas service, vented gas may accumulate and cause personal injury, death, or property damage due to fire or explosion. Vent a regulator in hazardous gas service to a remote, safe location away from air intakes or any hazardous area. The vent line or stack opening must be protected against condensation or clogging.

6. Position the body (key 1) and/or diaphragm spring case (key 29) so it will not collect moisture or debris into the screened vent. If the regulator requires repositioning, refer to the Body Area Maintenance Procedures and/or the Diaphragm and Spring Case Area Maintenance Procedures in the Maintenance section to reposition the screened vent for the application.



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Figure 3. De-Icer System Operational Schematic

Perform steps 7 through 9 for Types 627M, 627HM, and 627MR regulators only:

7. A Type 627M, 627HM, or 627MR regulator requires a downstream control line. Install the control line before putting the regulator into operation.
8. Ensure that the downstream control line piping is at least 3/8 inch / 9.5 mm or larger outside diameter tubing and connected to a straight section of outlet piping 10 diameters downstream of the regulator.
9. A hand valve should be installed in the control line. This hand valve can be used to throttle down and dampen outlet pulsations in control pressure which may cause instability or cycling of the regulator.

Remote Vent Line Installation

All 627 Series regulators have a vent assembly installed in the 3/4 NPT spring case vent opening. The vent assembly can be removed to install a remote vent line if necessary. Remote vent lines must have the largest practical diameter. It should be as short as possible with minimum number of bends or elbows.

Protect the remote vent opening against entrance of rain, snow, or any other foreign material that may plug

the vent or vent line and prevent proper operation of the regulator. Periodically check the vent opening to be sure it is not plugged with foreign debris.

Type 627M or 627HM Regulator De-Icer System Application

For the Type 627M or 627HM regulator de-icer system, refer to the application shown in Figure 3. With a large pressure drop across the working regulator, ice can form within this regulator. The formation of ice decreases the size of the orifice, so the regulator is unable to supply enough flow to satisfy the downstream demand. When the downstream pressure falls below the outlet pressure setting of the Type 627M or 627HM regulator, the disk assembly of the Type 627M or 627HM regulator moves off its orifice, permitting alcohol to flow into the main gas line. The alcohol carried to the main regulator by the flowstream prevents additional ice from forming on the orifice. When normal flow resumes, and as pressure in the downstream system is restored, the Type 627M or 627HM regulator shuts off.

Overpressure Protection

627 Series regulators have outlet pressure ratings that are lower than their inlet pressure ratings. A pressure-

Table 3. Type 627R Internal Relief Performance⁽¹⁾

OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR CODE	OUTLET PRESSURE SETTING		MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE		MAXIMUM INLET PRESSURE TO KEEP MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE FROM BEING EXCEEDED ⁽²⁾											
					Orifice Size, Inches / mm											
					3/32 / 2.4		1/8 / 3.2		3/16 / 4.8		1/4 / 6.4		3/8 / 9.5		1/2 / 13	
	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar		
5 ⁽³⁾ to 20 psig / 0.34 to 1.4 bar 10B3076X012 Yellow	10	0.69	60	4.1	1250	86.2	740	51.0	320	22.1	190	13.1	95	6.6	75	5.2
			100	6.9	2000	138	1500	103	620	42.7	390	26.9	180	12.4	130	9.0
			125	8.6	2000	138	1900	131	830	57.2	480	33.1	220	15.2	160	11.0
			175	12.1	2000	138	2000	138	1100	75.8	670	46.2	320	22.1	220	15.2
			200	13.8	2000	138	2000	138	1300	89.6	770	53.1	360	24.8	260	17.9
	250	17.2	2000	138	2000	138	1600	110	960	66.2	450	31.0	320	22.1		
	15	1.0	60	4.1	1000	69.0	620	42.7	260	17.9	170	11.7	90	6.2	70	4.8
			100	6.9	2000	138	1400	96.5	610	42.1	370	25.5	170	11.7	130	9.0
			125	8.6	2000	138	1900	131	810	55.8	480	33.1	220	15.2	160	11.0
			175	12.1	2000	138	2000	138	1100	75.8	670	46.2	320	22.1	220	15.2
			200	13.8	2000	138	2000	138	1300	89.6	770	53.1	360	24.8	260	17.9
	250	17.2	2000	138	2000	138	1600	110	960	66.2	450	31.0	320	22.1		
	20	1.4	60	4.1	850	58.6	490	33.8	210	14.5	130	9.0	80	5.5	65	4.5
			100	6.9	2000	138	1300	89.6	600	41.4	360	24.8	170	11.7	120	8.3
			125	8.6	2000	138	1800	124	800	55.2	480	33.1	220	15.2	160	11.0
175			12.1	2000	138	2000	138	1100	75.8	670	46.2	320	22.1	220	15.2	
200			13.8	2000	138	2000	138	1300	89.6	770	53.1	360	24.8	260	17.9	
250	17.2	2000	138	2000	138	1600	110	960	66.2	450	31.0	320	22.1			
15 to 40 psig / 1.0 to 2.8 bar 10B3077X012 Green	15	1.0	60	4.1	1000	69.0	380	26.2	210	14.5	130	9.0	80	5.5	65	4.5
			100	6.9	2000	138	1300	89.6	590	40.7	350	24.1	170	11.7	120	8.3
			125	8.6	2000	138	1800	124	800	55.2	470	32.4	220	15.2	160	11.0
			175	12.1	2000	138	2000	138	1100	75.8	640	44.1	320	22.1	220	15.2
			200	13.8	2000	138	2000	138	1300	89.6	780	53.8	370	25.5	260	17.9
	250	17.2	2000	138	2000	138	1600	66.2	960	66.2	450	31.0	320	22.1		
	20	1.4	60	4.1	630	43.4	200	13.8	150	10.3	100	6.9	70	4.8	65	4.5
			100	6.9	2000	138	1200	82.7	550	37.9	330	22.8	160	11.0	120	8.3
			125	8.6	2000	138	1700	117	760	52.4	450	31.1	210	14.5	160	11.0
			175	12.1	2000	138	2000	138	1100	75.8	630	43.4	320	22.1	220	15.2
			200	13.8	2000	138	2000	138	1300	89.6	770	53.1	360	24.8	260	17.9
	250	17.2	2000	138	2000	138	1600	66.2	960	66.2	460	31.7	320	22.1		
	30	2.1	100	6.9	2000	138	950	65.5	450	31.1	260	17.9	140	9.7	110	7.6
			125	8.6	2000	138	1500	103	670	46.2	400	27.6	190	13.1	150	10.3
			175	12.1	2000	138	2000	138	1000	69.0	610	42.1	300	20.7	220	15.2
			200	13.8	2000	138	2000	138	1200	82.7	760	52.4	360	24.8	260	17.9
			250	17.2	2000	138	2000	138	1600	110	970	66.9	460	31.7	320	22.1
	40	2.8	100	6.9	1500	103	700	48.3	330	22.8	200	13.8	120	8.3	108	7.4
			125	8.6	2000	138	1300	89.6	560	38.6	340	23.4	180	12.4	140	9.7
			175	12.1	2000	138	1800	124	1000	69.0	550	37.9	290	20.0	220	15.2
200			13.8	2000	138	2000	138	1200	82.7	730	50.3	350	24.1	250	17.2	
250			17.2	2000	138	2000	138	1600	110	970	66.9	460	31.7	320	22.1	

1. The internal relief performance values are obtained by removing the disk assembly.
 2. For inlet pressures in excess of 1000 psig / 69.0 bar, refer to the maximum body and disk pressure ratings in the Specifications section.
 3. For pressure settings under 10 psig / 0.69 bar, inlet pressure should be limited to approximately 100 psig / 6.9 bar so the setpoint adjustment can be obtained.
 [Shaded] - Shaded areas indicate maximum inlet pressures allowed during system malfunction only. Table 1 gives the maximum inlet pressure for normal regulator operation.

- continued -

relieving or pressure-limiting device must be provided by the user for the Types 627, 627H, 627M, and 627HM regulators if the inlet pressure can exceed the outlet pressure rating, since these regulators do not have internal relief.

Types 627R and 627LR regulators provide internal relief which limits the total outlet pressure buildup over setpoint. Use Tables 3 and 4 to determine the total outlet pressure. This internal relief may be adequate for the application, if not, provide additional pressure relief or a pressure-limiting device downstream.

Startup and Adjustment

Startup



To avoid personal injury or property damage due to explosion or damage to regulator or downstream components during startup, release downstream

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Table 3. Type 627R Internal Relief Performance⁽¹⁾ (continued)

OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR CODE	OUTLET PRESSURE SETTING		MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE		MAXIMUM INLET PRESSURE TO KEEP MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE FROM BEING EXCEEDED ⁽²⁾⁽³⁾											
					Orifice Size, Inches / mm											
					3/32 / 2.4		1/8 / 3.2		3/16 / 4.8		1/4 / 6.4		3/8 / 9.5		1/2 / 13	
	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar
35 to 80 psig / 2.4 to 5.5 bar 10B3078X012 Blue	40	2.8	125	8.6	2000	138	1100	75.8	500	34.5	300	20.7	170	11.7	140	9.7
			150	10.3	2000	138	1600	110	750	51.7	440	30.3	230	15.9	180	12.4
			175	12.1	2000	138	2000	138	980	67.6	580	40.0	290	20.0	220	15.2
			200	13.8	2000	138	2000	138	1200	82.7	720	49.6	340	23.4	250	17.2
			250	17.2	2000	138	2000	138	1600	110	940	64.8	450	31.0	320	22.1
	50	3.4	125	8.6	1400	96.5	820	56.5	400	27.6	230	15.9	150	10.3	140	9.7
			150	10.3	2000	138	1400	96.5	650	44.8	370	25.5	210	14.5	170	11.7
			175	12.1	2000	138	1900	131	700	48.3	530	36.5	270	18.6	210	14.5
			200	13.8	2000	138	2000	138	1100	75.8	670	46.2	330	22.8	240	16.5
			250	17.2	2000	138	2000	138	1500	103	920	63.4	430	29.6	320	22.1
	60	4.1	125	8.6	900	62.1	450	31.0	270	18.6	190	13.1	140	9.7	130	9.0
			150	10.3	1700	117	1100	75.8	540	37.2	300	20.7	190	13.1	160	11.0
			175	12.1	2000	138	1700	117	780	53.8	470	32.4	250	17.2	200	13.8
			200	13.8	2000	138	2000	138	1000	69.0	610	42.1	310	21.4	230	15.9
			250	17.2	2000	138	2000	138	1400	96.5	880	60.7	420	29.0	310	21.4
	70	4.8	150	10.3	1200	82.7	850	58.6	430	29.6	250	17.2	170	11.7	160	11.0
			175	12.1	2000	138	1400	96.5	670	46.2	400	27.6	230	15.9	190	13.1
			200	13.8	2000	138	2000	138	920	63.4	550	37.9	280	19.3	230	15.9
			250	17.2	2000	138	2000	138	1300	89.6	830	57.2	400	27.6	310	21.4
			150	10.3	800	55.2	500	34.5	300	20.7	200	13.8	160	11.0	150	10.3
80	5.5	175	12.1	1500	103	1200	82.7	550	37.9	330	22.8	210	14.5	190	13.1	
		200	13.8	2000	138	1700	117	800	55.2	480	33.1	270	18.6	220	15.2	
		250	17.2	2000	138	2000	138	1200	82.7	770	53.1	390	26.9	300	20.7	
		175	12.1	1900	131	600	41.4	400	27.6	260	17.9	200	13.8	175	12.1	
		200	13.8	2000	138	1200	82.7	630	43.4	380	26.2	250	17.2	210	14.5	
70 to 150 psig / 4.8 to 10.3 bar 10B3079X012 Red	70	4.8	250	17.2	2000	138	2000	138	1100	75.8	680	46.9	360	24.8	290	20.0
			175	12.1	1400	96.5	250	17.2	240	16.5	200	13.8	190	13.1	175	12.1
			200	13.8	2000	138	960	66.2	520	35.9	330	22.8	240	16.5	210	14.5
			250	17.2	2000	138	2000	138	1000	69.0	620	42.7	350	24.1	280	19.3
			200	13.8	1500	103	250	17.2	240	16.5	230	15.9	210	14.5	210	14.5
70 to 150 psig / 4.8 to 10.3 bar 10B3079X012 Red	80	5.5	250	17.2	2000	138	1600	110	770	53.1	520	35.9	320	22.1	270	18.6
			125	8.6	2000	138	1000	69.0	500	34.5	390	26.9	290	20.0	260	17.9
			150	10.3	1200	82.7	260	17.9	260	17.9	260	17.9	260	17.9	260	17.9
			175	12.1	1900	131	600	41.4	400	27.6	260	17.9	200	13.8	175	12.1
			200	13.8	2000	138	1200	82.7	630	43.4	380	26.2	250	17.2	210	14.5

- The internal relief performance values are obtained by removing the disk assembly.
 - For inlet pressures in excess of 1000 psig / 69.0 bar, refer to the maximum body and disk pressure ratings in the Specifications section.
 - For pressure settings under 10 psig / 0.69 bar, inlet pressure should be limited to approximately 100 psig / 6.9 bar so the setpoint adjustment can be obtained.
- - Shaded areas indicate maximum inlet pressures allowed during system malfunction only. Table 1 gives the maximum inlet pressure for normal regulator operation.

Table 4. Type 627LR Internal Relief Performance⁽¹⁾

OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR CODE	OUTLET PRESSURE SETTING		MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE		MAXIMUM INLET PRESSURE TO KEEP MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE FROM BEING EXCEEDED ⁽²⁾							
					Orifice Size, Inches / mm							
					3/32 / 2.4		1/8 / 3.2		3/16 / 4.8		1/4 / 6.4	
	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar
15 to 40 psig / 1.03 to 2.8 bar 10B3077X012 Green	30	2.1	55	3.8	500	34.5	270	18.6	110	7.6	80	5.5
			60	4.1	850	58.6	480	33.1	200	13.8	120	8.3
			66	4.5	1000	69.0	660	45.5	290	20.0	175	12.1
	40	2.8	66	4.5	380	26.2	190	13.1	85	5.9	80	5.5
			70	4.8	700	48.3	370	25.5	150	10.3	115	7.9
			75	5.2	1000	69.0	560	38.6	240	16.5	160	11.0

- The internal relief performance values are obtained by removing the disk assembly.
- For inlet pressures in excess of 1000 psig / 69.0 bar, refer to the maximum body and disk pressure ratings in the Specifications section.

Table 5. Flow Coefficients

ORIFICE		3/4 NPT			NPS 1 / DN 25 BODY			NPS 2 / DN 50 BODY		
Inch	mm	Wide-Open C _g for External Relief Sizing	Wide-Open C _g for External Relief Sizing	C ₁	Wide-Open C _g for External Relief Sizing	Wide-Open C _g for External Relief Sizing	C ₁	Wide-Open C _g for External Relief Sizing	Wide-Open C _g for External Relief Sizing	C ₁
3/32	2.4	6.9	0.24	29.2	6.9	0.24	28.5	6.9	0.23	29.7
1/8	3.2	12.5	0.43	29.1	12.5	0.43	29.4	12.5	0.42	29.5
3/16	4.8	29	1.01	28.6	29	0.93	31.2	29	1.02	28.5
1/4	6.4	50	1.63	30.6	50	1.71	29.3	52	1.66	31.3
3/8	9.5	108	2.99	36.1	108	3.42	31.6	115	3.39	33.9
1/2	13	190	4.87	39.0	190	5.29	35.9	200	5.01	39.9

Table 6. IEC Sizing Coefficients

ORIFICE SIZE		X _T			F _D	F _L
Inch	mm	3/4 NPT Body	NPS 1 / DN 25 Body	NPS 2 / DN 50 Body		
3/32	2.4	0.539	0.514	0.558	0.50	0.85
1/8	3.2	0.536	0.547	0.539		0.79
3/16	4.8	0.517	0.616	0.514		0.85
1/4	6.4	0.592	0.543	0.620		0.87
3/8	9.5	0.824	0.632	0.727		0.89
1/2	13	0.962	0.815	1.01		0.86

Table 7. Maximum Torque Values

KEY NUMBER ⁽¹⁾	DESCRIPTION	MAXIMUM TORQUE	
		FOOT-POUNDS	N•m
2	Orifice	25	34
3	Cap screw (with aluminum diaphragm casing)	16	22
	Cap screw (with ductile iron or steel/stainless steel diaphragm casing)	25	34
18	Lever cap screw	7	9.5
22	Diaphragm connector nut	17	23
26	Guide retainer (for Types 627R, 627LR, and 627MR only)	3	4.1
37	Spring case cap screw (with aluminum or ductile iron diaphragm casing)	7	9.5
	Spring case cap screw (with steel/stainless steel diaphragm casing)	35	47
46	Diaphragm cap screw (with Type 627 or 627M)	7	9.5
	Diaphragm cap screw (with Type 627H or 627HM)	14	19

1. Refer to Figures 7 through 13 for key number locations.

pressure to prevent an overpressure condition on the diaphragm of the regulator.

In order to avoid an overpressure condition and possible equipment damage, pressure gauges should always be used to monitor pressures during startup.

1. Slowly open the upstream shut-off valve.
2. Slowly open the downstream shut-off valve.
3. Check all connections for leaks.
4. Make final control spring adjustments according to the adjustment procedures.

Adjustment

The range of allowable pressure settings is marked on the nameplate. If a pressure setting beyond this range is necessary, substitute the appropriate regulator control spring. Change the nameplate to indicate the new pressure range.

Before increasing the setting, refer to Table 1, 2, 3, or 4. Review the pressure limits for the control spring range being used and be certain that the new pressure setting will not result in an overpressure condition.

Note

Always use a pressure gauge to monitor pressure when making adjustments.

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Refer to Figures 7 through 13 for key number locations.

1. Remove the adjusting screw cap (key 36).
2. Loosen the locknut (key 34).
3. Increase the outlet pressure setting by turning the adjusting screw (key 35) clockwise. Decrease the outlet pressure setting by turning the adjusting screw counterclockwise.
4. When the desired pressure is obtained, hold the adjusting screw (key 35) in place and tighten the locknut (key 34).

Shutdown

WARNING

To avoid personal injury or property damage due to explosion or damage to regulator or downstream components during shutdown, release downstream pressure to prevent an overpressure condition on the diaphragm of the regulator.

1. Close the nearest upstream shut-off valve.
2. Close the nearest downstream shut-off valve.
3. Open the vent valve between the regulator and the downstream shut-off valve nearest to it.
4. For a Type 627, 627H, 627R, or 627LR regulator, the regulator will open to release pressure between the upstream shut-off valve and the regulator.
5. A Type 627M, 627HM, or 627MR regulator requires venting the control line and downstream pressure from the regulator before maintenance. The pressure between these shut-off valves is released through the open regulator because the disk assembly remains open in response to the decrease in control line pressure.

Maintenance

Unless otherwise specified, the following maintenance procedures apply to all types of regulators. For a summary of maximum torque values required for all types of regulators, refer to Table 7.

Due to normal wear, damage from external sources, or debris in the air or gas line, regulator parts such as the disk assembly, orifice, and diaphragm must

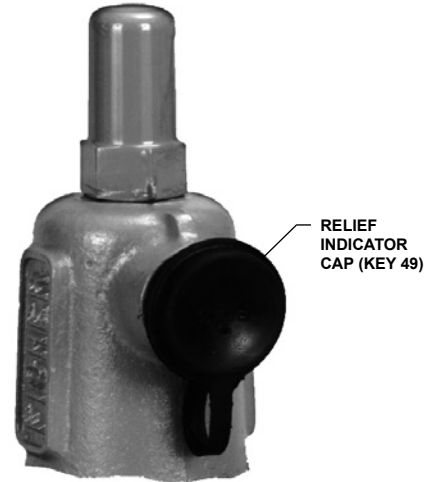


Figure 4. Relief Indicator

be inspected periodically and replaced as necessary to ensure correct performance. The frequency of inspection and replacement depends upon the severity of conditions and the requirements of state and federal laws. Normal wear of the orifice and disk assembly is accelerated with high pressure drops and with large amounts of impurities in the flowstream. Instructions are given below for replacing the disk assembly, orifice, diaphragm, and O-rings. These procedures may also be used for disassembly required for inspection and replacement of other parts.

Problem Indication for Types 627R, 627LR, and 627MR Regulators

WARNING

Isolate the regulator from all pressure to avoid personal injury and equipment damage due to explosion or sudden release of process pressure. Cautiously release pressure from the regulator before attempting disassembly.

The vent assembly is equipped with a relief indicator (key 49, Figure 4). The cap for the relief indicator snaps over the vent assembly opening. If the relief valve opens wide, exhaust gas pops the cap off the screen vent assembly opening indicating a problem with the regulator. If the cap pops off, refer to the shutdown and to the Body Area Maintenance Procedures to inspect the disk assembly and orifice.

If the disk assembly and orifice are not damaged, refer to the Diaphragm and Spring Case Area Maintenance Procedures in this section.

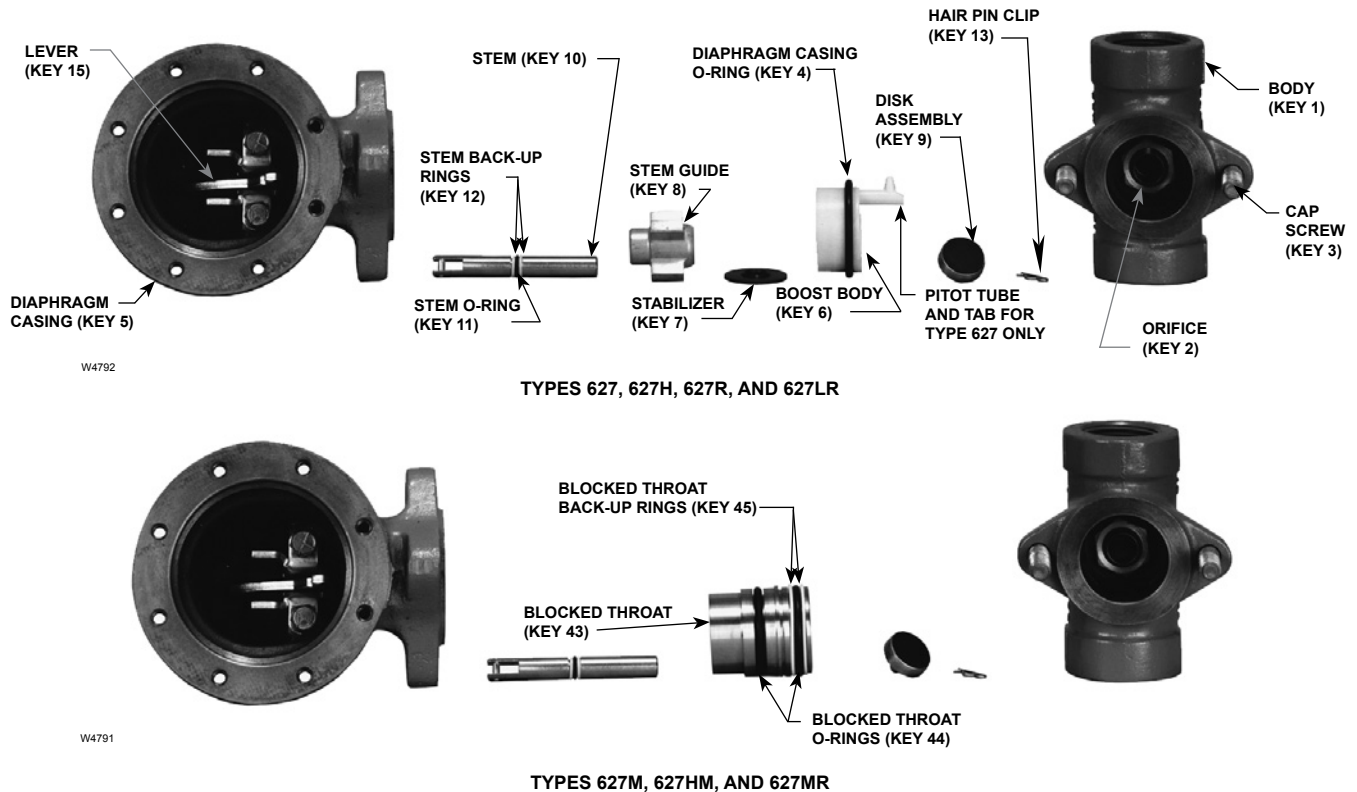


Figure 5. Stem Assemblies

The disk assembly and orifice can be inspected, removed, and replaced without removing the regulator body from the line connections. Refer to the Body Area Maintenance Procedures.

Body Area Maintenance Procedures

These procedures are for gaining access to the disk assembly, orifice, diaphragm casing O-ring, and stem assembly. All pressure must be released from the diaphragm casing before performing these steps.

While using the following procedures, refer to Figures 7 through 13 for key number locations.

Replacing the Disk Assembly or Orifice

1. To inspect and replace the disk assembly (key 9) or orifice (key 2), remove the cap screws (key 3, Figure 5), and separate the diaphragm casing (key 5) from the body (key 1).
2. Inspect and, if necessary, remove the orifice (key 2). If removed, coat the threads of the replacement orifice with lubricant and torque to 25 foot-pounds / 34 N•m.

3. Inspect the disk assembly (key 9) and, if necessary, remove the hair pin clip (key 13) that holds the disk assembly (key 9) in place. If replacing the disk assembly is the only maintenance required, skip to step 16.

Replacing the Stem Assembly

If it is necessary to perform maintenance on the stem assembly, continue with steps 4 through 8 and 15 through 19 for Types 627, 627H, 627R, and 627LR regulators, or steps 9 through 19 for Types 627M, 627HM, and 627MR regulators.

Perform steps 4 through 8 for Types 627, 627H, 627R, and 627LR Regulators only:

4. Use steps 5 through 8 to remove and replace the stem assembly.
5. Remove the boost body (key 6), stabilizer (key 7), and stem guide (key 8) from the diaphragm casing (key 5). Unhook and remove the stem (key 10) from the diaphragm casing (key 5).
6. Remove and inspect the diaphragm casing O-ring (key 4, Figure 7, 8, 9, or 12) and replace it if necessary.

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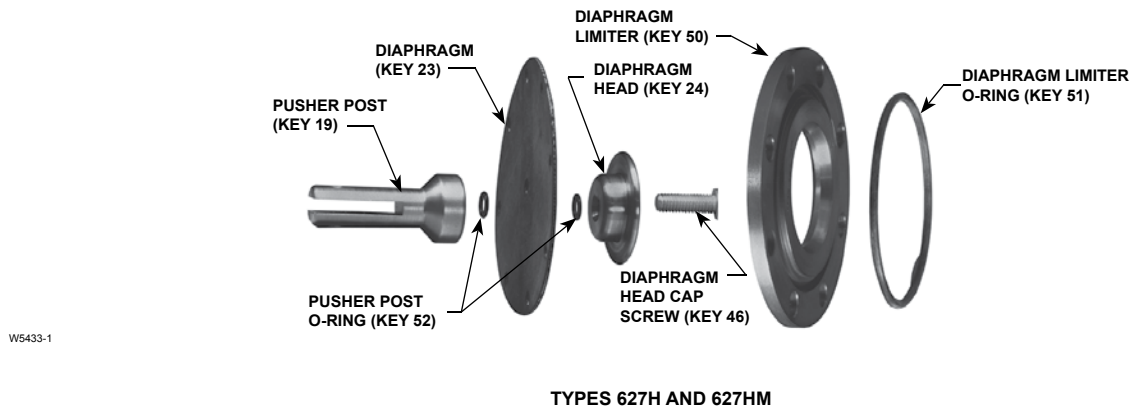
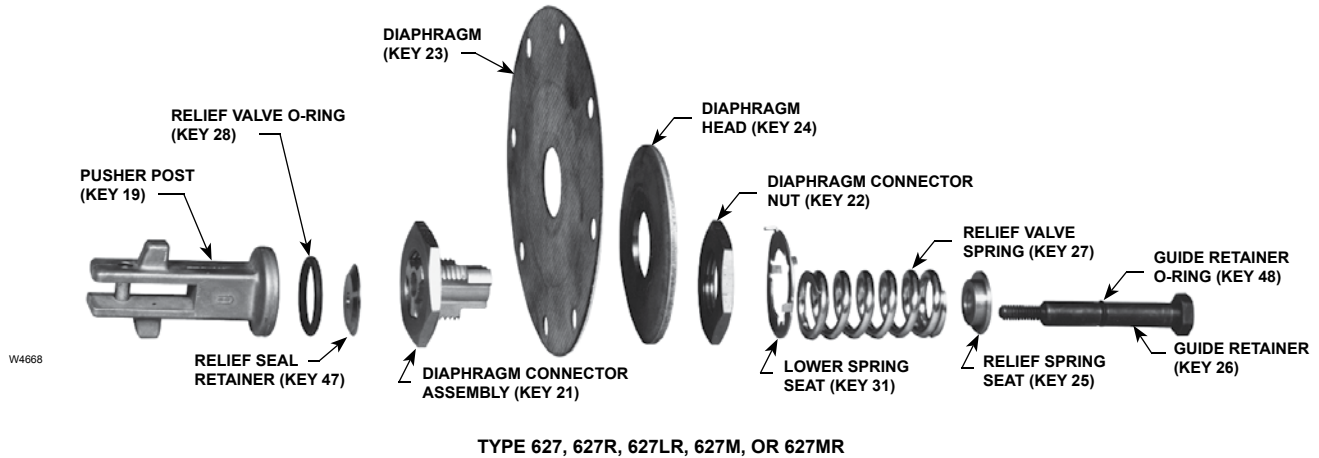


Figure 6. Diaphragm Assemblies

7. Apply lubricant to a replacement diaphragm casing O-ring (key 4, Figure 7, 8, 9, or 12) and install it onto the boost body (key 6). Skip to step 14.
 8. For the Type 627 or 627H regulators, be sure to insert the pitot tube (tab) into the outlet side of the body (see Figure 7 or 12). Skip to step 14.
- Perform steps 9 through 19 for Types 627M, 627HM, and 627MR Regulators only:**
9. Use steps 10 through 14 to remove and replace the stem assembly.
 10. To remove the blocked throat (key 43), insert a screw driver blade into the groove provided in the throat and pry it out of the diaphragm casing (key 5). Inspect and replace parts as necessary.
 11. Inspect and, if necessary, replace the blocked throat O-rings (key 44, Figure 5) and back-up rings (key 45, Figure 5).
 12. Apply lubricant to replacement blocked throat O-rings (key 44) and back-up rings (key 45).
 13. Apply lubricant to the replacement stem O-ring (key 11) and stem back-up rings (key 12) and install them on the stem (key 10).
 14. For assembly, lubricate the stem (key 10) and insert the diaphragm casing (key 5) and hook it on the lever (key 15).
 15. Lubricate the contact points of the lever (key 15).
 16. Insert parts into the diaphragm casing (key 5) that were removed in steps 5 and 6 or step 10 (see Figure 5).
 17. Install the disk assembly (key 9), line up the hole in the disk assembly and stem (key 10) and insert the hair pin clip (key 13).
 18. Position the diaphragm casing (key 5) plus attached parts in relation to the body (key 1) so that they are correct for the application.

19. Secure the diaphragm casing (key 5) to the body with the cap screws (key 3, Figure 5). For an aluminum diaphragm casing, torque the cap screws (key 3) to 16 foot-pounds / 22 N•m. For ductile iron or steel diaphragm casings, torque the cap screws (key 3) to 25 foot-pounds / 34 N•m.
20. It may be necessary to reposition the diaphragm spring case to prevent rain, ice, and foreign debris from entering the spring case. Refer to the Diaphragm and Spring Case Area Maintenance Procedures, steps 1, 2, and 21 through 25.

Diaphragm and Spring Case Area Maintenance Procedures

These procedures are for gaining access to the control spring, diaphragm assembly, and lever assembly. All spring pressure must be released from the diaphragm casing before these steps can be performed.

While using the following procedures, refer to Figures 7 through 13 for key number locations.

1. Remove the adjusting screw cap (key 36), loosen the lock nut (key 34), and turn the adjusting screw (key 35) counterclockwise until all compression is removed from the control spring (key 32).
2. Remove the spring case cap screws (key 37), the nameplates, and lift off the spring case (key 29). If changing the control spring (key 32) or repositioning the spring case (key 29) is the only maintenance required, install the replacement control spring or rotate the spring case so it is correct for the application. Skip to step 21. For diaphragm area maintenance, continue with step 3.
3. Remove the diaphragm limiter O-ring and diaphragm limiter (keys 51 and 50, on the Type 627H or 627HM only). Remove the diaphragm assembly by tilting it so that the pusher post (key 19) slips off the lever (key 15).
4. If it is necessary to replace the lever assembly, remove the lever cap screws (key 18).
5. Install the replacement lever (key 15) into the lever retainer (key 16) by inserting the lever pin (key 17). Secure the lever assembly into the diaphragm casing with the cap screws (key 18) and torque the cap screws to 7 foot-pounds / 9.5 N•m.

If it is necessary to perform maintenance on the diaphragm assembly, continue with steps 6 through 11 and step 20 for Types 627, 627H, 627M, and 627HM regulators, or steps 12 through 19 for Types 627R, 627LR, and 627MR regulators.

Perform steps 6 through 11 for Types 627, 627H, 627M, and 627HM Regulators only:

6. For Types 627, 627H, 627M, and 627HM regulators (Figures 5 and 6), use steps 7 through 11 to disassemble and reassemble the diaphragm assembly.
7. Remove the diaphragm head cap screw (key 46), lower spring seat (key 31, Type 627 or 627M only), and diaphragm head (key 24). On the Type 627H or 627HM, remove the pusher post O-rings (key 52). Separate the diaphragm (key 23) from the pusher post (key 19).
8. Install the diaphragm (key 23), in reverse order in step 7, on the pusher post (key 19), insert and finger tighten the diaphragm head cap screw (key 46).
9. Hook the pusher post on the lever (key 15), then turn the diaphragm (key 23) to match the holes in the diaphragm with the holes in the spring casing.
10. Unhook the pusher post from the lever (key 15) and torque the diaphragm head cap screw (key 46) to 7 foot-pounds / 9.5 N•m for the Type 627 or 627M. On the Type 627H or 627HM, torque the diaphragm head cap screw to 14 foot-pounds / 19 N•m.
11. Hook the pusher post on the lever (key 15) and check the hole alignment. If necessary, loosen the cap screw (key 46) and reposition the diaphragm (key 23) on the pusher post (key 19). Retorque the screw (see step 10). Skip to step 20.

Perform steps 12 through 19 for Types 627R, 627LR, and 627MR Regulators only:

12. For Types 627R, 627LR, and 627MR regulators (Figure 6), use steps 13 through 19 to disassemble and reassemble the diaphragm assembly.
13. Remove the guide retainer (key 26) and separate the diaphragm parts. Refer to Figure 6 for the sequence of parts.
14. To remove the diaphragm (key 23), remove the diaphragm connector nut (key 22) and lift off the diaphragm head (key 24) and diaphragm (key 23) from the connector assembly (key 21). Do not attempt to disassemble the connector assembly (key 21).

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15. Position the replacement diaphragm (key 23) on the connector assembly (key 21), install the diaphragm head (key 24) and connector nut (key 22), then torque to 17 foot-pounds / 23 N•m.
16. If necessary, replace the guide retainer O-ring (key 48) and, set the guide retainer (key 26) aside, ready for assembly.
17. On the pusher post (key 19) install the relief seal O-ring (key 28) and apply lubricant. Also, install the relief seal retainer (key 47), diaphragm connector assembly (key 21, with attached parts) relief spring (key 27), upper relief spring seat (key 33), and guide retainer (key 26). Torque the guide retainer (key 26) to 3 foot-pounds / 4.1 N•m.
18. Hook the pusher post (key 19) (with attached parts) on the lever (key 15) to check the alignment of the holes in the diaphragm with the holes in the spring casing. If the holes do not line up, unhook the pusher post from the lever, hold the pusher post, and rotate the diaphragm to the correct position.
19. Install the lower spring seat (key 31) over the relief spring so it rests flat on the connector nut (key 22).
20. Insert the diaphragm assembly into the diaphragm casing (key 5) and hook the pusher post on the lever (key 15).
21. Install the control spring (key 32) and upper spring seat (key 33), and apply lubricant to the upper spring seat (key 33).
22. Install the spring case (key 29) so that the screened vent assembly (key 30) is in the correct position for the application. Place the nameplates over the screw holes, insert the spring case cap screws (key 37), and finger tighten.
23. Screw in the adjusting screw (key 35) to put slack into the diaphragm (key 23).
24. Using a crisscross pattern, finish tightening the spring case cap screws (key 37) to 7 foot-pounds / 9.5 N•m of torque.
25. If necessary, refer to the installation and/or the Startup and Adjustment procedures.
26. Install the adjusting locknut (key 34) after regulator adjustment.

Parts Ordering

When corresponding with your local Sales Office about this equipment, always reference the equipment serial number or FS number that can be found on the nameplate.

When ordering replacement parts, reference the key number of each needed part as found in the following parts list. Separate kits containing all recommended spare parts are available.

Parts List

Note

In this parts list, parts marked NACE are intended for corrosion-resistant service as detailed in the NACE International Standard MR0175.

Key	Description	Part Number
	Type 627 Parts Kit with Aluminum/Nitrile (NBR) trim (include keys 4, 9, 11, 12, and 23)	R627X000A12
	Type 627 Parts Kit with Stainless steel/ Nitrile (NBR) trim (include keys 4, 9, 11, 12, and 23)	R627X000S12
	Type 627H Parts Kit with SST/Nylon (PA) trim	R627HX00S12
	Type 627R Parts Kit with Aluminum/ Nitrile (NBR) trim (include keys 4, 9, 11, 12, 23, 28, and 48)	R627RX00A12
	Type 627R Parts Kit with Stainless steel/ Nitrile (NBR) trim (include keys 4, 9, 11, 12, 23, 28, and 48)	R627RX00S12
1	Body ⁽¹⁾	
	Ductile iron	
	1000 psig / 69.0 bar maximum inlet pressure	
	3/4 NPT	30B3046X012
	1 NPT	30B3048X012
	2 NPT	30B3096X012
	Ductile iron (Long Body)	
	1000 psig / 69.0 bar maximum inlet pressure	
	1 NPT	39B2451X012
	2 NPT	39B0414X012
	Steel	
	2000 psig / 138 bar maximum inlet pressure	
	3/4 NPT	30B3050X012
	1 NPT	30B3051X012
	2 NPT	30B7452X012
	Steel (Long Body)	
	2000 psig / 138 bar maximum inlet pressure	
	1 NPT	39B0412X012
	2 NPT	39B0415X012
	Steel, CL600 RF flanged	
	1500 psig / 103 bar maximum inlet pressure	
	NPS 1 / DN 25	40B6754X012
	NPS 2 / DN 50	40B6756X012
	Steel, CL300 RF flanged	
	750 psig / 51.7 bar maximum inlet pressure	
	NPS 1 / DN 25	41B8978X012
	NPS 2 / DN 50	41B8080X012

1. Bodies can be used for both standard and NACE constructions.

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Key	Description	Part Number	Key	Description	Part Number
1	Body ⁽¹⁾ (continued)		4*	Diaphragm Case O-ring	
	Steel, CL150 RF flanged			Nitrile (NBR)	
	290 psig / 20.0 bar maximum inlet pressure			For Type 627, 627H, or 627R only	17A2325X022
	NPS 1 / DN 25	43B8656X022		Fluorocarbon (FKM)	
	NPS 2 / DN 50	44B0666X012		For Types 627, 627R, and 627LR only	10A0037X012
	Steel, BWE		5	Diaphragm Case	
	1000 psig / 69.0 bar maximum inlet pressure			For Type 627, 627R, or 627LR	
	NPS 1 / DN 25	33B6723X012		Aluminum without 1/8-inch / 3.2 mm gauge tap	40B3084X012
	NPS 2 / DN 50	38B1688X012		Aluminum with 1/8-inch / 3.2 mm gauge tap	
	Steel, PN 16/25/40 RF			for 627 Series (except Types 627H and 627HM)	11B5380X012
	580 psig / 40.0 bar maximum inlet pressure			Ductile iron without 1/8-inch / 3.2 mm gauge tap	30B3053X012
	NPS 1 / DN 25	44B0386X012		Ductile iron with 1/8-inch / 3.2 mm gauge tap	
	NPS 2 / DN 50	44B3342X012		for 627 Series (except Types 627H and 627HM)	31B0641X012
	Stainless Steel ⁽²⁾ , NPT			For Type 627, 627R, or 627LR	
	2000 psig / 138 bar maximum inlet pressure			Steel	30B3104X012
	3/4 NPT	30B3050X062		Ductile iron with 1/4 NPT gauge tap for	
	1 NPT	30B3051X092		627 Series (except Types 627H and 627HM)	39A5987X012
	2 NPT	30B7452X052		Steel with 1/4 NPT gauge tap for 627 Series	
	Stainless Steel ⁽²⁾ , CL150 RF flanged			(except Type 627H)	30B8734X012
	275 psig / 18.9 bar maximum inlet pressure			For Type 627M or 627MR	
	NPS 1 / DN 25	43B8656X052		Ductile iron	39A5987X012
	NPS 2 / DN 50	44B0666X022		Steel	30B8734X012
	Stainless Steel ⁽²⁾ , CL300 RF flanged			For Type 627H, Steel	30B3104X012
	720 psig / 49.6 bar maximum inlet pressure			For Type 627, Stainless steel	30B3104X082
	NPS 1 / DN 25	41B8978X072		For Type 627HM, Steel	30B8734X012
	NPS 2 / DN 50	41B8080X072	6	Boost Body (not for Type 627M, 627HM,	
	Stainless Steel ⁽²⁾ , CL600 RF flanged			or 627MR), Delrin [®]	
	1440 psig / 99.2 bar maximum inlet pressure			For Type 627 or 627H	30B3056X012
	NPS 1 / DN 25	40B6754X102		For Type 627R or 627LR	30B3057X012
	NPS 2 / DN 50	40B6756X062	7	Stabilizer	
	Stainless Steel ⁽²⁾ , PN 16/25/40 RF			Nitrile (NBR)	
	580 psig / 40.0 bar maximum inlet pressure			For Types 627, 627H, 627R, and 627LR only	10B3060X012
	NPS 1 / DN 25	44B0386X032		Fluorocarbon (FKM)	
	NPS 2 / DN 50	44B3342X032		For Types 627, 627R, and 627LR only	10B3060X022
2*	Orifice		8	Stem Guide (for Types 627, 627H, 627R, and	
	Aluminum			627LR only), Powdered metal	20B3061X012
	3/32 inch / 2.4 mm	0R044109022	9*	Disk Assembly (for all Orifice Size)	
	1/8 inch / 3.2 mm	1A936709012		Aluminum holder and Nitrile (NBR) disk	1C4248X0212
	3/16 inch / 4.8 mm	00991209012		303 Stainless steel holder and Nitrile (NBR) disk	1C4248X0202
	1/4 inch / 6.4 mm	0B042009012		Aluminum holder and Nylon (PA) disk	1C4248X00A2
	3/8 inch / 9.5 mm	0B042209012		303 Stainless steel holder and Nylon (PA) disk	1C4248X0062
	1/2 inch / 13 mm	1A928809012		316 Stainless steel holder and Nylon (PA) disk	1C4248X0262
	303 Stainless steel			316 Stainless steel holder and Nitrile (NBR) disk	1C4248X0252
	3/32 inch / 2.4 mm	0R044135032		303 Stainless steel holder and	
	1/8 inch / 3.2 mm	1A936735032		Fluorocarbon (FKM) disk	1C4248X0052
	3/16 inch / 4.8 mm	00991235032		Aluminum holder and Fluorocarbon (FKM) disk	1C4248X0182
	1/4 inch / 6.4 mm	0B042035032		316 Stainless steel holder and	
	3/8 inch / 9.5 mm	0B042235032		Fluorocarbon (FKM) disk	1C4248X0192
	1/2 inch / 13 mm	1A928835032	10	Stem	
	316 Stainless steel, NACE construction only			303 Stainless steel	10B3059X012
	3/32 inch / 2.4 mm	0R0441X0012		316 Stainless steel (NACE)	10B3059X022
	1/8 inch / 3.2 mm	1A9367X0022	11*	Stem O-ring	
	3/16 inch / 4.8 mm	009912X0012		Nitrile (NBR)	
	1/4 inch / 6.4 mm	0B0420X0012		Fluorocarbon (FKM) For Types 627, 627R,	
	3/8 inch / 9.5 mm	0B0422X0012		627LR, 627M, and 627MR only	1N430406382
	1/2 inch / 13 mm	1A9288X0012	12*	Stem Back-up Ring,	
3	Cap Screw (not shown), (2 required)			Polytetrafluoroethylene (PTFE) (2 required)	1K786806992
	627 Series		13	Hair Pin Clip, Stainless steel	10B3058X012
	For Ductile iron/Steel diaphragm case	1A560724052	14	Drive Pin, Plated steel	1H3671X0012
	For Aluminum diaphragm case		15	Lever, Plated steel	20B3063X012
	(not applicable for Types 627H and 627HM)	1A352524052	16	Lever Retainer, Plated steel	30B3097X012
	Type 627 Only		17	Lever Pin	
	For Ductile iron/Steel diaphragm case	1A5607X0052		Stainless steel	10B3083X012
	For Aluminum case with Steel diaphragm case	10A3869X012		316 Stainless steel (NACE)	10B3083X022
	For SST Case and body	1A5607X0052			
	For Aluminum Case and SST body	10A3869X022			

*Recommended spare part.

1. Bodies can be used for both standard and NACE constructions.

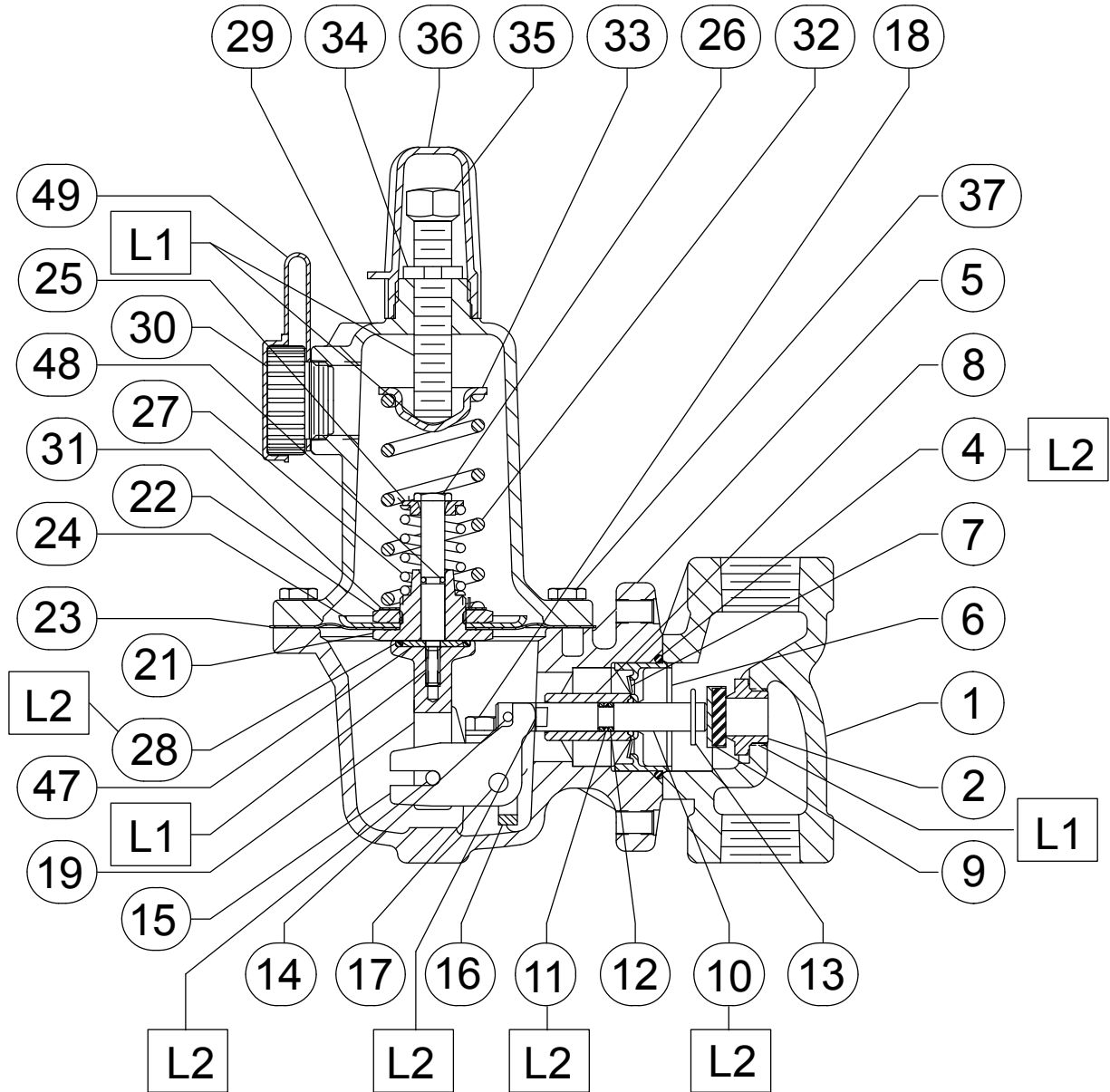
2. Stainless steel body material can be used for applications in temperature ranges down to -40°F / -40°C and are only available for Types 627, 627R, and 627H.

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Key	Description	Part Number	Key	Description	Part Number
18	Lever Cap Screw (2 required) Plated steel	10B7454X012	30	Screened Vent Assembly, Plastic	10B3093X012
	316 Stainless steel (NACE)	1B2905X0012	31	Lower Spring Seat, Plated steel For Type 627 or 627M	1D666625072
19	Pusher Post, Aluminum For Type 627 or 627M	10B3098X012		For Type 627R, 627LR, or 627MR	20B3073X012
	For Type 627R, 627LR, or 627MR	10B3098X022	32	Control Spring, Plated steel	
	For Type 627H or 627HM, 416 Stainless steel	10B3098X032		5 to 20 psig / 0.34 to 1.4 bar, Yellow	10B3076X012
	Stainless steel (NACE)	10B3098X102		15 to 40 psig / 1.0 to 2.8 bar, Green	10B3077X012
21	Diaphragm Connector (for Type 627R, 627LR, or 627MR only), Stainless steel	28B8832X012		35 to 80 psig / 2.4 to 5.5 bar, Blue	10B3078X012
22	Diaphragm Connector Nut (for Type 627R, 627LR, or 627MR only), Stainless steel	10B7449X012		70 to 150 psig / 4.8 to 10.3 bar, Red	10B3079X012
23*	Diaphragm Nitrile (NBR) For Type 627 or 627M with Aluminum or Ductile iron diaphragm case	10B3069X012	33	Upper Spring Seat, Plated steel	1D667125072
	For Type 627 or 627M with Steel diaphragm case	10B8735X012	34	Locknut, Plated steel	1D667728982
	For Type 627R, 627LR, or 627MR with Aluminum or Ductile iron diaphragm case	10B3068X012	35	Adjusting Screw, Plated steel For Type 627, 627M, 627H, or 627HM	10B3081X012
	For Type 627R, 627LR, or 627MR with Steel diaphragm case	10B8736X012		For Type 627R, 627LR, or 627MR	10B3080X012
	For Type 627H or 627HM with Steel diaphragm case (diaphragm is Neoprene (CR) with Nylon (PA) fabric)	12B0178X012	36	Adjusting Screw Cap, Plastic	20B3082X012
	Fluorocarbon (FKM) For Types 627R, 627LR, and 627MR with Steel case	10B8736X022	37	Spring Case Cap Screw, Plated steel (8 required) For Aluminum or ductile iron diaphragm case	1A391724052
	For Types 627 and 627M with Steel case	10B8735X042		For Steel diaphragm case	1A368324052
	For Types 627R, 627LR, and 627MR with Ductile Iron and Aluminum Casing	10B3068X022		For Stainless steel case and body	1A3683X0062
	For Types 627 and 627M with Ductile Iron and Aluminum Casing	10B3069X032		For Aluminum case and SST body	1A3917X0062
24	Diaphragm Head, Plated steel For Type 627 or 627M, Plated steel	1D666428982		For Type 627H/HM, steel diaphragm case	1A346424052
	For Type 627R, 627LR, or 627MR, Plated steel	10B3071X012		For Type 627H, Stainless steel case and body	1A3464X0022
	For Type 627H or 627HM, 416 Stainless steel	12B0175X012	43	Blocked Throat (For Type 627M, 627HM, or 627MR only), Stainless steel	10B3085X012
25	Relief Spring Seat (For Type 627R or 627MR only), Steel	10B7446X012	44*	Blocked Throat O-ring Nitrile (NBR) For Type 627M, 627HM, or 627MR only (2 required)	1E264306992
26	Guide Retainer (For Type 627R, 627LR, or 627MR only), Stainless steel	10B7450X012		Fluorocarbon (FKM) For Types 627M and 627MR only	1E2643X0022
27	Relief Spring (For Type 627R or 627MR only), Plated steel	10B6757X012	45*	Blocked Throat Back-up Ring (For Type 627M, 627HM, or 627MR only), PTFE (2 required)	10B3106X012
	For Type 627LR	1B541327022	46	Diaphragm Head Cap Screw, Steel For Type 627 or 627M	1B290524052
28*	Relief Seal O-ring Nitrile (NBR) For Type 627R, 627LR, or 627MR only	1J108506992		For Type 627H or 627HM	1C379124052
	Fluorocarbon (FKM) For Types 627R, 627LR, and 627MR only	1J1085X0042	47	Relief Seal Retainer (For Type 627R, 627LR, or 627MR only), Stainless steel	10B7445X012
29	Spring Case For Type 627, 627R, or 627LR		48*	Guide Retainer O-ring Nitrile (NBR) For Type 627R, 627LR, or 627MR only	1D682506992
	Aluminum	40B3086X012		Fluorocarbon (FKM) For Types 627R, 627LR, and 627MR only	1N423906382
	Ductile iron	30B3055X012	49	Relief Indicator (For Type 627R, 627LR, or 627MR only), Rubber (not shown)	30B3100X012
	Steel	30B3102X012	50	Diaphragm Limiter (For Types 627H and 627HM only)	22B0176X012
	Stainless steel (Types 627 and 627R only)	30B3102X092	51*	Diaphragm Limiter O-ring For Types 627H and 627HM only	1K877606992
29	Spring Case (continued) For Type 627M or 627MR		52*	Pusher Post O-ring (2 required) For Types 627H and 627HM only	1C853806992
	Ductile iron	30B3055X012	58	Pipe Plug, Zinc	1D8293T0022
	Steel	30B3102X012	67	Drive Screw, 18-8 Stainless steel	1A368228982
	For Type 627H or 627HM		72	Pipe Plug, Zinc-plated steel	1A767524662
	Steel	30B3102X012			
	Stainless steel (Type 627H only)	30B3102X092			

*Recommended spare part.

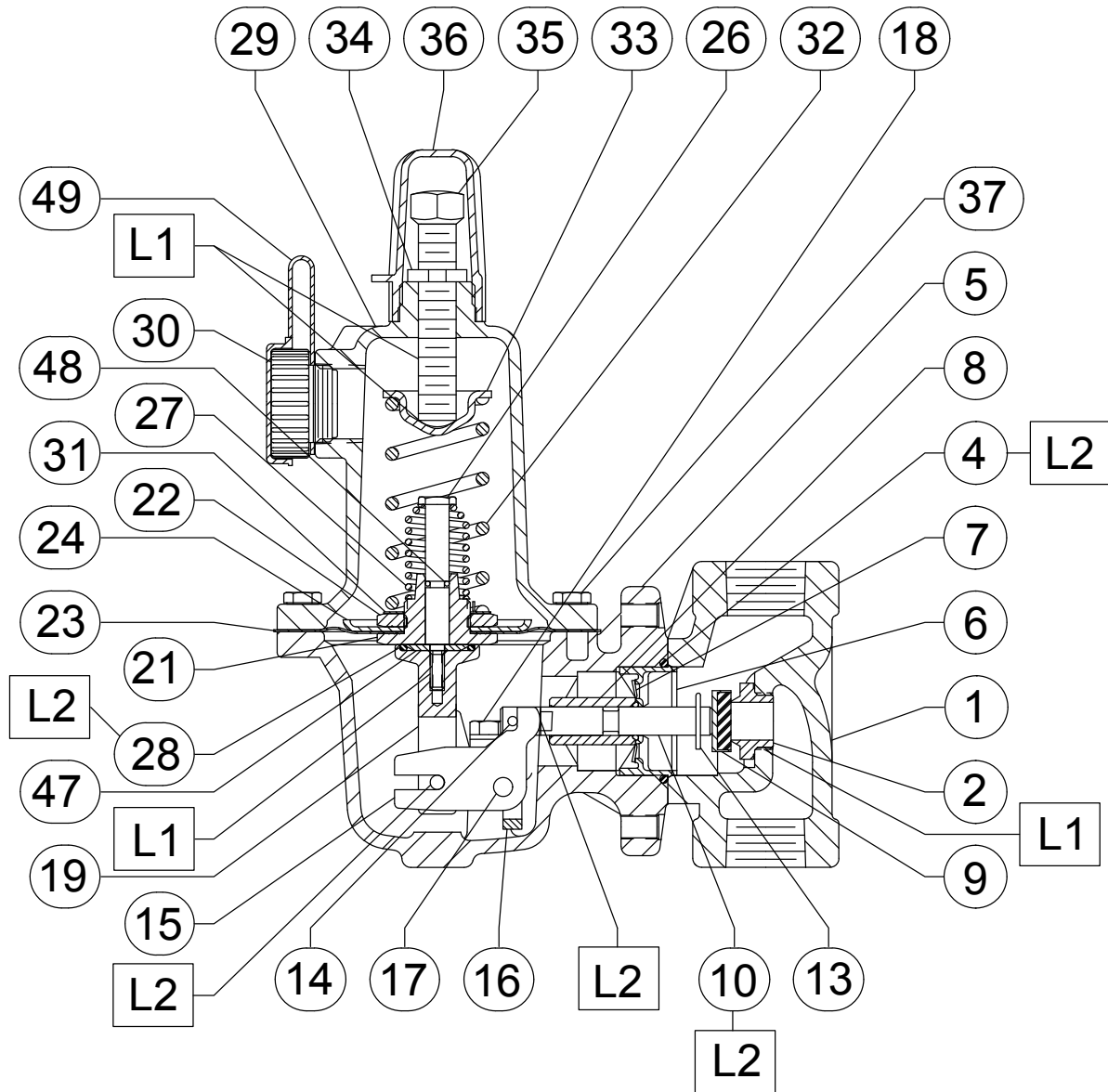


30B3089_G

- APPLY LUBRICANT⁽¹⁾
- L1 = MULTI-PURPOSE LITHIUM POLYMER TYPE GREASE
- L2 = EXTREME LOW-TEMPERATURE BEARING GREASE
- PARTS NOT SHOWN: 3

1. Lubricants must be selected such that they meet the temperature requirements.

Figure 8. Type 627R Regulator Assembly



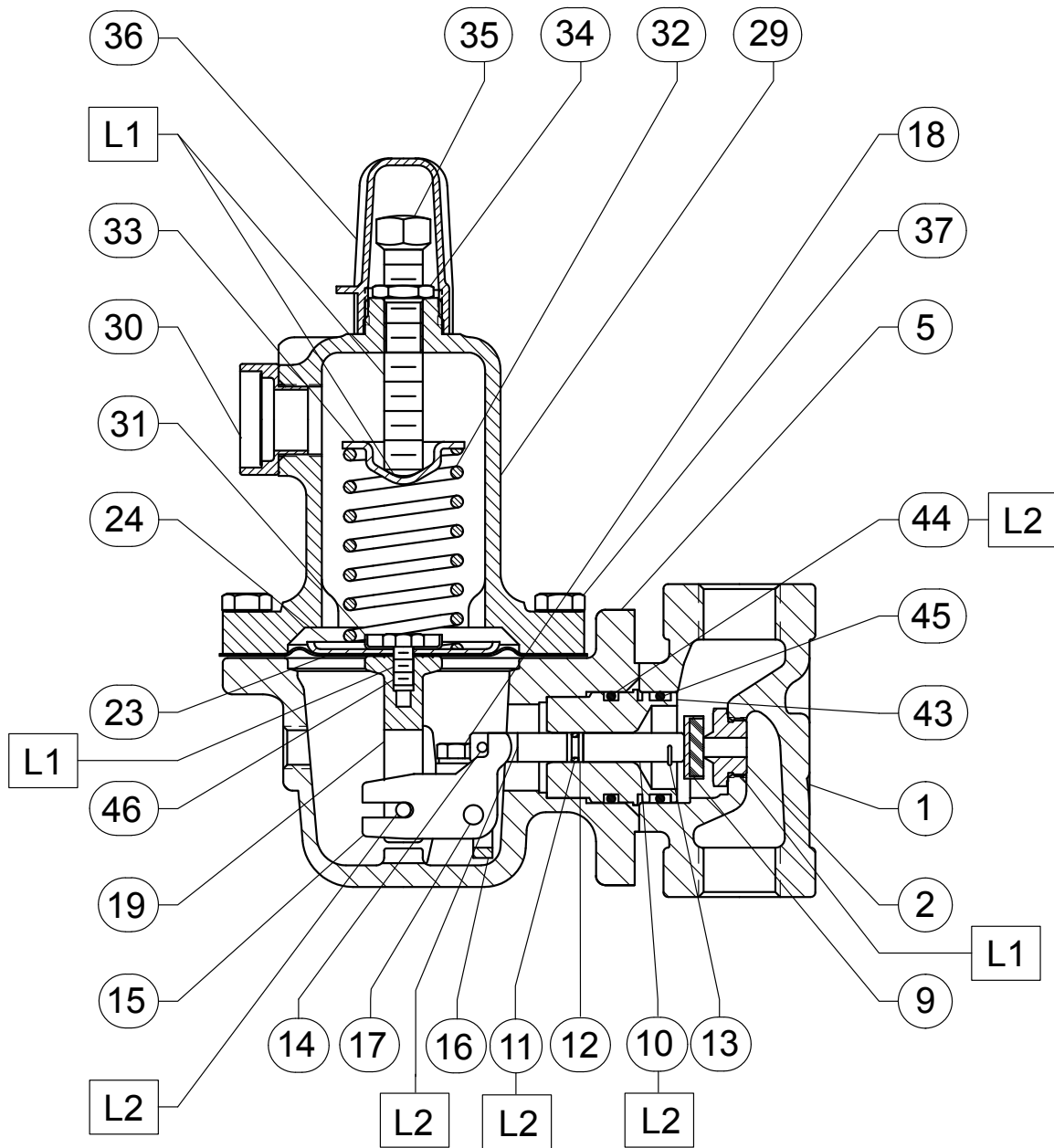
38B4843_C

□ APPLY LUBRICANT⁽¹⁾
 L1 = MULTI-PURPOSE LITHIUM POLYMER TYPE GREASE
 L2 = EXTREME LOW-TEMPERATURE BEARING GREASE
 PARTS NOT SHOWN: 3

1. Lubricants must be selected such that they meet the temperature requirements.

Figure 9. Type 627LR Regulator Assembly

627 Series

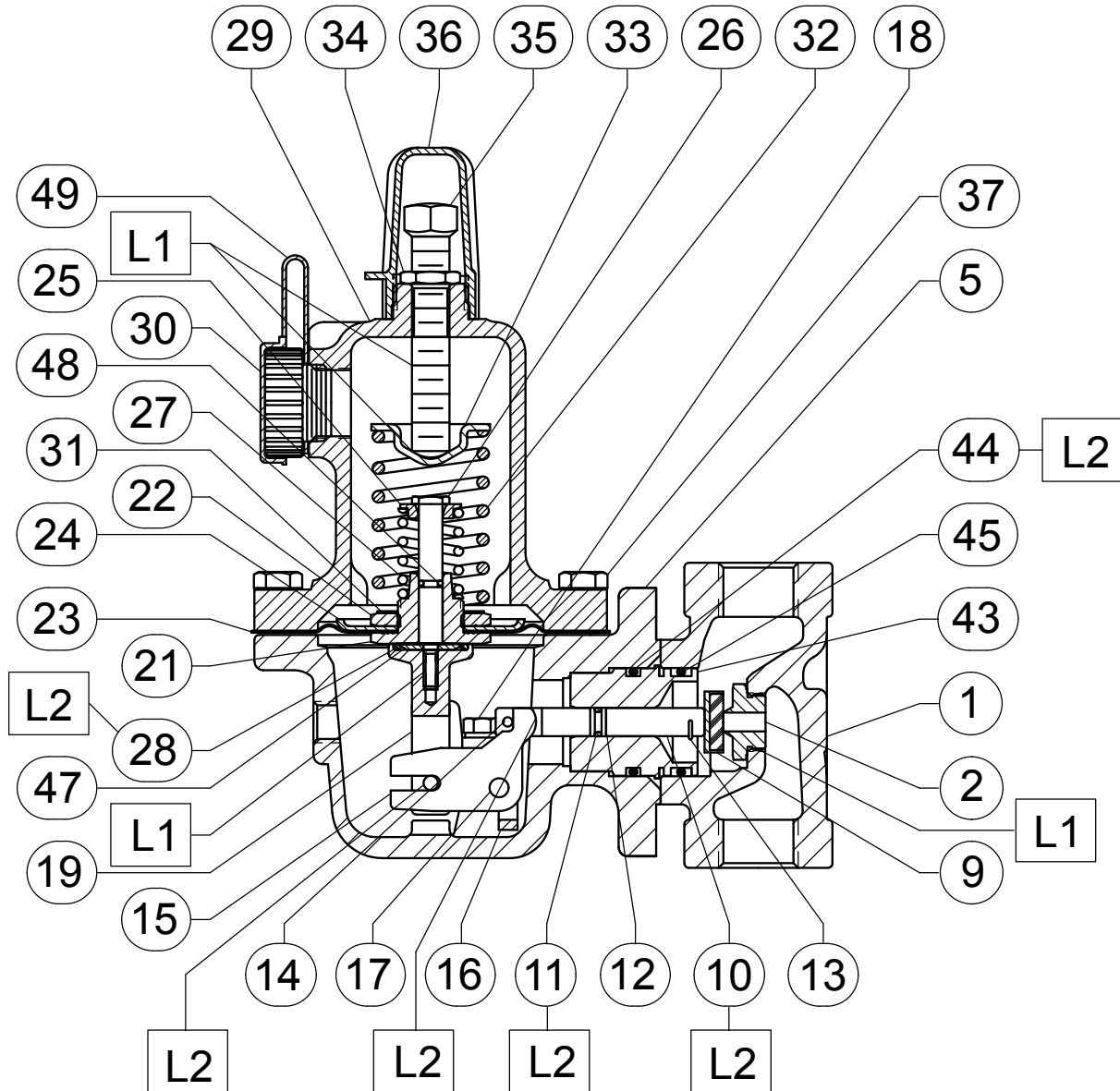


30B6433_E

- APPLY LUBRICANT⁽¹⁾
- L1 = MULTI-PURPOSE LITHIUM POLYMER TYPE GREASE
- L2 = EXTREME LOW-TEMPERATURE BEARING GREASE
- PARTS NOT SHOWN: 3

1. Lubricants must be selected such that they meet the temperature requirements.

Figure 10. Type 627M Regulator Assembly

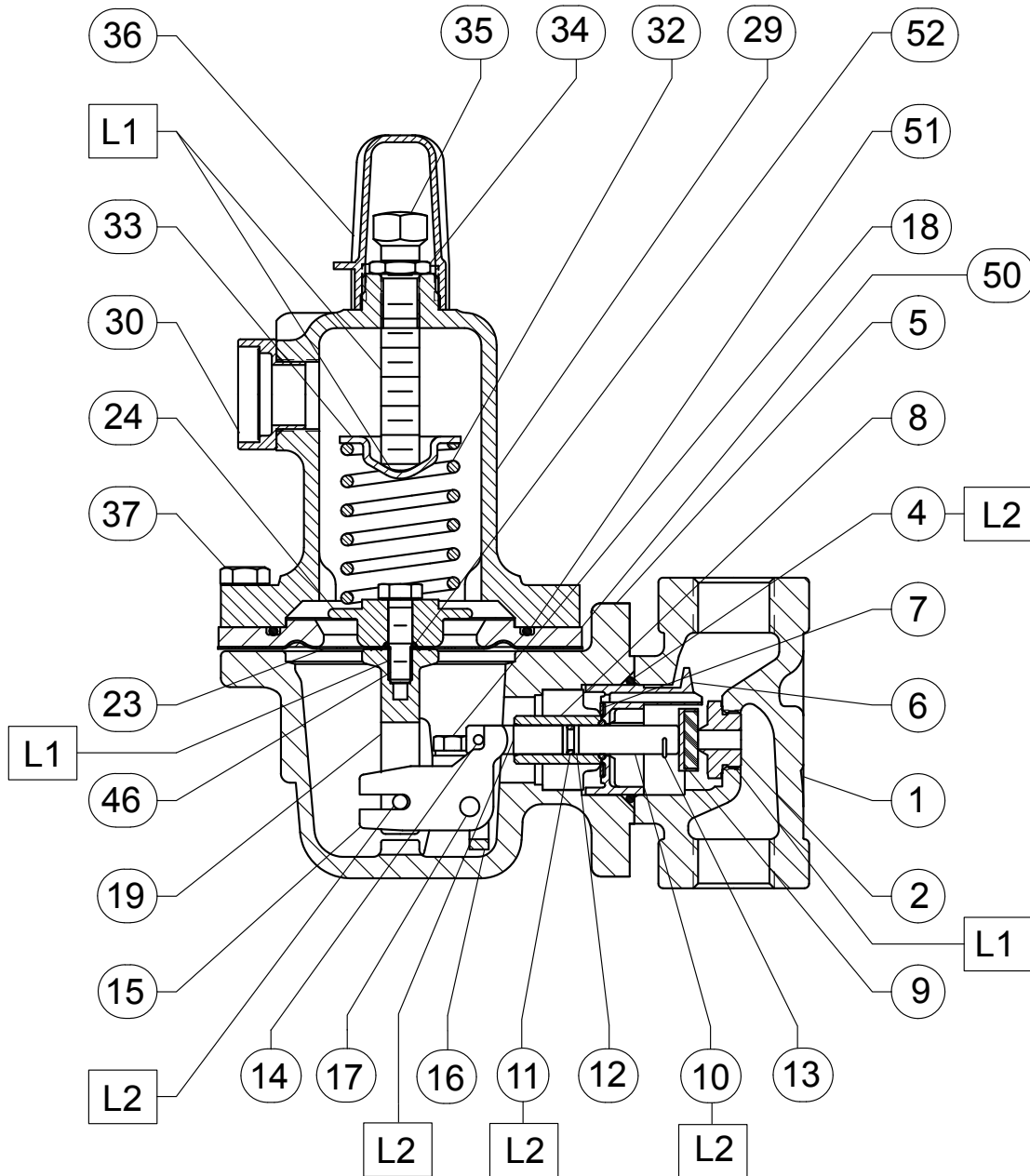


30B6434_E

- APPLY LUBRICANT⁽¹⁾
- L1 = MULTI-PURPOSE LITHIUM POLYMER TYPE GREASE
- L2 = EXTREME LOW-TEMPERATURE BEARING GREASE
- PARTS NOT SHOWN: 3

1. Lubricants must be selected such that they meet the temperature requirements.

Figure 11. Type 627MR Regulator Assembly

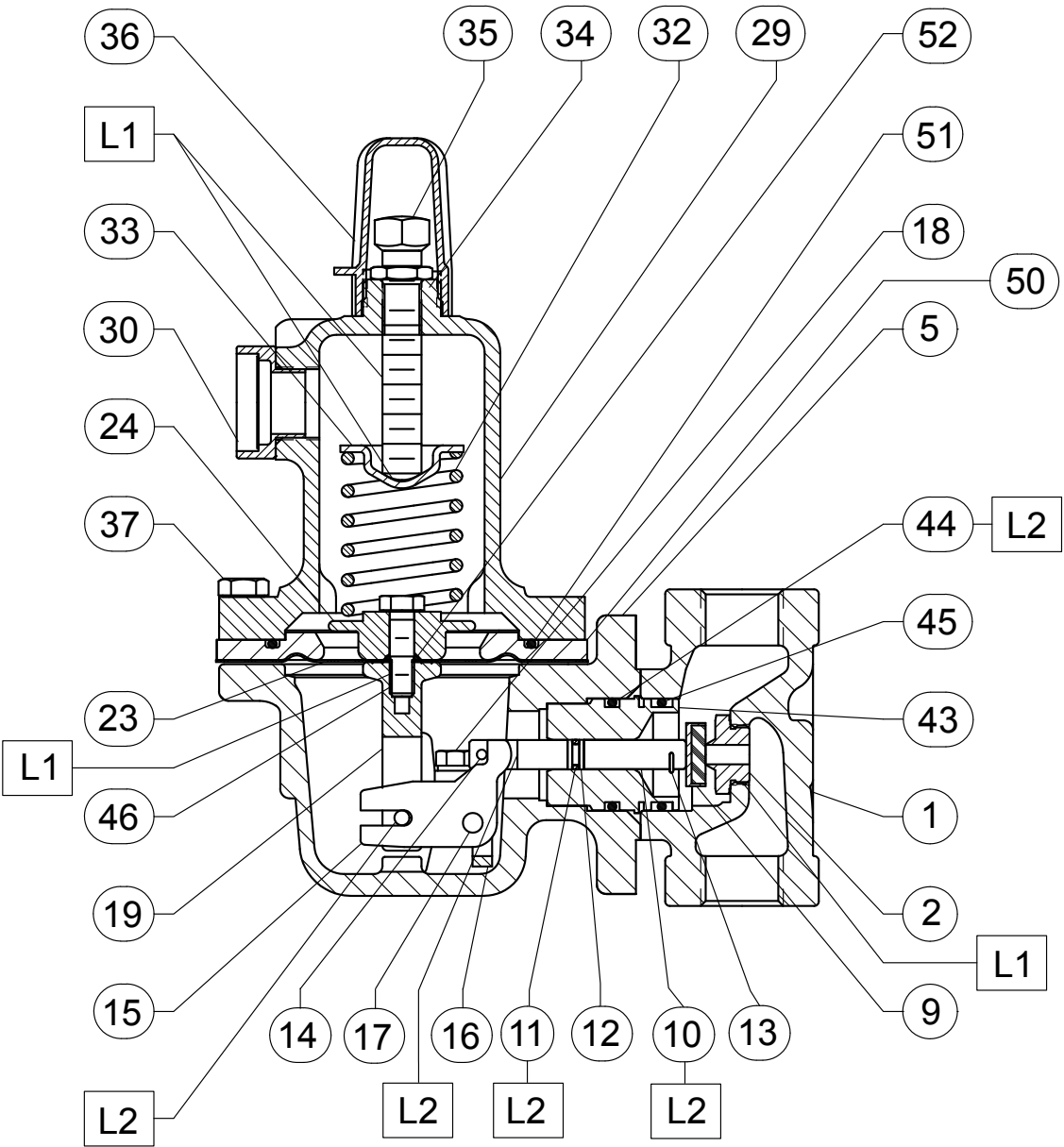


31B5374_D

□ APPLY LUBRICANT⁽¹⁾
 L1 = MULTI-PURPOSE LITHIUM POLYMER TYPE GREASE
 L2 = EXTREME LOW-TEMPERATURE BEARING GREASE
 PARTS NOT SHOWN: 3

1. Lubricants must be selected such that they meet the temperature requirements.

Figure 12. Type 627H Regulator Assembly



31B9872_D

□ APPLY LUBRICANT⁽¹⁾
 L1 = MULTI-PURPOSE LITHIUM POLYMER TYPE GREASE
 L2 = EXTREME LOW-TEMPERATURE BEARING GREASE
 PARTS NOT SHOWN: 3

1. Lubricants must be selected such that they meet the temperature requirements.

Figure 13. Type 627HM Regulator Assembly

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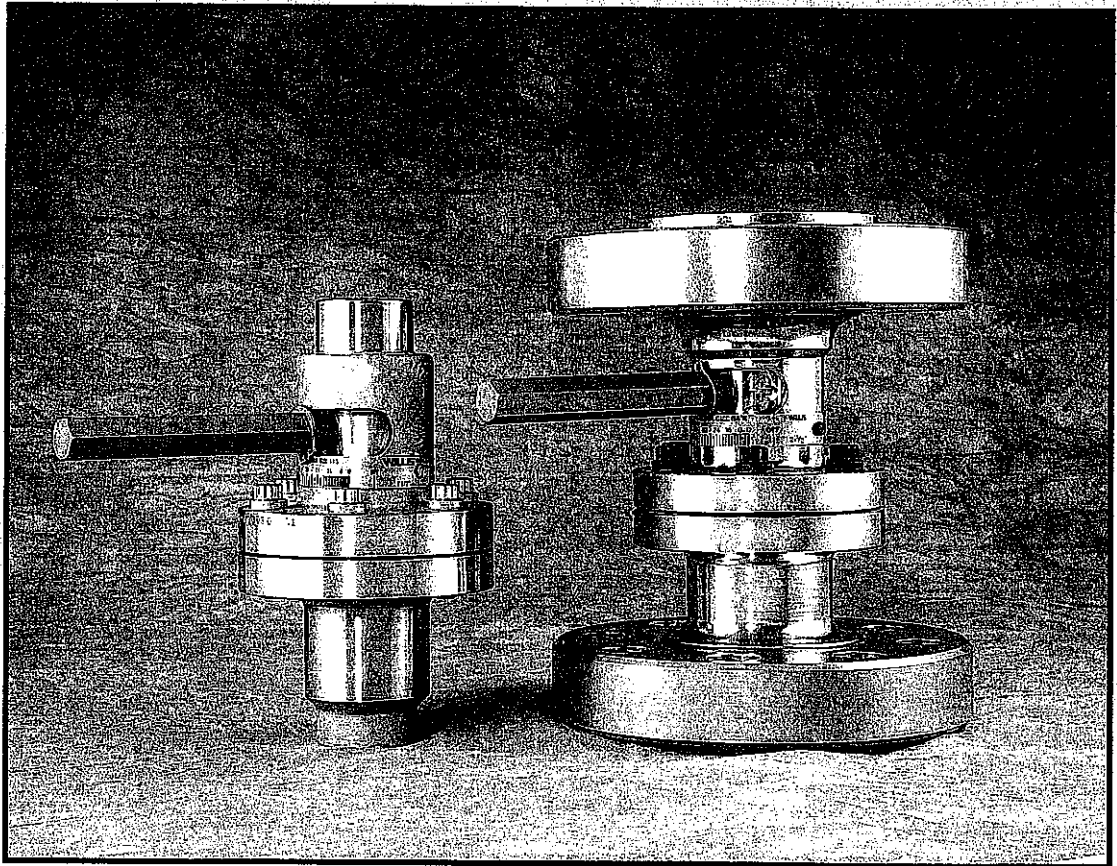


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Installation, Operation, and Maintenance Manuals (IOM's)

MC-10 & MC-20 In-Line Chokes

Service Instructions and Parts List



TC1155



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**When ordering spare parts, include part number and complete part description from the Parts List and choke serial number.*

MC-10 & MC-20 In-Line Chokes

Installation

Install with flow through the choke in the direction indicated by the flow arrow marked on the outlet hub. The choke can be mounted in any position without affecting its efficiency.

Operation

The multiple orifice valves use the McEvoy-Willis "rotating disc" principle to effect fully adjustable settings.

Precision control is achieved by shifting the handle to the desired position. This rotates the movable front disc against the face of the stationary back disc. When the holes line up, maximum flow passes through the choke. Shifting the handle causes the holes to partially block each other, reducing the flow passage. At 90 degree rotation the flow passage is closed.

Note: For extended disc life, the choke should not be operated in the "red area" shown on the calibration band for extended periods. (The red area is approximately 20% of C_v before closing.)

Maintenance

To avoid jamming or seizing, the handle should be operated from full open to fully closed at least every 30 days. This ensures free operation and helps clean the disc faces for more precise control.

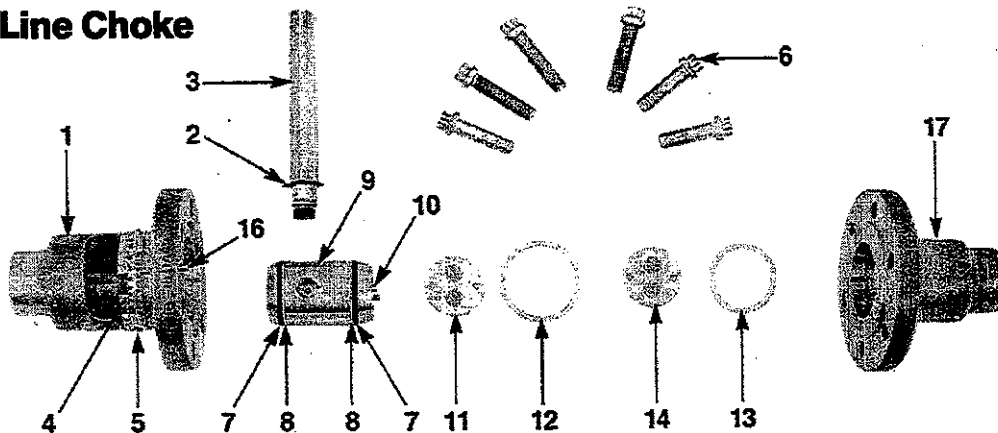
Ordering Parts

When ordering parts, include the choke serial number, part number and description.

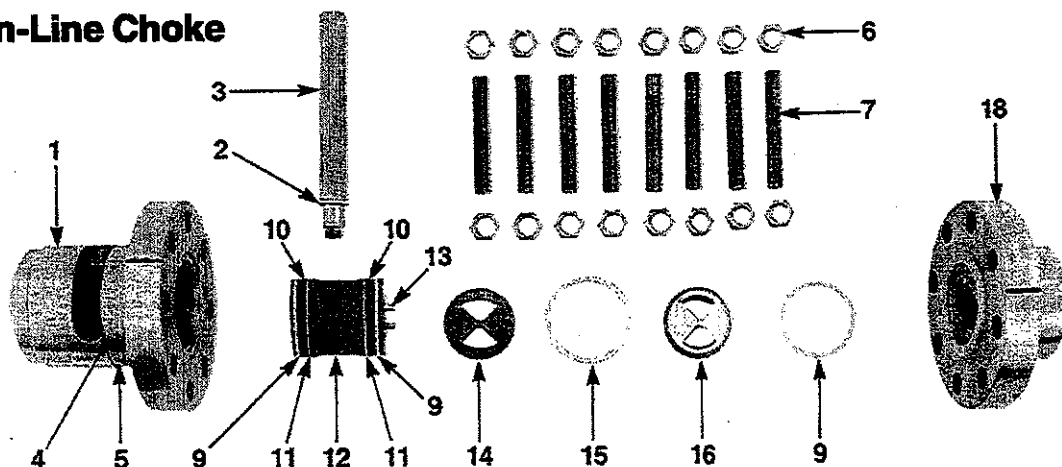
Optional Materials

For severe operating conditions, Tungsten Carbide discs and Stellite or Tungsten Carbide extended sleeves are available from the factory. Other options include stainless steel and carbon steel body assemblies.

MC-10 In-Line Choke



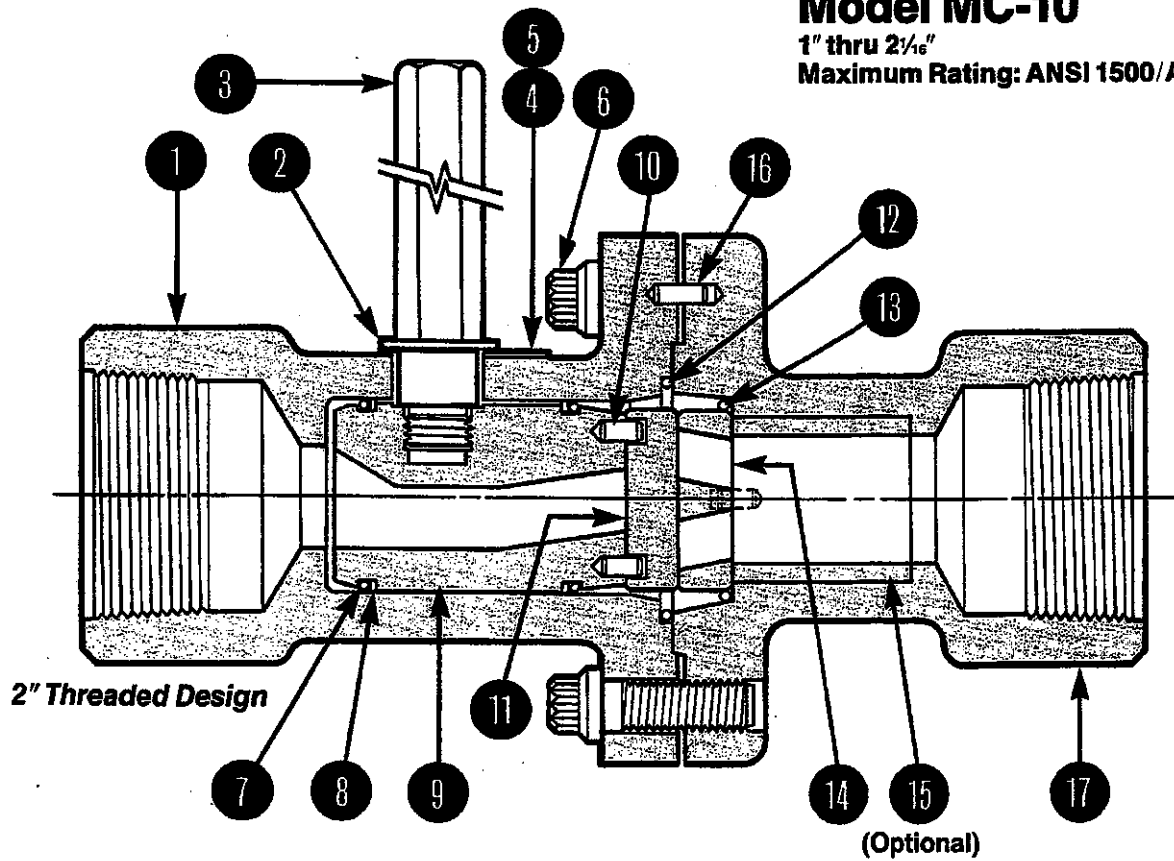
MC-20 In-Line Choke



Model MC-10

1" thru 2 1/8"

Maximum Rating: ANSI 1500/API 3000



MC-10 Parts List

Item No.	Description	Qty.	Standard Material
1	Body	1	Ni-Al-Bz or Stainless Steel
2	Indicator Ring	1	Stainless Steel
3	Handle	1	Alloy Steel
4	Calibration Band	1	Stainless Steel
5	Drive Screw	2	Stainless Steel
6	Capscrew	6	High Strength Alloy
*7	O-Ring	2	Viton
*8	Back-Up Ring	2	Teflon
9	Rotator	1	Ni-Al-Bz or Stainless Steel
10	Dowel Pin	4	Stainless Steel
11	Front Disc	1	Ceramic or Tungsten Carbide
*12	O-Ring	1	Teflon
*13	O-Ring	1	Teflon
*14	Back Disc	1	Ceramic or Tungsten Carbide
15	Wear Sleeve (Optional)	1	Stellite or Tungsten Carbide
16	Dowel Pin	1	Stainless Steel
17	Outlet Hub	1	Ni-Al-Bz or Stainless Steel

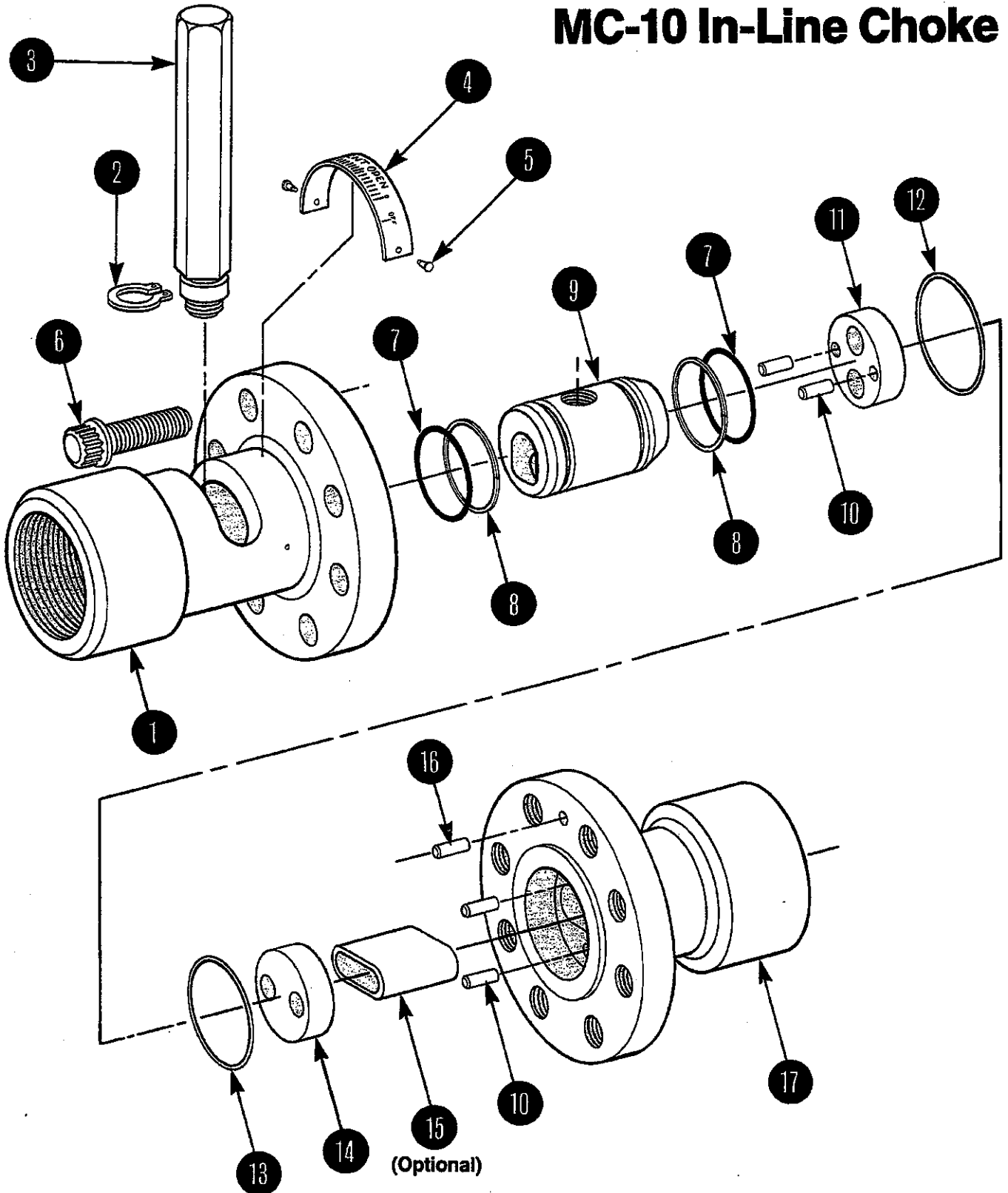
MC-10 Physical Dimensions

Inlet & Outlet Connections	Face to Face inches	Face to Face mm	Weight lbs	Weight kgs
1" Female NPT, (Ni-Al-Bz)	8.87	225	16	7
1" Female NPT, (C.S., S.S.)	10.30	262	20	9
2" Female NPT	10.30	262	20	9
2" ANSI Class 900 RF	10.30	262	64	29
2" ANSI Class 900 RTJ	10.30	262	64	29
2" ANSI Class 1500 RF	10.30	262	64	29
2" ANSI Class 1500 RTJ	10.30	262	64	29
2 1/8" 3000 API	10.30	262	64	29

*Recommended Spare Parts for One Year of Service.



MC-10 In-Line Choke



MC-10 Disassembly

MC-10

Tools Required for Disassembly and Assembly

1/2" Box Wrench
 3/4" Open End Wrench
 O-Ring Installation Tool, P/N 0502622
 Rotator Drive Tool, P/N 0502621
 Soft Tip Hammer

Grease:

Water, Oil or Gas Service:

Dow Corning FS-1292 or equivalent is recommended.

CO2 Service:

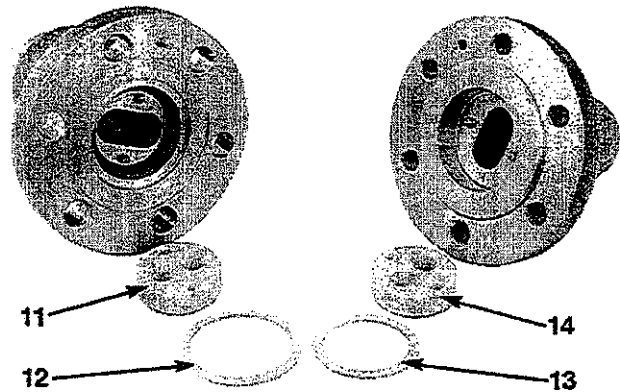
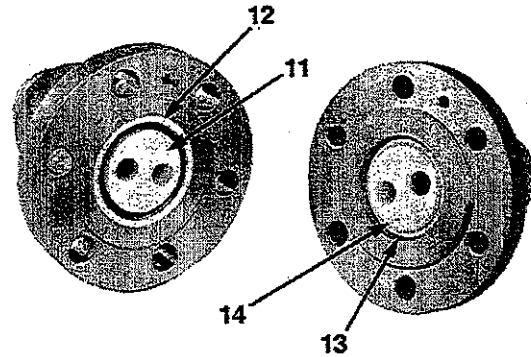
Jet Lube AP-1W Hi-temp or equivalent is recommended.

Disassembly

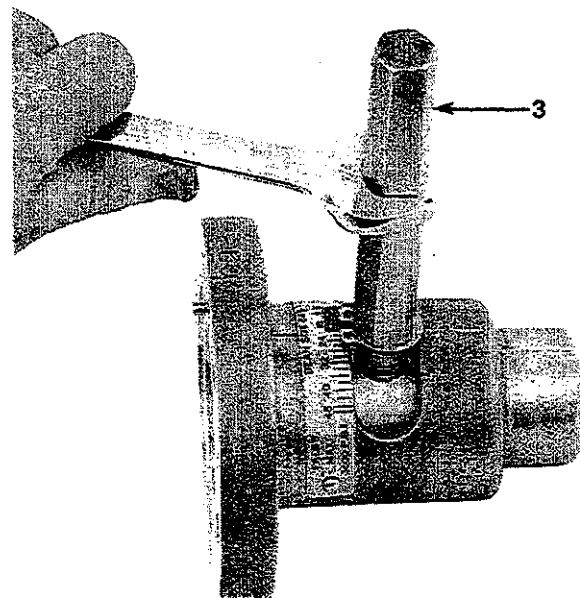
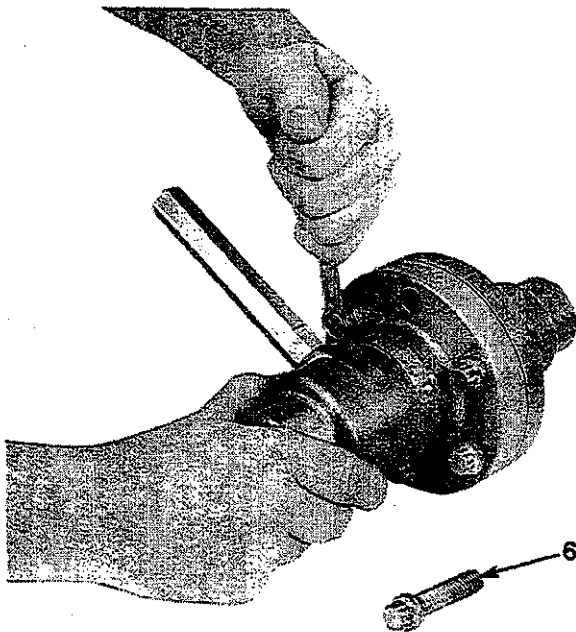
1. Depressurize lines upstream and downstream of choke to isolate it.
2. Place choke in open position and bleed all remaining pressure from piping system.
3. Remove choke from line.
4. With 1/2" box wrench, remove the six capscrews (Item 6) and separate the flanges.

Caution: Discs are only retained by loose fitting pins.

5. Remove both discs (11) and (14) and o-rings (12) and (13).



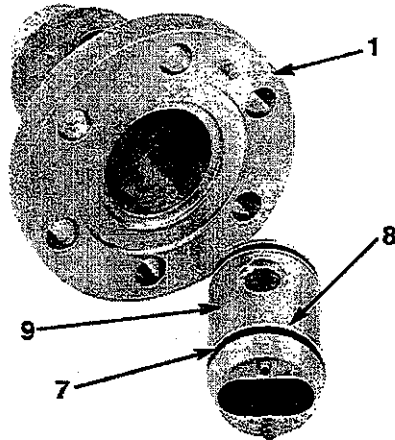
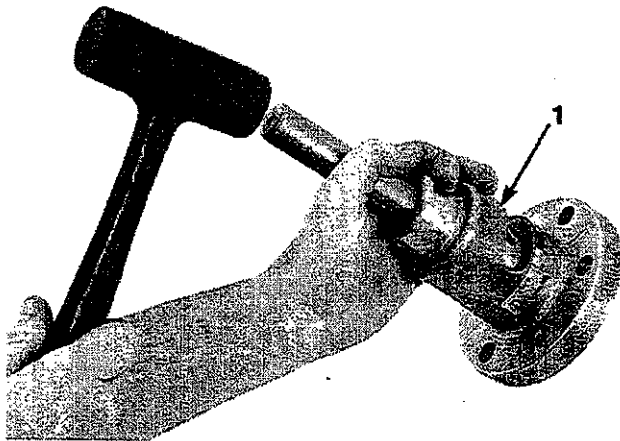
6. Unscrew handle (3) using 3/4" open end wrench.



Note: See pages 1, 2 or 3 for parts not shown.



- 7. Using rotator drive tool (P/N 0502621) and soft tip hammer, tap rotator (9) out of the body (1). Remove o-rings (7) and back-up rings (8) from rotator.



- 8. For chokes equipped with wear sleeves, (15) return the choke to the nearest McEvoy-Willis facility for wear sleeve replacement. If circumstances require field maintenance, the wear sleeve may be replaced in the field as described below.

Note: When ordering a replacement sleeve (15), be sure to order the appropriate epoxy resin along with it.

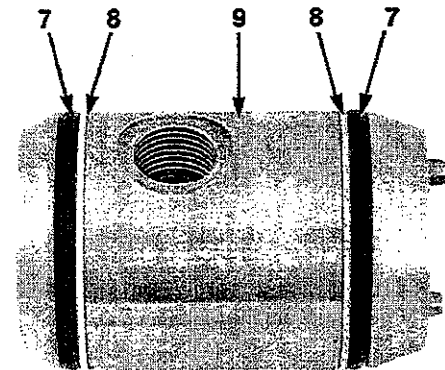
Heat the outlet hub to a maximum of 350° F. Monitor the temperature with a temperature stick to make certain that the heat does not exceed 350° F. The sleeve is fixed into position with epoxy resin which—when heated to approximately 250° F—drops from its position in the outlet hub. Air cool the outlet hub to room temperature. Coat the O.D. of the sleeve and the I.D. of the outlet hub with the epoxy resin and slide the sleeve back into the hub. Allow two-to-three hours' cure time, at room temperature (72°F), before putting the choke back into service.

ASSEMBLY

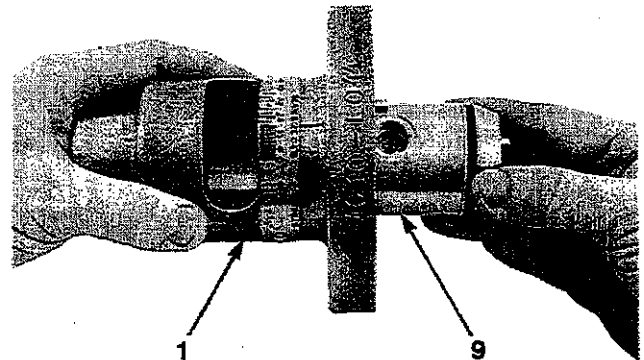
- 1. Replace all worn or damaged parts. Be sure to grease all o-rings and o-ring grooves with a grease that is compatible with the flowing medium.

Caution: If a new size of trim is being installed, the calibration band must be also changed to give correct bean size indication.

- 2. Install both back-up rings (Item 8) and o-rings (7) on the rotator (9) Place back-up rings on side of grooves closest to handle hole.



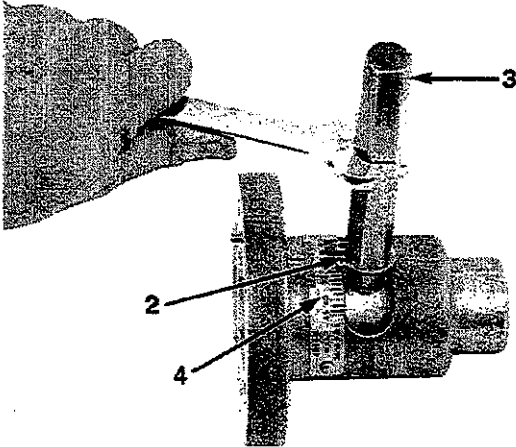
- 3. Align the handle hole in the rotator with the slot in the body (1) and slide the rotator into the body.



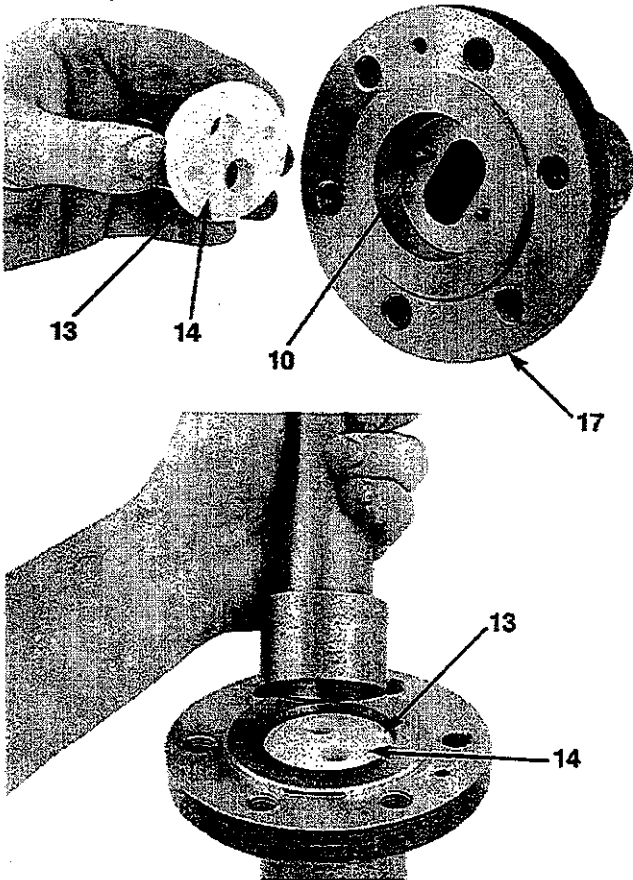
Note: See pages 1, 2 or 3 for parts not shown.

MC-10 Assembly

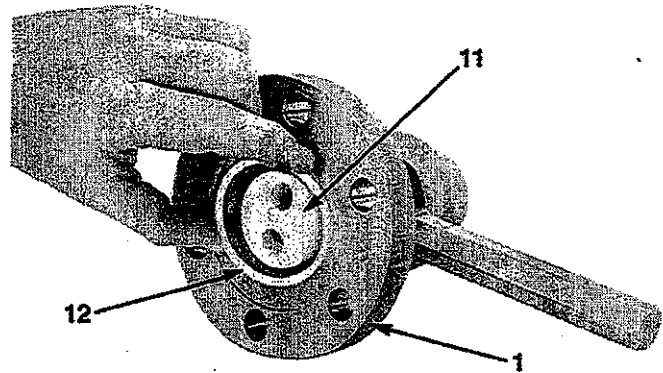
4. Install and tighten the handle (3) into the rotator and align the opening in the indicator ring (2) with the calibration band (4).



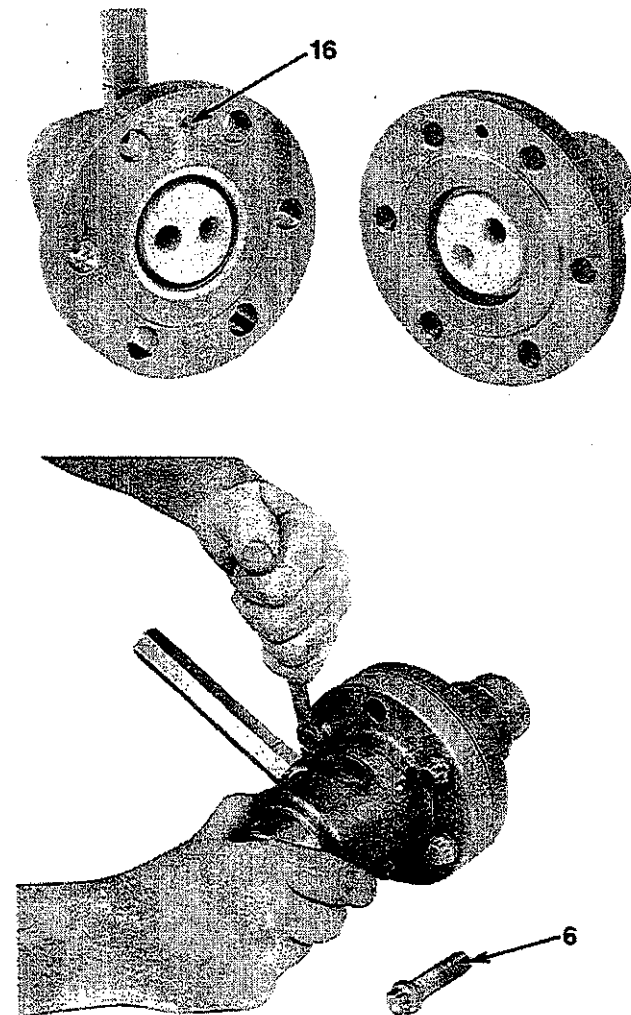
5. Place the o-ring (13) around the disc (14) and install over pins (10) in outlet hub (17). Seat o-ring using o-ring installation tool (P/N 0502622). If installation tool is not available, use a rounded soft tip tool to press the o-ring down into the groove.



6. Position the second disc (11) onto the rotator dowel pins (10) and install the o-ring (12) in place on the body flange.



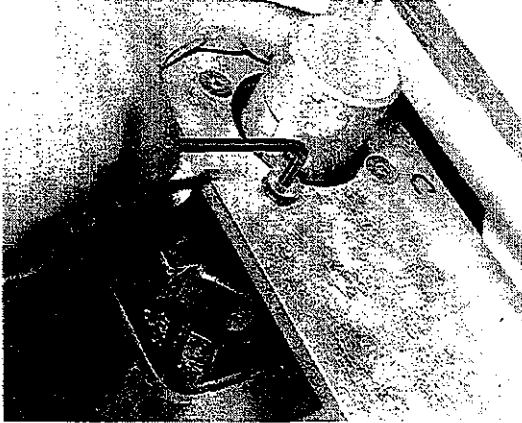
7. Use the dowel pin (16) to align the outlet hub and body and install the six capscrews (6). Recommended tightening torque for 1/2"-13 UNC capscrews is 636 in.-lbs. (53 ft.-lbs.).



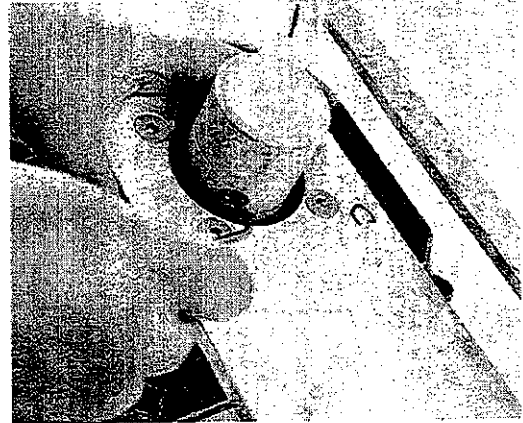
Note: See pages 1, 2 or 3 for parts not shown.

Actuation

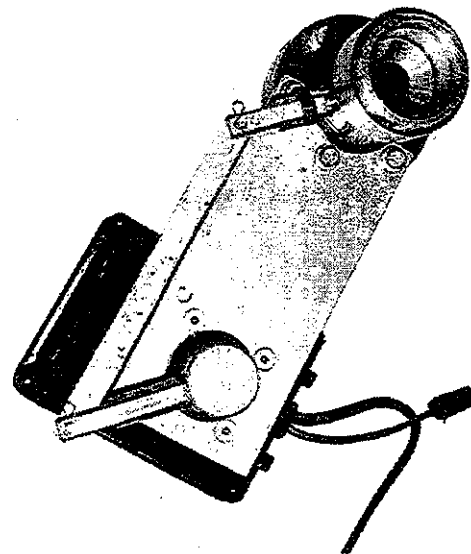
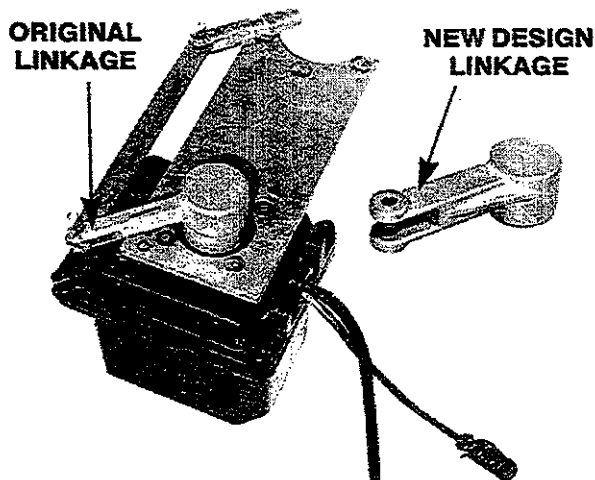
The MC-10 and MC-20 In-Line Chokes can be automated by use of easily installed electric, hydraulic or pneumatic actuators.



1. Mount the actuator onto the mounting bracket with the four screws provided with the actuator.



2. Attach the linkage to the exit shaft on the actuator so the actuator/linkage assembly looks like the one shown.



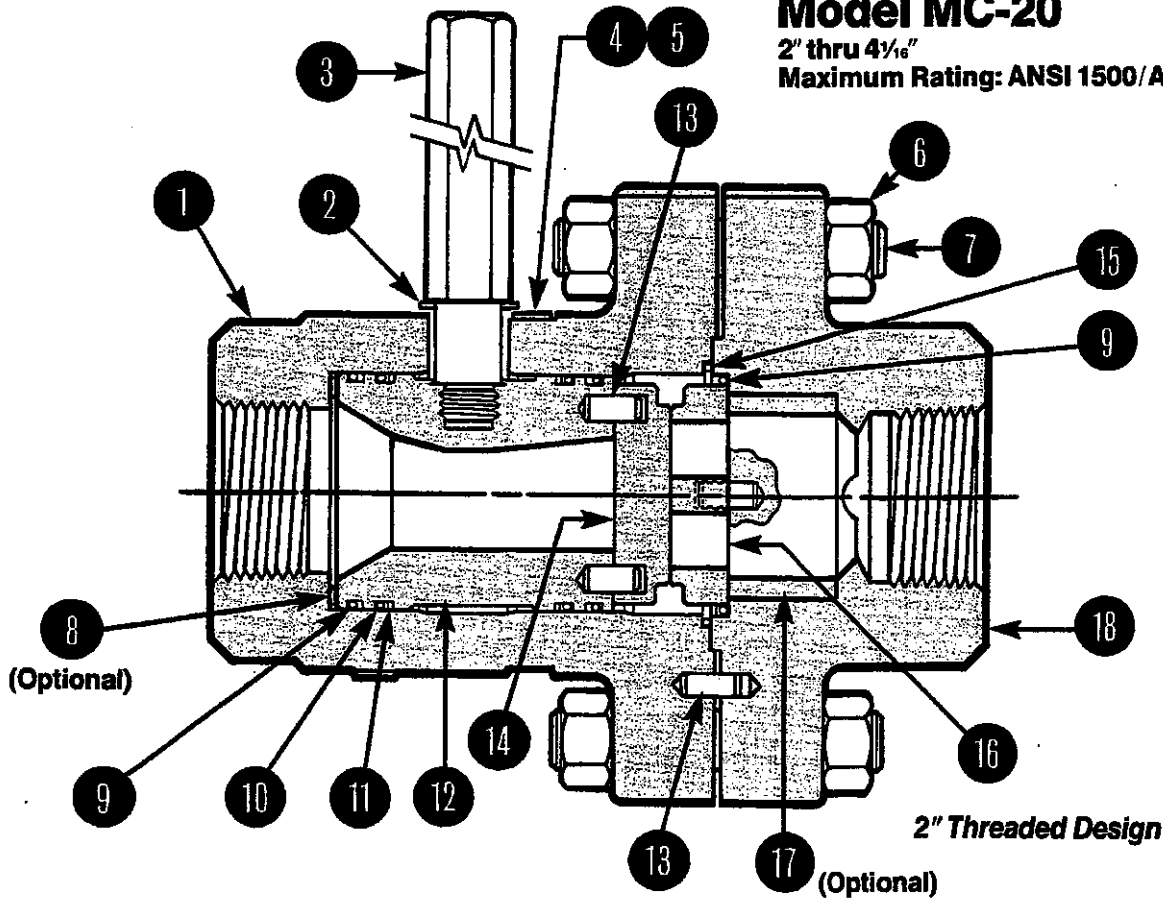
3. Unscrew the handle from the rotator. Unscrew the three flange bolts facing the calibration band. Position the mounting bracket to fit the three holes. Replace the flange bolts with longer flange bolts.
4. Unfasten the linkage brackets. Screw the end bracket into the rotator. Adjust the position of the bracket to match the other bracket and re-fasten.

For disassembly, reverse the steps indicated above.

Model MC-20

2" thru 4 1/8"

Maximum Rating: ANSI 1500/API 5000



2" Threaded Design

MC-20 Parts List

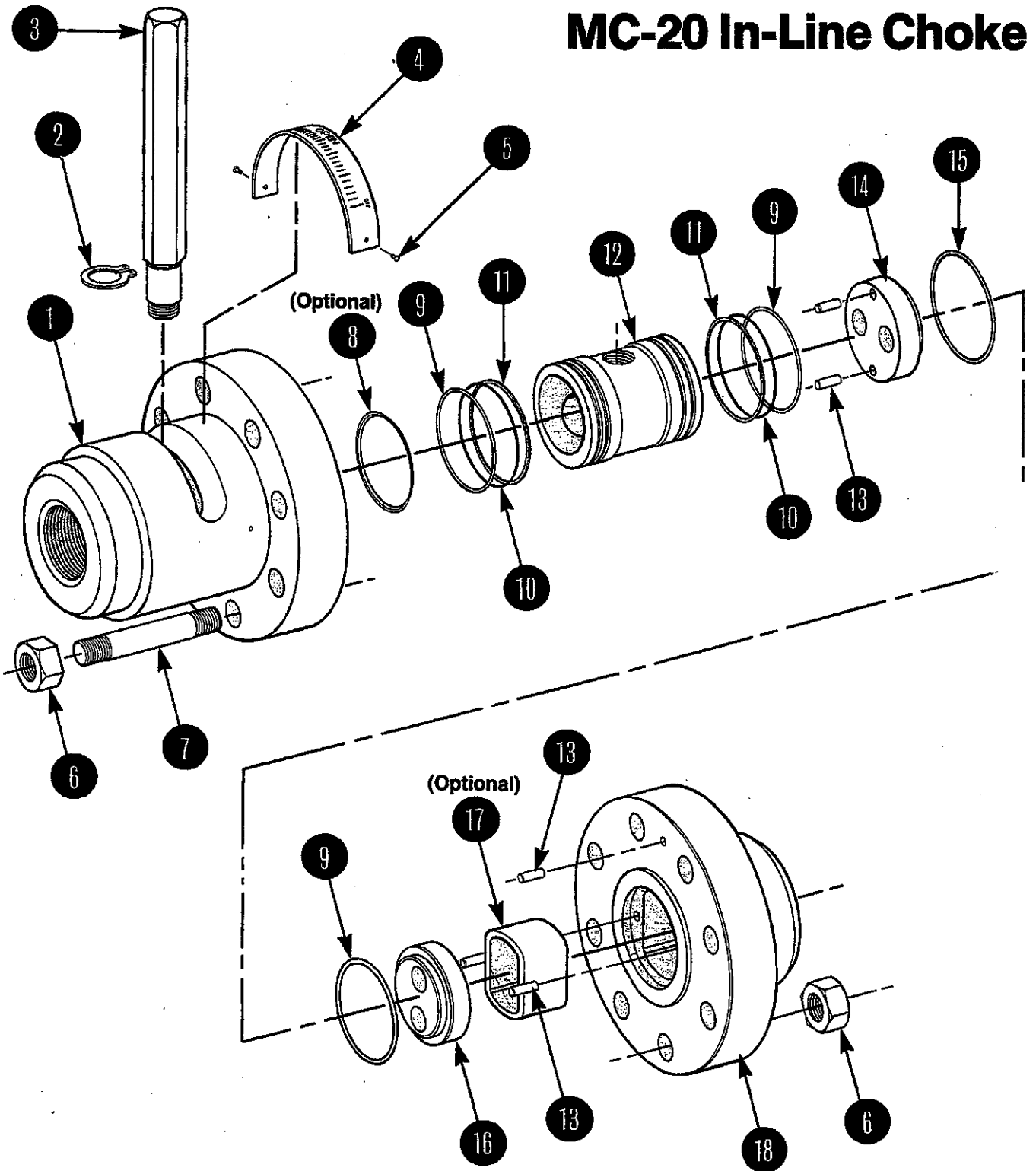
Item No.	Description	Qty.	Standard Material
1	Body	1	Alloy Steel or Stainless Steel
2	Indicator Ring	1	Stainless Steel
3	Handle	1	Alloy Steel
4	Calibration Band	1	Stainless Steel
5	Sheet Metal Screw	2	Stainless Steel
6	Nut	16	High Strength Alloy
7	Stud	8	High Strength Alloy
8	Belville Washer (Optional)	1	Inconel 718
*9	O-Ring	3	Teflon
*10	O-Ring	2	Buna-N
*11	Back-Up Ring	2	Teflon
12	Rotator	1	Alloy Steel or Stainless Steel
13	Dowel Pin	5	Stainless Steel
*14	Front Disc	1	Ceramic or Tungsten Carbide
*15	O-Ring	1	Teflon
*16	Back Disc	1	Ceramic or Tungsten Carbide
17	Wear Sleeve (Optional)	1	Stellite or Tungsten Carbide
18	Outlet Hub	1	Alloy Steel or Stainless Steel

*Recommended Spare Parts for One Year of Service.

MC-20 Physical Dimensions

Inlet & Outlet Connections	Face to Face inches	Face to Face mm	Weight lbs	Weight kgs
2" Female NPT	10.39	264	64	29
2" ANSI Class 600 RF	16.59	421	84	38
2" ANSI Class 600 RTJ	16.71	424	84	38
2" ANSI Class 900 RF	18.81	478	112	51
2" ANSI Class 900 RTJ	18.93	481	112	51
2" ANSI Class 1500 RF	18.81	478	112	51
2" ANSI Class 1500 RTJ	18.93	481	112	51
3" ANSI Class 600 RF	17.31	440	100	46
3" ANSI Class 600 RTJ	17.43	443	100	46
3" ANSI Class 900 RF	18.81	478	122	56
3" ANSI Class 900 RTJ	18.93	481	122	56
3" ANSI Class 1500 RF	20.00	483	160	73
3" ANSI Class 1500 RTJ	20.12	486	160	73
4" ANSI Class 600 RF	18.81	478	138	63
4" ANSI Class 600 RTJ	18.93	481	138	63
4" ANSI Class 900 RF	19.80	503	166	76
4" ANSI Class 900 RTJ	19.92	506	166	76
4" ANSI Class 1500 RF	20.50	521	202	92
4" ANSI Class 1500 RTJ	20.62	524	202	92
2 1/16" API 3000	18.93	481	112	51
2 1/16" API 5000	18.93	481	112	51
2 9/16" API 3000	19.20	488	136	62
2 9/16" API 5000	19.20	488	136	62
3 1/8" API 3000	18.93	481	122	56
3 1/8" API 5000	20.12	486	160	73
4 1/16" API 3000	19.92	506	166	76
4 1/16" API 5000	20.62	524	202	92

MC-20 In-Line Choke



MC-20 In-Line Chokes

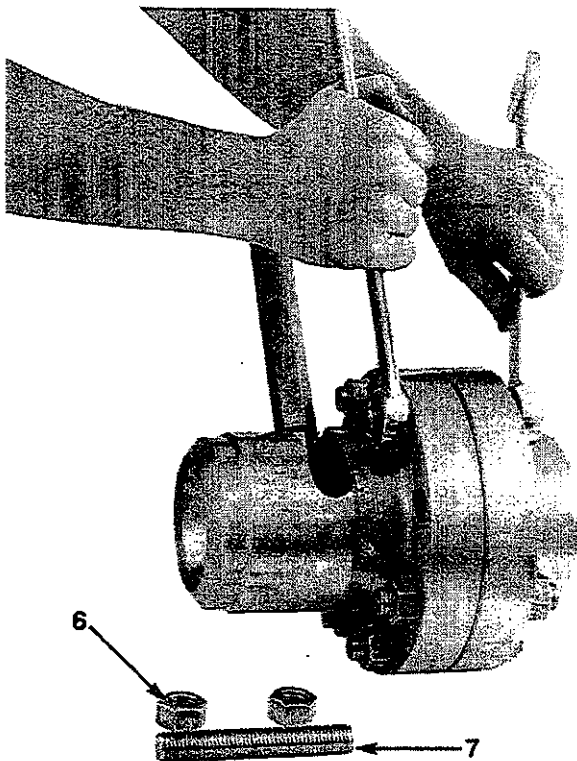
Tools Required for Disassembly and Assembly

- 1" Open End Wrench
- Two-1 1/8" Box Wrenches or Equivalent
- Rotator Drive Tool, (P/N 0502631)
- Soft Tip Hammer
- 6" Regular Screw Driver

Disassembly

1. Depressurize lines upstream and downstream of choke to isolate it.
2. Place choke in open position and bleed all remaining pressure from piping system
3. Remove choke from line.
4. Using two 1 1/8" box wrenches, loosen all sixteen hex nuts (**Item 6**) approximately two full turns before removal of any one stud (to insure any trapped internal pressure is vented). Then remove the nuts and studs and separate the flanges.

Caution: Discs are only retained by loose fitting pins.



Grease:

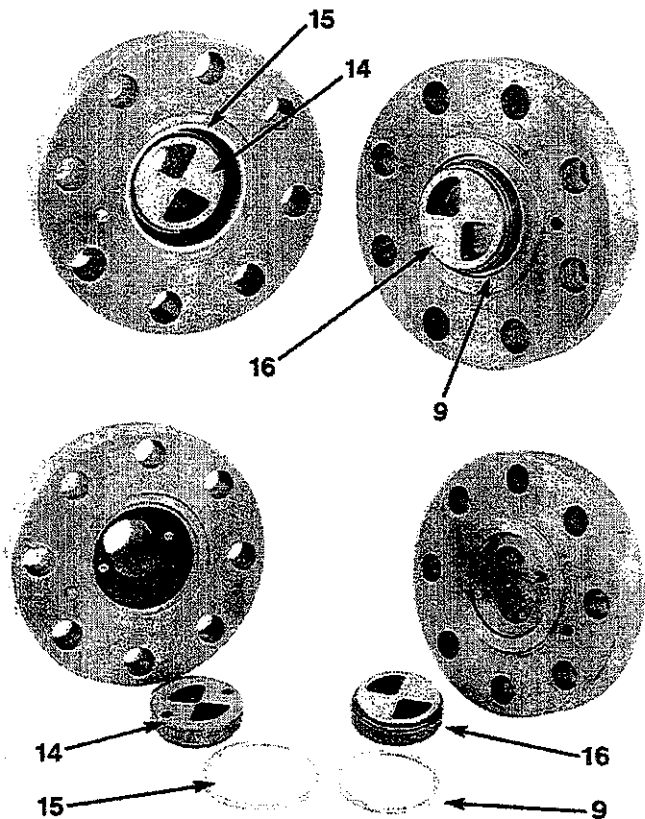
Water, Oil or Gas Service:

Dow Corning FS-1292 or equivalent is recommended.

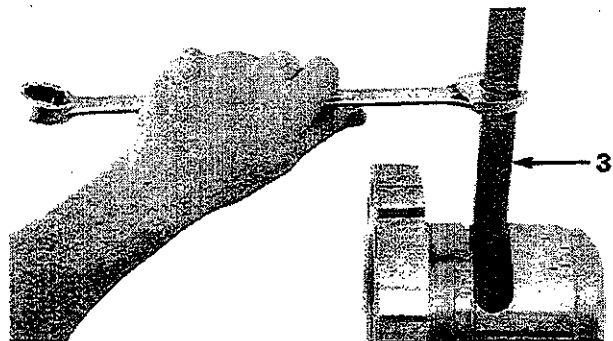
CO₂ Service:

Jet Lube AP-1W Hi-Temp or equivalent is recommended.

5. Remove both discs (**14**) and (**16**) and o-rings (**15**) and (**9**).

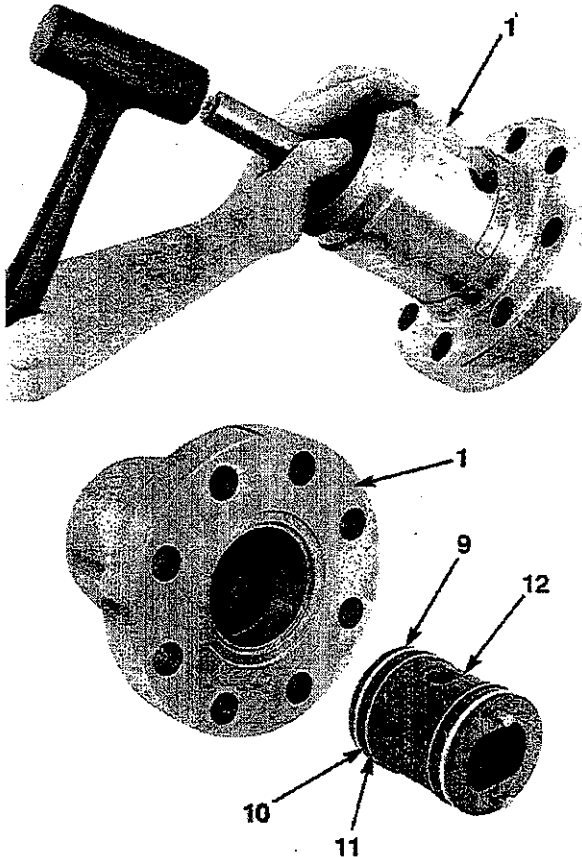


6. Unscrew handle (**3**) using 1" open end wrench.



Note: See pages 1, 8 or 9 for parts not shown.

7. Using rotator drive tool (P/N 0502631) and soft tip hammer, tap rotator (12) out of the body (1). Remove o-rings (9) and (10) and back-up rings (11) from rotator.



8. If applicable, remove optional bellville washer (8) from body (1).
9. For chokes equipped with wear sleeves, (17) return choke to nearest McEvoy-Willis facility for wear sleeve replacement. If circumstances require field maintenance, the wear sleeve may be replaced in the field as described below.

Note: When ordering a replacement sleeve (17), be sure to order the appropriate epoxy resin along with it.

Heat the outlet hub to a maximum of 350° F. Monitor the temperature with a temperature stick to make certain that the heat does not exceed 350° F. The sleeve is fixed into position with epoxy resin which, when heated to approximately 250° F, drops from its position in the outlet hub. Air cool the outlet hub to room temperature. Coat the O.D. of the sleeve and the I.D. of the outlet hub with the epoxy resin and slide the sleeve back into the hub. Allow two-to-three hours cure time, at room temperature (72° F), before putting the choke back into service.

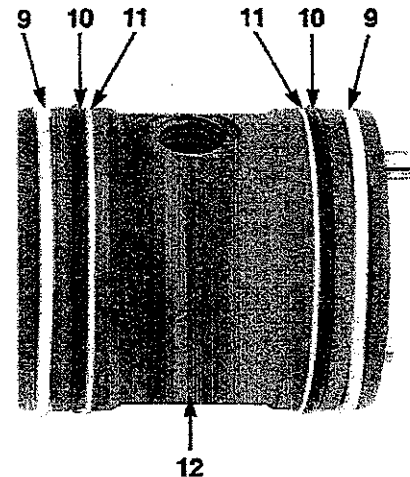
Note: See pages 1, 8 or 9 for parts not shown.

Assembly

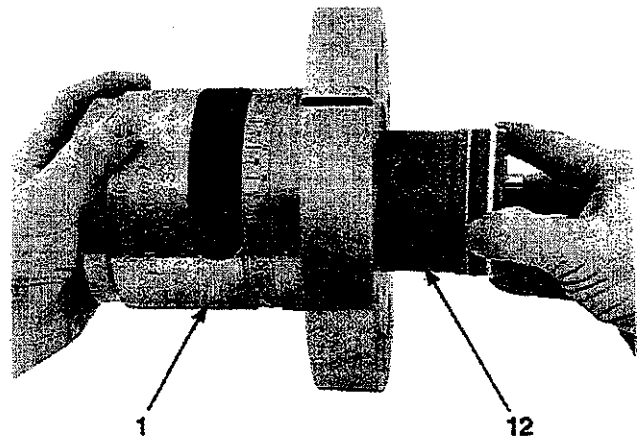
1. Replace all worn or damaged parts. Be sure to grease all o-rings and o-ring grooves with a grease that is compatible with the flowing medium.

Caution: If a new size trim is being installed, the calibration band must also be changed to give correct bean size indication.

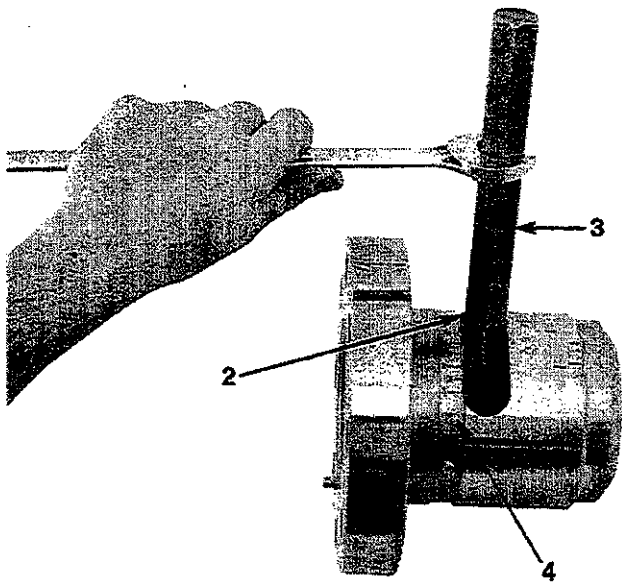
2. Install both back-up rings (Items No. 11) and o-rings (9) and (10) on the rotator (12). Place back-up rings (11) on inside grooves closest to handle hole.



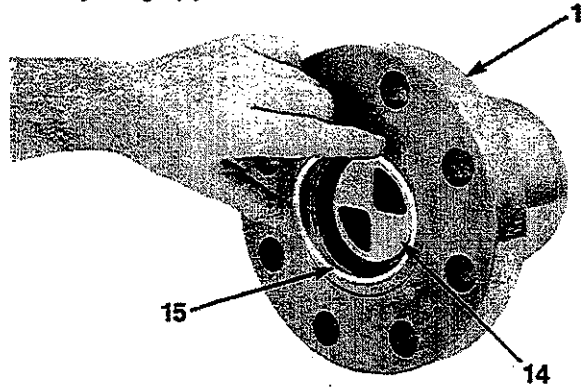
3. If applicable, install optional bellville washer (8) into body (1).
4. Align the handle hole in the rotator with the slot in the body (1) and slide the rotator into the body. Light tapping to the rotator may be necessary to ensure complete installation into the body.



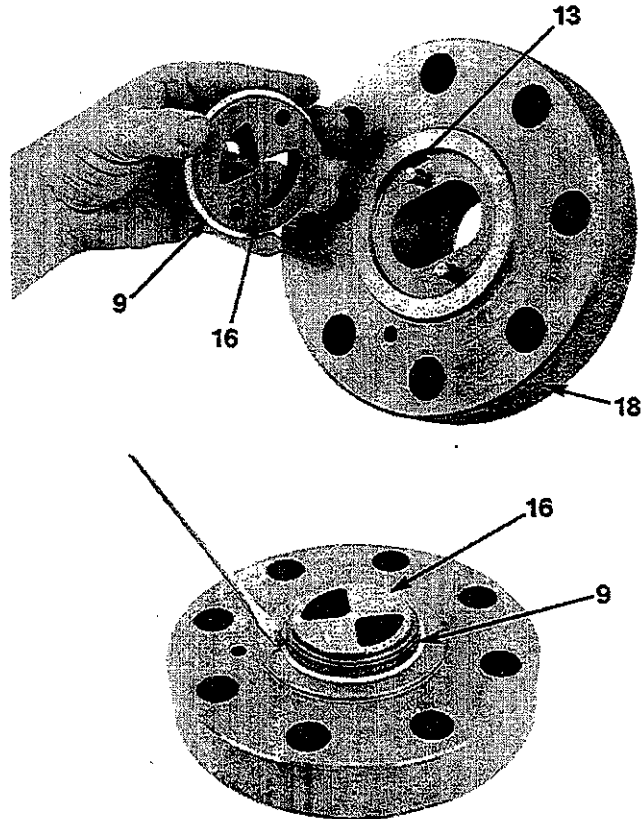
5. Install and tighten handle (3) into rotator and align the opening in indicator ring (2) with the calibration band (4).



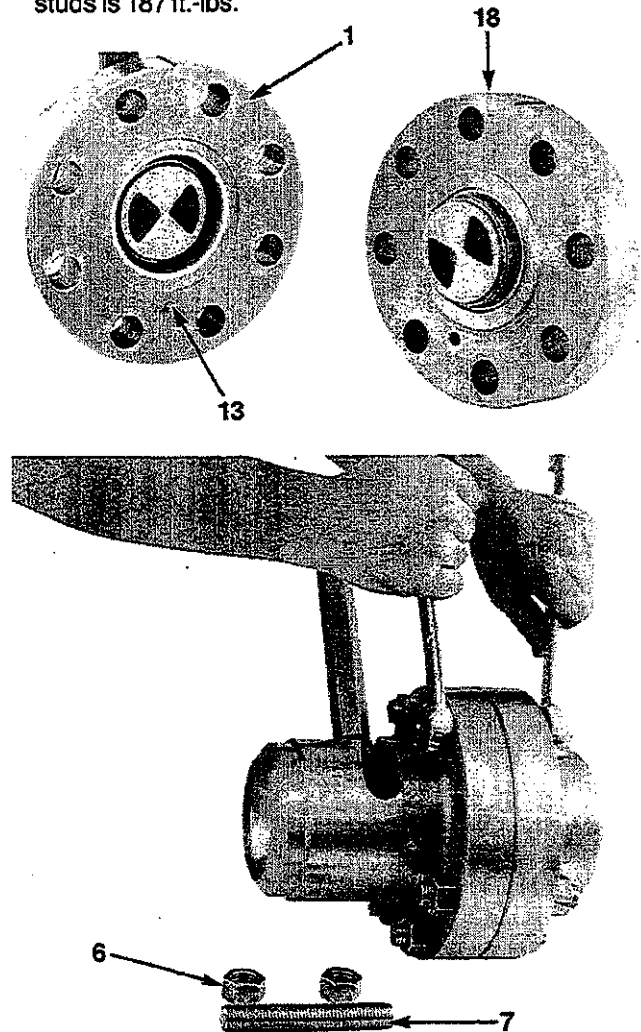
7. Position the second disc (14) onto the rotator dowel pins (13) and install the o-ring (15) in place on the body flange (1).



6. Place the o-ring (9) around the disc (16) and install over pins (13) in outlet hub (18). Seat o-ring using a 6" screw driver or other rounded tip tool into groove. Be careful not to cut or damage o-ring.



8. Use the dowel pin (13) to align the outlet hub (18) and body (1). Install the eight studs (7) and tighten the sixteen hex nuts (6) evenly around the flange. Recommended tightening torque for 3/4"-10 UNC studs is 187 ft.-lbs.



Note: See pages 1, 8 or 9 for parts not shown.

MC-10 Trim
1" thru 2 1/16"
Maximum Rating: ANSI 1500/API 3000‡

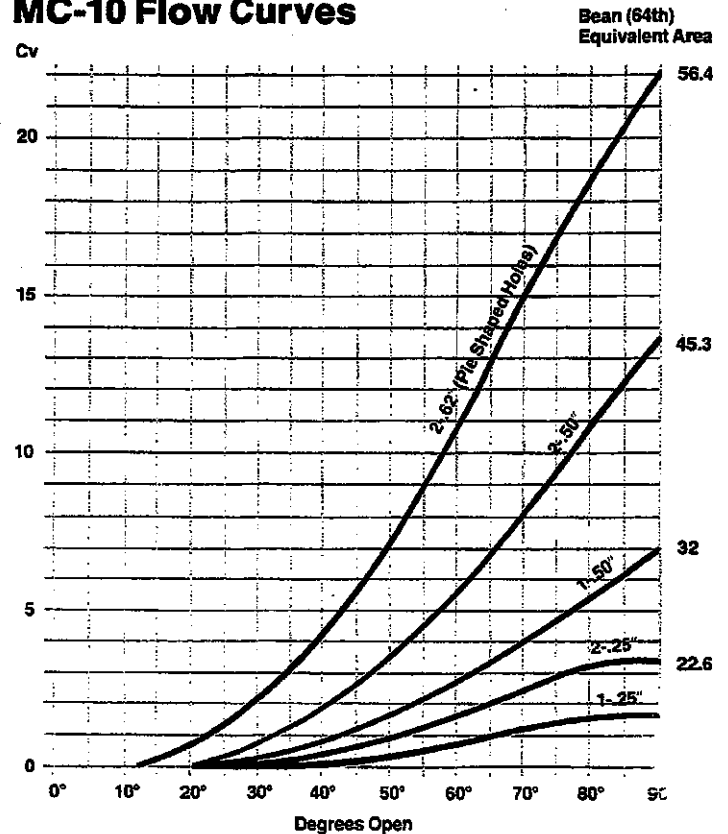
Trim Size No. of Holes	Dia.	Flow Coefficient Cv (Maximum) §
1	1/8"	0.33
2	1/8"	0.70
1	1/4"	1.60
2	1/4"	3.33
1	1/2"	6.85
2	1/2"	13.50
2	5/8"	22.00#

‡Valve pressure rating for specific configurations may be less depending on end connections, valve style, and use of ceramic or tungsten carbide trim.

§C_v values given in table are subject to variation depending on valve end connections and options such as wear sleeves and back pressure beans.

Pie shaped holes.

Because of McEvoy-Willis' continued research, testing and product improvement programs, flow coefficient, C_v, values are subject to change.

MC-10 Flow Curves

MC-20 Trim
2" thru 4 1/16"
Maximum Rating: ANSI 1500/API 5000‡

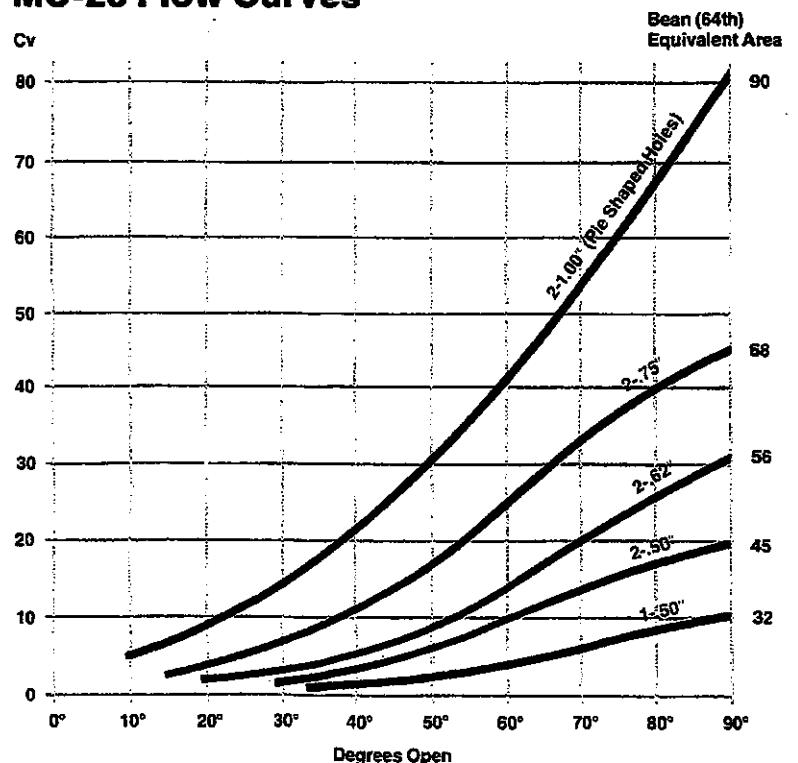
Trim Size No. of Holes	Dia.	Flow Coefficient Cv (Maximum) §
1	1/2"	10.00
2	1/2"	20.00
2	5/8"	31.00
2	3/4"	46.00
2	1"	81.00#

‡Valve pressure rating for specific configurations may be less depending on end connections, valve style, and use of ceramic or tungsten carbide trim.

§C_v values given in table are subject to variation depending on valve end connections and options such as wear sleeves and back pressure beans.

Pie shaped holes.

Because of McEvoy-Willis' continued research, testing and product improvement programs, flow coefficient, C_v, values are subject to change.

MC-20 Flow Curves


Western Hemisphere
Cameron
P.O. Box 1212
Tel 713.939.2211
Fax 713.939.2620
www.camerondiv.com

Eastern Hemisphere
Cooper Cameron (U.K.) Ltd.
5 Mondial Way
Harlington
Hayes UB3 5AR
Tel 44 208 9901800
Fax 44 208 9901888
www.camerondiv.com

Asia Pacific/Middle East
Cooper Cameron (Singapore) Pte. Ltd.
Number 2 Gul Circle, Jurong Industrial Est.
Locked Bag Service Number 3
Jurong Town Post Office
Singapore 629560
Republic Of Singapore
Tel 65 8613355
Fax 65 8616197
www.camerondiv.com

Cameron Willis
10810 N.W. Freeway
Houston, Texas 77092
Tel 713.354.1200
Fax 713.354.1291
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Cameron Willis
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Republic Of Ireland
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Fax 011 353 43 41560
www.camerondiv.com

Cameron Willis
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Edmonton, Alberta T6E 5S9
Tel 403 434 3476
Fax 403 437 7397
www.camerondiv.com



**CAMERON
WILLIS**

Cameron Willis
10810 N.W. Freeway
Houston, TX 77092
713-683-4600

ISE-MAGTECH

LG SERIES LIQUID LEVEL GAGES

INSTRUCTION MANUAL



- Visual indication from 100 ft.
- No process liquid in contact with glass
- Metallic flags or shuttle indicator (hermetically sealed)
- Welding specifications to boiler/piping codes (ASME B31.1/B31.3)
- Non-invasive alarms and transmitters
- For high temperature, pressure and corrosive service
- Replace problem sight glasses

Page 1	Detailed Description
Page 1	Standard Indication
Page 1	Flipper/Roller Indication (Optional)
Page 1	Installation
Page 1	Pressure Testing Flanges &
Page 1	Connections Placing the
Page 2	Gage in Service
Page 2	Removing the Gage from Service
Page 2	Routine Maintenance LG
Page 3	Series Parts List
Page 3	Flipper/Roller Retrofit
Page 3	Troubleshooting Level Gages
Page 4	MLS-3, MLS-3EX Level Switches
Page 5	MLS-5EX, MLS-10EX Level Switches
Page 6	PS-2 Pneumatic Switch
Page 7	LT-1 2-Wire Transmitter
Page 8	LT-1 Transmitter - Diagram
Page 9	Gage Mount-LTM Transmitter
Page 9	Field Insulation of Gages w/ Transmitters

The LG Series Level Gage consists of a glass (or polycarbonate) indicator or Flipper/Roller and float chamber, which is mounted directly to the process vessel. Standard gages are normally flanged or coupled to the process vessel, but a variety of mounting styles are available to suit most any vessel or piping requirements. (See Table 1 of the brochure for more details.)

Gages are manufactured to meet the exact specifications of the process such as operating pressure, temperature, specific gravity, etc. Standard materials are stainless steel, however most any non-magnetic material may be used including PVC, Kynar, Hastelloy, Monel, Alloy 20, and many others. A magnetized float is contained inside the chamber, which is designed to meet the requirements of the process conditions. (For this reason, floats are not interchangeable unless process conditions are similar.) The float moves freely inside the gage chamber as level rises and falls. Under normal conditions, the float should be about 70% submerged in the process fluid, but it is important to note that the position of the float in the fluid will vary with different process conditions.

STANDARD INDICATION

The scale assembly used for indicating level consists of the clear indicator tube with the red magnetic follower or “bird” and a graduated scale marked with feet and inches (special scales are available, i.e.: metric, gallons, 0-100%, etc.). The scale is mounted parallel and immediately next to the indicator tube. The tube is hermetically sealed to prevent moisture and dirt accumulation. A rubber “bumper” is sealed inside the bottom of the tube to cushion the impact of the “bird” against the glass. The bright red bird provides maximum visibility (even at night), however light kits for illuminating gages are available. A black reference line around the bird allows the operator to match the graduated scale with the actual level of the process fluid. Positive zero indication is provided by a nameplate at the lower end of the scale. If the bird is de-coupled from the float, the bird will fall down behind this nameplate and will not be visible. Thus, when the vessel is empty, the level gage will read zero and the bird is still visible. To prevent the float from losing magnetic coupling with the bird, a spring or stop plate is mounted into the top and bottom of the gage chamber. This cushions the impact of the float against the chamber when the process vessel is completely full or empty.

FLIPPER/ROLLER INDICATION (OPTIONAL)

MagTech offers a flipper/roller style indicator as an option to the standard tube/follower indicator. “Flippers” are industrial grade indicators, which consist of a series of metal flags, silver on one side and red on the other. As the magnetic float moves up and down with the level, each flag will rotate 180° to show the other color. MagTech flippers are housed in a rugged, hermetically sealed aluminum housing with a recessed glass window. Each flag rotates on a ceramic and stainless steel bearing surface, which eliminates “sticking” or hanging up. Flipper assemblies are built to the length of the level gage in one continuous piece up to 20 feet with no joints or blind spots.

FLIPPER/ROLLER INDICATION (OPTIONAL) (Cont.)

Flipper assemblies are offered as an option to the standard MagTech indicator where surging or turbulent levels may cause “de-coupling” problems. They have higher visibility than the standard indicator. They come with or without the scale in feet and inches.

INSTALLATION

LG Series gages are securely packed in specially designed crates to provide maximum protection of the glass tube and float chamber during shipment. It is important to unpack and inspect each gage upon receipt to insure the glass tube and chamber are free from damage. If you should find bent or broken parts, contact MagTech immediately. All MagTech gages are fully insured against damage or loss (unless otherwise specified by customer), however claims must be filed within 15 days from date of receipt of shipment.

The float chamber should always be leveled vertically. If it is not leveled vertically, the float may become magnetically uncoupled from the bird. Should this happen during installation, simply use a permanent magnet or magnet tool (available from MagTech) to pull the bird back up to the float’s magnetic field. See the **TROUBLESHOOTING** section of this manual for more details on re-coupling float and birds.

Valves should be installed between the process vessel and level gage to allow draining, cleaning, etc. Standard block valves may be used and can be ordered with the gage from MagTech or supplied by the customer. All gages are shipped complete with 0.125 inch composition gaskets. **NOTE: IF COMPOSITION GASKETS ARE NOT COMPATIBLE WITH YOUR PROCESS CONDITIONS, APPROPRIATE GASKETS SHOULD BE USED IN PLACE OF THOSE SHIPPED WITH THE GAGE.**

PRESSURE TESTING

All MagTech gages are hydrostatically tested to 1.5 times the specified flange/pressure rating prior to shipment to insure pressure tolerance. However, the gage should be blocked in or the float removed if the process vessel is to be pressure tested in the field by the customer as most vessels are tested at much higher pressures than the maximum operating process pressure. While the float chamber is capable of withstanding these higher pressures, the float is not and may collapse under vessel tests. Should floats be damaged during testing, replacements are supplied at the customer’s expense.

FLANGES & CONNECTIONS

Process connections and vent/drain flanges are designed to meet each customer’s specifications. The graduated scale assembly is based on the length of the float chamber from center to center of the process connections. All flange bolt holes straddle the center lines unless otherwise specified. On STYLE A Level Gages “stop plates” are supplied to insure the float is contained inside the chamber. For more information on dimensions, flanges, etc., see Table 1-3 in the brochure.

IMPORTANT!!!

IF YOU DON'T READ ANY OTHER PART OF THIS MANUAL, PLEASE READ THIS PAGE. IT WILL SAVE YOU TIME, MONEY AND MUCH FRUSTRATION.

PLACING THE GAGE IN SERVICE

To insure proper operation of the level gage, the following steps should be taken:

1. Make sure that operating conditions (temperature, pressure, specific gravity, etc.) are within maximum rating of the gage. Each gage has a permanent nameplate at the bottom of the scale indicating process specifications, serial number, tag number, etc.
2. Install float. The float is marked "TOP" to insure proper orientation.
 - 2a. On STYLE E Level Gages (Top Mount) remove float stop.
 - 2b. STYLE A Level Gages are supplied with float stops which should be installed between top and bottom process connections.
3. The float chamber should be closed with no openings to the atmosphere. Check to see that all drain and vent plugs are securely in place and any vent and drain valves are closed.

IMPORTANT NOTE: THIS STEP IS VERY IMPORTANT IN HIGH PRESSURE APPLICATIONS. IF THE BOTTOM VALVE IS OPENED FIRST AND THE VESSEL IS UNDER PRESSURE, THE FLOAT INSIDE THE CHAMBER WILL SHOOT UP LIKE A "CANNONBALL" AND COULD LODGE IN THE TOP OF THE CHAMBER CAUSING SEVERE DAMAGE TO THE FLOAT AND CHAMBER.

4. When the gage is mounted and ready to be put into service, the TOP process connection valve should be opened first and should be opened slowly to allow any pressure to equalize. This allows process fluid or vapor to enter the gage slowly and reach operating pressure and temperature at a reasonable rate.
5. When the gage has reached process pressure, then open the bottom process connection and installation should be complete.

CAUTION: NEVER USE THE VENT OR DRAIN ON THE GAGE AS A PRESSURE RELIEF FOR THE PROCESS. DOING SO MAY PERMANENTLY DAMAGE GAGE AS WELL AS CAUSING HAZARD TO PERSONNEL.

REMOVING THE GAGE FROM SERVICE

To remove the gage from service, the following steps should be followed carefully:

1. Close the BOTTOM process connection valve to prevent further filling of the gage. Then close the TOP process connection valve to completely isolate the gage from the process pressure.
2. Attach proper vapor collection equipment to the gage vent connection if required. Open the top vent to relieve pressure in the gage and allow air to flow when the bottom drain is opened.
3. Attach the proper liquid collection equipment to the bottom drain and remove liquid. After all process fluid is out of the gage, the gage is then ready to be removed from service.

ROUTINE MAINTENANCE

Standard MagTech gages have a ½ inch vent and drain plug in the top and bottom of the float chamber to allow cleaning and removal of the process fluid as required. Some gages are connected by the customer to a solvent or steam line, which allows them to be decontaminated or "blown down" periodically without taking the gage out of service or removing the drain flange and float. MagTech gages should be cleaned and inspected at least on an annual basis, or more frequently depending on the severity of the process. To perform maintenance and clean gage, follow these procedures:

1. Block in the float and chamber with the process connection valves or wait until the vessel is empty or out of service. Follow the steps on previous page for "Removing the Gage from Service".
2. When all the fluid has been drained from the gage chamber, remove the drain flange and let the float slide out of the chamber. Be sure to examine the float for excessive wear and clean as required.
3. Clean the inside wall of the chamber with a "bottle brush" or similar scrubbing tool. Some processes may dictate the use of suitable solvent for cleaning.
4. If the gage is located where the bottom drain is near the floor or other equipment where it is difficult to reach, it is possible to order gages with a top flange in place of the standard vent plug, or inverted where drain flange would become the top and the weld cap would be on the bottom. This allows the gage to be cleaned and serviced through the top end.
5. After cleaning the chamber, replace the float and drain flange. A new flange gasket may be required. (Note: Make sure to use gaskets compatible with the process fluid if replaced.)
6. Check the stainless steel pipe clamps to insure they are tight and adjust the scale holder up or down on the float chamber to make sure the positive zero is correctly positioned.

ROUTINE MAINTENANCE (CONT.)

7. Use a permanent magnet or a magnet tool from MagTech to attract the red "bird" until it is again coupled to the float inside the chamber on standard indication.

LG SERIES PARTS LIST

When ordering replacement parts for MagTech Gages, the following information is required:

1. Serial Number of gage or accessory item
 2. Description of item
 3. Original purchase order if possible
- A. TYPICAL FLOAT CHAMBER PARTS
1. Vent plug and spring
 2. Drain flange and spring
 3. Drain plug
 4. Magnetized float
 5. Top float spring
 6. (Style A Only) Float stop plates with spring
- B. INDICATOR SCALE ASSEMBLY
1. Scale/Channel Assembly
 2. Indicator Tube (glass or polycarbonate)
 3. Pipe Clamps
 4. Name Plate
 5. Indicator Tube mounting blocks (top and bottom)
- C. FLIPPER/ROLLER OPTION

FLIPPER/ROLLER RETROFIT

INSTALLATION & START-UP

When flipper indicators are purchased with a MagTech gage no installation is necessary. However, if the indicator is removed or a retrofit kit is purchased for a gage already in service, the following should be noted:

1. The mounting clamps connecting the flipper assembly to gage chamber, are adjustable to most manufacturers' standard (i.e.: 2" to 3" pipe).
2. If the gage is in service and there is liquid in the tank, only the individual flippers adjacent to the float will rotate to red when the indicator assembly is clamped on.
3. To reset indicator to show true level, the operator can
 - a. Run a magnet along window of indicator from 0 to where red is showing as noted in item 2OR
 - b. Drain gage to empty to zero the indicator, then fill again and as float rises with the level indicator will then be set and read properly (red = liquid, silver = vapor space).

TROUBLESHOOTING

MAGTECH LEVEL GAGES

MagTech gages are a relatively simple to install and use. The following troubleshooting tips may be of help during installation and startup but reading the entire manual helps even more.

1. **"Float magnetically de-couples from red indicator "bird".**
(Note: if bird is de-coupled, it will fall behind nameplate and will not be visible.)
If this is a recurring problem, it could be caused by several things, most of them resulting from improper installation of the gage.
 - a. Check to make sure that scale and channel assembly is tight against the gage chamber the entire length of the scale so that magnetic coupling is maintained from top to bottom of the indicator tube. Sometimes, especially with longer gages over 5-6 feet, the glass will bow out slightly and the float will lose coupling with the bird at some point. Stainless steel tie-wires are supplied with gages over 5 feet long to keep the glass from bowing out. Make sure these tie-wires are in place, tightened and secure.
 - b. Check to make sure the float inside the chamber is right side up. If the float has been placed in the chamber upside down, it has only half-normal magnetic strength and will de-couple from the indicator bird. All floats are clearly marked "TOP".
 - c. If float-stop springs or plates mounted in the top and bottom of the gage chamber have been removed, the float will continue to rise past the top of the indicator tube and will lose coupling with the bird at that point.
 - d. Sudden violent surges of process fluid could cause de-coupling. If this is a common problem, de-coupling may be minimized by partially closing the process connection valves (or retrofit gage with flipper/roller option).
 - e. If the center-to-center dimension has been miscalculated and the gage is slightly too long, do not force it into place as this may cause the chamber to bow slightly and the float will not be able to pass freely through the entire length of chamber. This will also cause de-coupling.

If none of the above tips applies to your de-coupling problem, contact MagTech for more information or for replacement floats and/or indicators. Also note that magnets exposed to extreme temperatures (over 1100°) will lose their magnetic properties. Other problems that could damage float causing de-coupling problems include over pressurization, solids or large particulate lodged in the chambers or even dropping the float.

2. **"MagTech gage's level differs from true level in the tank."**
This is a fairly common problem during start-up and is easily corrected. Under normal conditions, most floats are about 70% submerged in the process fluids (magnets are in upper portion of the float).

It is important to note that the position of the float in the fluid will vary with different process conditions. To get a true reading, simply loosen the pipe clamps that mount the indicator scale and tube and adjust the scale up or down the chamber as required to get an exact reading (within 1/2 inch).

TROUBLESHOOTING (Cont.)

3. “Indicator tube is cracked or broken.”

If the glass indicator tube is cracked or broken replacement can be shipped usually within 24 hours after ordered. One of the advantages of the MagTech gage is the glass is easily replaced without taking the gage out of service or shutting down the process. To replace the glass, loosen the two screws in the PVC or Teflon block located in the top or bottom of the scale assembly, remove the block and slide out the broken glass. If the gage is over 6 feet tall, it may be easier to remove the entire scale and channel by loosening the pipe clamps and taking it off the gage. This will protect the new glass when replacing it and remounting it to the gage chamber.

4. “Level switches don’t trip properly.”

All level switches may be wired to trip on rising or falling level. After the switch is wired for the desired alarm action (see instructions in this manual), it is necessary to set the switch. This is easily accomplished by passing the float either manually or by filling the gage chamber till it passes the highest switch. This will trip the switch to the desired setting so it will alarm properly with rise or fall of level.

GAGE MOUNT LEVEL SWITCHES

MLS-3, MLS-3EX LEVEL SWITCHES

SPECIFICATIONS

Deadband:	.50 Inches
Max. Temperature:	650°F - HT Version 350°F - STD Version
Min. Temperature:	-40°F
Contacts:	Form C SPDT
Maximum Ratings:	
Switching Voltage:	150 Volts AC/DC
Current:	1.0 Amps AC/DC
Power:	25 Watts DC/VA

WIRING DETAILS

RISING LEVEL ALARM

MLS-3	Yellow	Green	Red	Green	
MLS-3EX		A(NC)	C	B(NO)	C

FALLING LEVEL ALARM

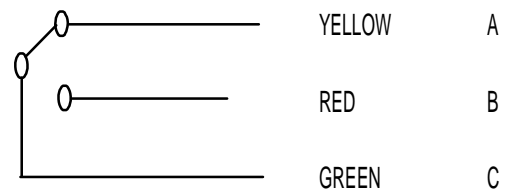
MLS-3	Red	Green	Yellow	Green	
MLS-3EX		B(NC)	C	A(NO)	C

SWITCH OPERATION/MOUNTING

To mount the MLS Series Level Switch simply clamp it directly to the side of the level gage chamber using the adjustable pipe clamps provided. Alarm set points may be changed by simply loosening the clamps and sliding the switch to the desired alarm level. To set up desired starting state follow the steps below:

SCHEMATIC

MLS-3 / MLS-3EX



GAGE MOUNT LEVEL SWITCHES (CONT.)

MLS-5EX LEVEL SWITCH

SPECIFICATIONS

Deadband: .50 Inches
 Max. Temperature: 650°F - HT Version
 350°F - STD Version
 Min. Temperature: -40°F
 Contacts: Form C DPDT

Maximum Ratings:
 Switching Voltage: 240V/30V AC/DC
 Current : 5 Amps
 Power: 1KVA/150W

Contact Ratings:
 5A @ 240VAC resistive
 5A @ 120VAC resistive
 5A @ 30VDC resistive
 1/8HP @ 250VAC

1.5A @ 240VAC inductive (cosec=0.4)
 1.5A @ 120VAC inductive (cosec=0.4)
 1.5A @ 24VDC inductive (L/R=7msec)

MLS-10EX LEVEL SWITCH

SPECIFICATIONS

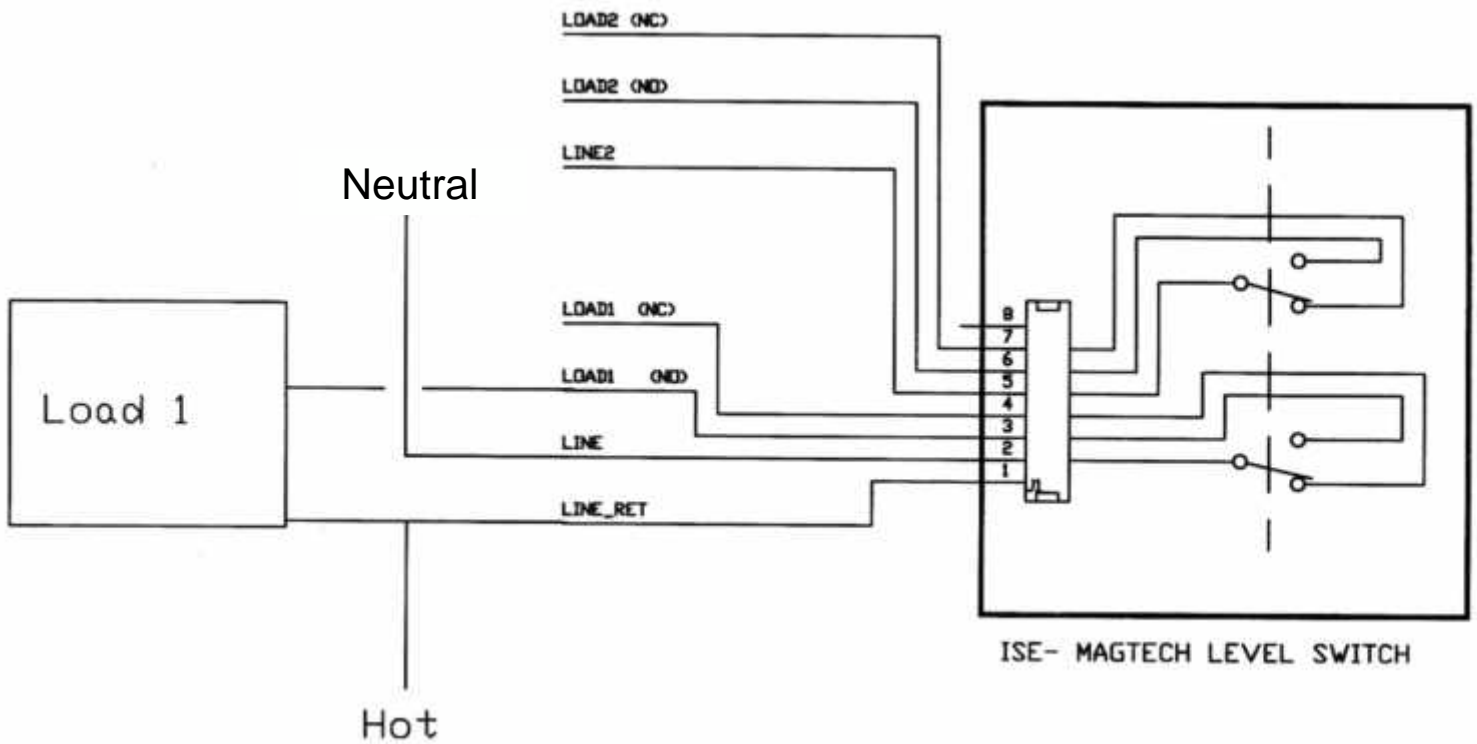
Deadband: .50 Inches
 Max. Temperature: 650°F - HT Version
 350°F - STD Version
 Min. Temperature: -40 °F
 Contacts: Form C DPDT

Maximum Ratings:
 Switching Voltage: 240V/30V AC/DC
 Current : 10 AMPs
 Power: 1KVA/150W

Contact Ratings:
 10A @ 240VAC resistive
 10A @ 120VAC resistive
 10A @ 30VDC resistive
 1/8HP @ 250VAC

8A @ 240VAC inductive (cosec=0.4)
 8A @ 120VAC inductive (cosec=0.4)
 8A @ 24VDC inductive (L/R=7msec)

MLS-5EX & MLS-10EX



GAGE MOUNT LEVEL SWITCHES (Cont.)

PS-2 PNEUMATIC SWITCH

PS-2 SPECIFICATIONS

Deadband	0.7 inch
Max. Temperature	300°F
Min. Temperature	0°F
Supply Pressure @ 70°F	15 - 100 psi
Supply Pressure @ 300°F (Dry, Filtered air or gas)	15 - 35 psi

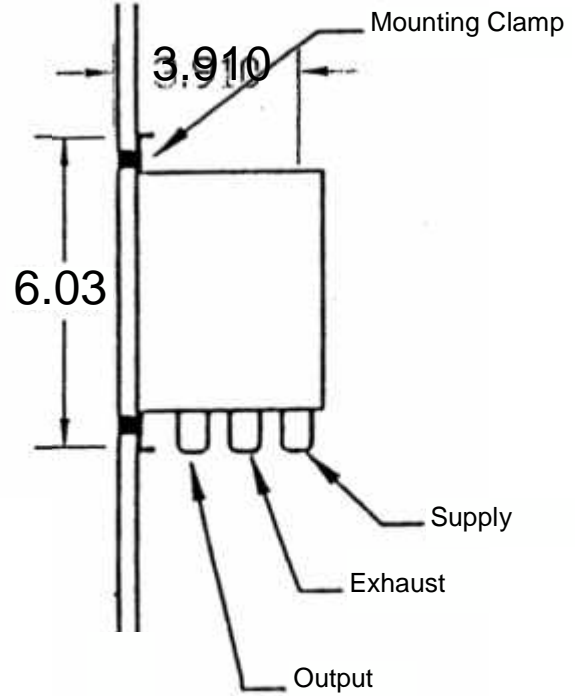
Housing 316SS, Nema 4

SWITCH OPERATION/MOUNTING

To mount the MLS Series Level Switch simply clamp it directly to the side of the level gage chamber using the adjustable pipe clamps provided. Alarm set points may be changed by simply loosening the clamps and sliding the switch to the desired alarm level.

After the switches are mounted and wired, they need to be set to the desired state for rising or falling level as noted previously. This is easily accomplished by either manually pushing the float or magnet past the highest switch, or filling the gage chamber with fluid until all switches are properly set.

PS-2 Mounting Diagram



PS-2 Side view

Note: The switch should be mounted to the side of the gage as shown.

Note: PS-2 Switch is factory set for rising or falling level. This must be specified at time of order (Not field adjustable).

LT-1/LT-2 2-WIRE TRANSMITTER

DESCRIPTION

The LT-1 Level Transmitter is designed for use with the LG Series Level gage to provide a 4-20 mA control signal proportional to level. The transmitter consists of a sensor tube made up of a string of resistors and magnetically operated reed switches. There is a switch and resistor every ½ inch or ¼ inch along the length of the sensor tube.

The circuit board containing the resistors and switches may be the same length as the measured range or any portion thereof. The sensor circuit is enclosed in the stainless steel sensor tube. A threaded connection at the top of the tube is for mounting the transmitter housing. This housing is rated for Class 1, Division 1, Groups C & D hazardous areas. The LT-1 assembly may be made intrinsically safe by remote mounting of the transmitter in a safe area and operating the sensor through an approved safety barrier.

As the magnetic float inside the gage chamber rises with increasing fluid level, the switches close, thereby changing the resistance in the circuit. A two-wire transmitter converts this resistance change to a 4-20 mA current signal corresponding to fluid level. Resolution of the transmitter is ¼ or ½ inch (proportional to the spacing of the sensor switches).

SPECIFICATIONS

SENSOR	TRANSMITTER
Length: Up to 30 Feet	Output: 4-20 mA
Resolution: ½ Inch LT1-4/20-L-½	Power: 24 VDC Nominal
¼ Inch LT1-4/20-L-¼	Load: 750 Max
Sensor Tube: 304 Stainless Steel	
Operating Temp.: to 500° F (Process Fluid)	
Approvals: UL, CSA, Class 1 Div. 1 EXP.	

LT1 CALIBRATION AND TROUBLESHOOTING

The following warnings must be considered when installing the LT-1 Transmitter:

“Caution – To Reduce the Risk of Ignition of Hazardous Atmospheres, Disconnect The Device From The Supply Circuit, or Area Must Be Known to be Nonhazardous, Before Opening.”

“Power Must be Supplied by an Isolating Supply”

Simulation procedure for the Magtech LT-1 Transmitter:

The simulation procedure will help verify if the electronics are functioning properly.

- 1. Verify that you are looking at the correct board and the right orientation.**
Make sure that you can see the, “Ise of Texas” and “LT-2-2/3/4” text right side up, the text should be located in the bottom right side of the board.
- 2. Place an ammeter in series with a 24Vdc isolated power supply.**
Power is applied on the terminal block positions 1 (+ 4/20mA) and 3 (- 4/20mA).
- 3. Verify if the LT-1 electronic card is working correctly by simulation of current.**
There is a dip-switch box on the left side of the electronics board. Position 4 should be ON and positions 1,2,3 should be OFF (this is normal operation).
 - a. To simulate 4mA: Turn OFF positions 1,2,4 and turn ON position 3. You should see 4 mA on the ammeter.
 - b. To simulate 12mA: Turn OFF positions 1,3,4 and turn ON position 2. You should see 12mA on the ammeter.
 - c. To simulate 20mA: Turn OFF positions 2,3,4 and turn ON position 1. You should see 20mA on the ammeter.

4. If the 4, 12, 20 mA simulation is not accurate there are corresponding potentiometers that can adjusted.

- a. Simulate 4mA, then adjust P6 until the ammeter reads 4mA accurately.
- b. Simulate 12mA, then adjust P5 until the ammeter reads 12mA accurately.
- c. Simulate 20mA, then adjust P4 until the ammeter reads 20mA accurately.

5. Place electronics back to normal operation mode: Turn OFF positions 1, 2, 3 and Turn ON position 4.

NOTE: If unable to achieve any of the simulation points either a recalibration is required or the electronics are no longer working and need to be replaced.

Recalibration procedure Magtech LT-1 Transmitter:

The recalibration procedure will help bring the unit back to the original factory calibration settings. If anything else is required please contact the factory for verification.

- 1. Verify that you are looking at the correct board and the right orientation.**
Make sure that you can see the, “Ise of Texas” and “LT-2-2/3/4” text right side up, the text should be located in the bottom right side of the board.
- 2. NOTE:**
 - a. It is recommended that this procedure be done in an electronics shop if at all possible.
 - b. A voltmeter and an ammeter are required.
 - c. Level simulation is also required for recalibration, meaning the float inside the level gage (chamber) will have to be moved from 0% to 100% OR the LT-1 transmitter can be removed from the level gage and an external magnet can be used to simulate level. Make sure the transmitter reacts to the magnet.
 - d. Power the LT-1 at positions 1 (+4/20mA) and 3 (-4/20mA) on the terminal block and make sure the wires from the sensor probe are in positions 4 and 5 on the terminal block.
- 3. Place the magnet (or float level inside gage) at the 0% or 4mA point.**
- 4. Place the negative lead of the voltmeter on position 2 of the terminal lock. This is circuit ground.**
- 5. Locate U1 (it is the only 14pin chip on the board).**
On pin 7 of U1 (bottom left) place the positive lead of the voltmeter and adjust P1 until there is 0.00 Vdc on the voltmeter.
- 6. Place an ammeter in series with the power supply.**
Note: The voltmeter is no longer needed.
- 7. Adjust P2 until the ammeter reads 4mA**
- 8. Move the magnet (or float level in the gage) to the 100% or 20mA point.**
- 9. Adjust P3 until the ammeter reads 20mA.**

If this procedure is successful the unit has been recalibrated successfully. If this procedure is unsuccessful please contact the factory for further assistance.

NOTE: The simulation potentiometers (P4, P5, P6) may have to readjusted after the recalibration procedure has been completed successfully.

Troubleshoot the sensor probe:

Troubleshooting the sensor probe will verify if the sensor probe has gone bad and needs to be replaced or reworked by the factory.

- 1. NOTE:** An Ohmmeter is required for this procedure.
- Disconnect the transmitter from the power supply.
- Remove the sensor probe wires from positions from 4 and 5 of the terminal block.
- Place the ohmmeter on the two wires from the sensor probe.
- Place a magnet at the 0% or 4mA point and slowly raise the magnet along the sensor probe.
- Carefully was the resistance increase. Make sure that there are no large jumps in resistance or that the resistance does not get stuck after a certain point as the magnet is raised along the sensor probe.
- If the magnet has been raised all the way to 100% or 20mA point without any issues then the sensor probe is good. Place the sensor wires back into positions 4 and 5 on the terminal block. (Note: polarity is not an issue with the sensor wires)
- If any issues discussed in step 6 occur please contact the factory for further assistance.

NOTE: If actual level in the gage can be moved from 0 to 100% then the magnet is not necessary. The magnetic float within the level gage will actuate the sensor probe.

WIRING

- Term 1 + 4/20 mA
- Term 3 - 4/20 mA
- Term 4 Sensor
- Term 5 Sensor

SENSOR TUBE ORIENTATION

The LT1 sensor tube comes pre-mounted to the level gage chamber. Transmitters with 1/4" resolution, as indicated on the back of the conduit, will have a black line located at the top of the sensor tube. If removed in the field it is VERY IMPORTANT to re-attached the tube with black line facing the float chamber. The black line is located at the top of the sensor tube and must be parallel with the chamber.

Dip Switch Settings

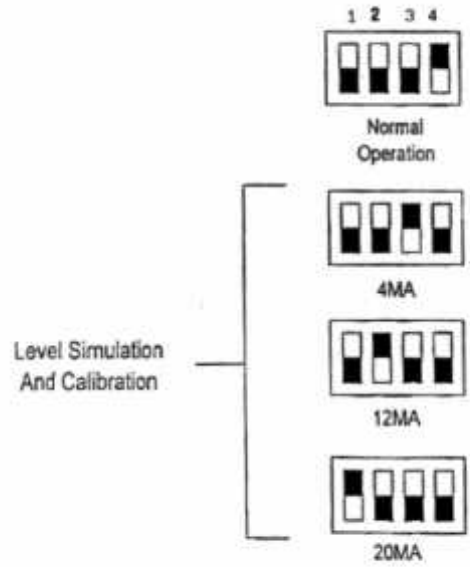
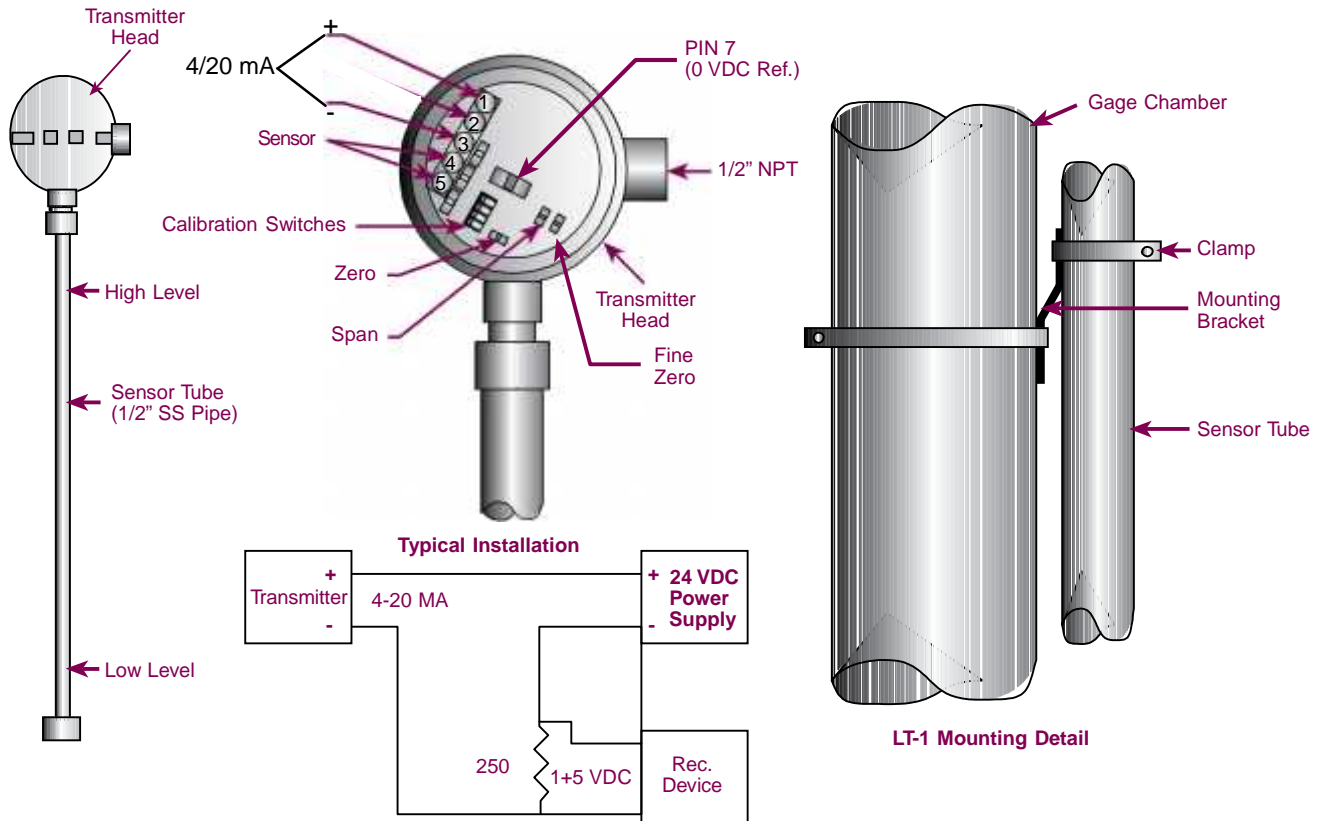


Figure 1-1

LT-1 TRANSMITTER WIRING AND MOUNTING



NOTE: For information on insulating gages with transmitters see section on field insulation.

Gage-Mounted LTM Magnetostrictive Transmitter

Gage and Transmitter Installation

1. Visually inspect mag gage and transmitter installation to insure transmitter is positioned with the 4 mA and 20 mA labels directly adjacent to the process connections. Make sure transmitter is securely clamped and parallel to gage chamber.
2. Remove bottom flange and install float. Each float is clearly tagged with serial number of the mag gage and process parameters. Top of float is clearly marked "TOP" to insure float is in right side up.
3. Inspect bottom flange for proper gasket and spring. This spring protects float and keeps it from dropping below the bottom process connection. To determine proper spring length measure "A" dimension of gage. This is the length from the center of the bottom process connection to face of the bottom drain flange. Length of spring should be

(“A” DIMENSION) (-) minus (Float Length + 2 inches)

EXAMPLE: “A” Dimension is 14”, Float length is 12”, + 2” = 4” Spring Length.
$$14 - 12 + 2 = 4 \text{” spring}$$
4. Float is properly installed if the bottom 2-3 flippers on gage indicator have flipped.
5. If no float is present, or magnetic field is lost, HART Communicator will display:
Generic Mode - "More Status Indicated, but Inaccessible."
Device Description - "Check Float"
6. For push-button calibration without using HART, or to change range consult the LTM instruction manual.

Note: In service over 400 Deg F (204 C) Gages and Transmitters should be properly insulated with transmitter OUTSIDE the blanket. See LTM Transmitter Instruction Manual for details.

NOTE:

During the installation or calibration of the LTM level transmitter, the technician should be very careful not to move the magnet perpendicular to the sensor tube as this could leave magnetic indentation in the sensor wire. The LTM level transmitter has an inductor located inside the bulkhead of the sensor tube. During operation of the transmitter, this inductor emits a magnetic field as current passes through the sensor wire. If an external magnet or the float comes in contact with the bulkhead, this can cause magnetization of the coil, which means the coil is biased. In other words, the phase is reversed. If this occurs, the inductor should quickly recover. It may be manually reversed or de-magnetized very simply by "swiping" a magnet parallel to the bulkhead in an arching motion. For complete information regarding LTM Magnetostrictive Transmitters consult LTM I/O Manual.

NOTE: there is a top spring in the mag gage to protect float and prevent it from passing the top process connection. DO NOT REMOVE EITHER SPRING.

Transmitter Check-out and Calibration

NOTE: The LTM Series Transmitters are 24VDC Loop powered (2-wire) and require a minimum of 15 Volts at 20 mA.

1. Using a loop calibrator (HART compatible if LTM has HART) connect red wire from the LTM to positive lead of calibrator and white wire from LTM to negative lead of calibrator.
2. With float in the gage at 4mA, the output of the LTM should be 4mA. For units with HART connect the HART communicator to HART terminals on the LTM control board (see I/O manual for details). Upon power up, the HART Communicator should read the LRV (lower range value) or 0 inches at 4mA.
3. With float in the gage at 20mA, the output of the LTM should be 20mA. HART should also display URV (upper range value) or span length in inches at 20mA.
4. To insure complete functionality of gage and transmitter, fill the gage chamber with liquid and drain slowly to observe transmitter and gage are tracking properly.
5. Flexible type insulation jackets (NOT HARD SKIN) are required and must be installed around the Mag Gage chamber only. DO NOT cover the transmitter tube, as this may burn up the sensor and possibly the electronics.
6. After the insulation jacket is installed, the sensor tube must be re-mounted at its factory-preset distance from the Mag Gage chamber and must be parallel to the chamber as well. (Small cut-outs in the jacket are required to re-attach the transmitter properly)
7. Make sure the 4mA and 20mA marking's on the sensor tube are re-aligned at the centers of the process connections.

FIELD INSULATION OF GAGES WITH TRANSMITTERS

We strongly recommend that experienced MagTech personnel do any insulation of the magnetic level gages with externally mounted transmitters.

If Cryogenic "Hard Skin" cold service type insulation is required, it MUST be done at the factory due to the custom "Tube in Tube" design necessary for removal of the transmitter if needed.

If insulation is going to be done in the field, then the following guidelines MUST be followed:

Mid-West[®] Instrument

“Piston Type”

Differential Pressure Gauges Switches & Transmitters

Model 120



A low cost differential pressure gauge for use in measuring the pressure drop across filters, strainers, separators, valves, pumps, chillers, etc., and for local flow indication and control.



Model 120
0-50 PSID
2-1/2" Dial

Due to precision sizing of piston and body bore, leakage across piston will not exceed 15 SCFH air at 100 PSID at ambient temperature.

- Simple, rugged, compact design.
- Working pressures up to 6,000 PSIG (400 bar)
- Over-range protection to maximum pressure.
- Body Materials: Aluminum or 316L Stainless Steel with 316 stainless steel internals. Aluminum Bronze & Monel available upon request.
- Weather-resistant construction standard.
- Shatter resistant acrylic lens.
- Variety of Dial type and Sizes: 2-1/2", 3-1/2" & 4-1/2" (Uni-directional or Bi-directional)
- Available DP Ranges: Inches H₂O, PSID, bar, and Kpa
- 1/4" FNPT & 1/2" FNPT Process Connections
- Multiple mounting options available
- Temperature Limits: -40°F(-40°C) to +200°F(+93°C)



Model 120 0-30 PSID
With Maximum Follower Pointer



Model 120
0-50 PSID
4-1/2" Dial



Model 120
0-50 PSID
With Special 3 Color Dial

An optional maximum indication follower pointer provides automatic indication of maximum differential occurring during a time period or system cycle. Reversed pressure ports are optionally available to facilitate installation and readability depending on which side of a filter, etc., the instrument must be installed.

Model	Body Material	Accuracy	Min. ΔP Range	Max. ΔP Range	MWP PSIG (Bar)	Switch Options
120	Aluminum & 316L S.S.	±3/2/3%	0-5 PSID (0-0.35 bar)	0-110 PSID (0-7 bar)	ALM.= 3,000 (200) S.S. = 6,000 (400)	1 & 2 switch Hermetically Sealed

Proof Pressure: Two times rated working pressure at ambient temperature

Standards: Model 120 Gauge either conforms to and/or is designed to the requirements of the following standards:

- | | |
|----------------------------|-----------------------------|
| ASME B1.20.1 | NACE MR0175 |
| ASME B40.100 | NEMA Std. No. 250 |
| CSA-C22.2 No. 14.25 and 30 | SAE J514 |
| EN-61010-1 | UL Std. No. 50,508 and 1203 |

“Piston Type” Differential Pressure Gauge Switch & Transmitter Options Models 120, 122, 123 & 124



The Model 120-124 Series DP gauges are available with one or two hermetically sealed reed switches or 4-20mA transmitter depending on model. (See chart below)

The switches are adjustable (see table for adjustment range) within a defined percentage of the full scale range of the gauge and are available in SPDT and SPST, normally open or normally closed configurations for various load power ratings. The switches can be set to activate or deactivate on rising or falling pressure.

The standard reed switch is enclosed in a weather-resistant plastic housing. Adjustment of the switch setting is made with an external screw adjustment.

The switch functionality will be different for gauges with bi-directional operation for positive and negative delta pressure. For example a SPDT switch with positive .P applied to the gauge, the red wire will be N.O. and the black will be N.C.. For negative .P the functionality will be reversed.

Location for a single SPDT (grommet or conduit) switch will be on the bottom of the gauge body for a normal port and on the top for a reverse port. Locations for a single SPST (grommet or conduit) N.O. or SPST N.C. switch will be on the bottom and top respectively for a normal port gauge. The locations will be reversed for a reverse port gauge.

A non-indicating (no dial) differential pressure switch is also available.

Hazardous Location switches are 3rd Party Certified Class I Div 2 or Class I Div 1 dependant on type of switch. Listings are for the entire design and not just the enclosure. Standard and weatherproof units are CE marked for conformance with the Low Voltage Directive to harmonized standard EN 61010-1.

Transmitters feature Microprocessor based, external zero interface, 8-28 Vdc loop powered, 2 wire interface. Standard output of 4-20mA with a max loop resistance of 1000 Ohms.

Model Type	•120, ^122,+123, +124 SPDT	•120,^122, •123, SPDT	•120, ^122,+123, +124 SPST NO	•120, •123,•124 SPST NC	•120, •123,•124 SPST NO/NC	121, 124 4-20mA
Power	3 W	60 W	60 W	60 W	60 W	4-20 mA Loop Power
Max Current	0.25 Amps	1.0 Amps	3.0 Amps	3.0 Amps	3.0 Amps	8-28 VDC Loop Powered 2-Wire interface
Max Voltage VAC/VDC	125	240	240	240	240	1000 Ohm max Loop resistance at 28 vdc
Setting Full Scale	•10-90%	•25-100%	•25-95%	•25-95%	•25-95%	20-100%
	^10-100%	^25-100%	^25-100%			
	+15-90%		+25-95%			
Hysteresis (Max / Norm)	10% / 5% (FS)	20% / 13% (FS)	15% / 8% (FS)	15% / 8% (FS)	15% / 8% (FS)	N/A
Repeatability	1% F.S.	1% F.S.	1% F.S.	1% F.S.	1% F.S.	1% F.S.
Leads 22 Awg	(3) 24"	(3) 24"	(2) 24"	(2) 24"	(2) 24"	N/A



Mid-West[®] Instrument

Standard Dial Ranges: Model 120, 122, 123, 124

Range Type			
PSID	Kpa	Bar	Dual Scale
0-5 PSID	0-35 Kpa	0-1.0 Bar	0-5 PSID & 0-0.35 Kg/Cm2
0-10 PSID	0-70 Kpa	0-1.6 Bar	0-5 PSID & 0-35 KPA
0-15 PSID	0-100 Kpa	0-2.0 Bar	0-10 PSID & 0-0.7 BAR
0-20 PSID	0-160 Kpa	0-2.5 Bar	0-10 PSID & 0-0.7 KG/CM2
0-25 PSID	0-250 kpa	0-4.0 Bar	0-10 PSID & 0-70 KPA
0-30 PSID	0-400 Kpa	0-6.0 Bar	0-100 PSID & 0-7 BAR
0-50 PSID	0-600 Kpa	0-7.0 Bar	0-100 PSID & 0-7 KG/CM2
0-60 PSID	0-700 Kpa		0-100 PSID & 0-700 KPA
0-75 PSID			0-15 PSID & 0-1 BAR
0-100 PSID			0-15 PSID & 0-1 KG/CM2
0-110 PSID			0-15 PSID & 0-100 KPA
**0-150 PSID			0-20 PSID & 0-1.4 BAR
**0-200 PSID			0-20 PSID & 0-140 KPA
**0-250 PSID			0-25 PSID & 0-1.75 BAR
**0-300 PSID			0-25 PSID & 0-1.75 KG/CM2
**0-400PSID			0-25 PSID & 0-175 KPA
			0-30 PSID & 0-2 BAR
Bi-Directional	Bi-Directional	Bi-Directional	0-30 PSID & 0-2 KG/CM2
5-0-5 PSID	40-0-40 Kpa	0.4-0-0.4 Bar	0-30 PSID & 0-200 KPA
10-0-10 PSID	60-0-60 Kpa	0.6-0-0.6 Bar	0-50 PSID & 0-3.5 BAR
15-0-15 PSID	100-0-100 Kpa	1-0-1 Bar	0-50 PSID & 0-3.5 KG/CM2
20-0-20 PSID	160-0-160 Kpa	1.6-0-1.6 Bar	0-50 PSID & 0-350 KPA
25-0-25 PSID	250-0-250 Kpa	2.5-0-2.5 Bar	0-75 PSID & 0-500 KPA
30-0-30 PSID	400-0-400 Kpa	4-0-4 Bar	
50-0-50 PSID	600-600 Kpa	6-0-6 Bar	
60-0-60 PSID			
100-0-100 PSID			

Bi-Directional ranges available for Model 120 4-1/2" Dials only.

The above mentioned ranges are some of the most popular requested today. Mid-West Instrument can provide special un-cataloged dial range requirements. As well as multiple scale dials, multiple color dials and special decals. Please consult factory for complete information.

Model	Min. ΔP Range	Max. ΔP Range
120	0-5 PSID (0-0.35 bar)	0-110 PSID (0-7 bar)
122	0-5 PSID (0-0.35 bar)	0-100 PSID (0-7 bar)
**123	0-150 PSID (0-10 bar)	0-400 PSID (0-27.0 bar)
**124	0-5 PSID (0-0.35 bar) 0-150 PSID (0-10 bar)	0-110 PSID (0-7 bar) 0-400 PSID (0-27.0 bar)

Proof Pressure: Two times rated working pressure at ambient temperature

Temperature Limits: -40°F (-40°C) to +200°F (+93°C) - These limits are based on the entire instrument being saturated to these temperatures. System (process) temperatures may exceed these limitations with proper installation. Contact our customer service representative for details.

Standards: Model 120 -124 Series gauges either conform to and/or are designed to the requirements of the following standards:

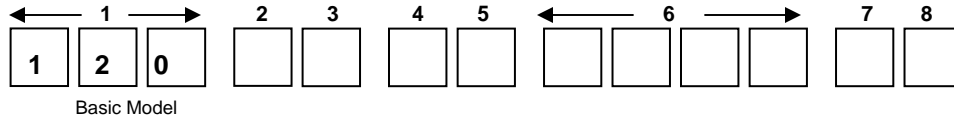
- | | |
|----------------------------|-----------------------------|
| ASME B1.20.1 | NACE MR0175 |
| ASME B40.100 | NEMA Std. No. 250 |
| CSA-C22.2 No. 14.25 and 30 | SAE J514 |
| EN-61010-1 | UL Std. No. 50,508 and 1203 |

Standard Model Specifications: 120-AA-00-00

3000 PSIG Working Pressure, Aluminum Body & End Plugs, Stainless Steel Piston,
Ceramic Magnet, Buna-N Seals, 1/4" FNPT Back Connections,
2-1/2" round dial, Engineered Plastic Case with Shatter Resistant Acrylic Lens,
Accuracy ±3/2/3% Full Scale (Ascending)

Mid-West Instrument
1-800-648-5778

Range 0-5 PSID to 0-110PSID (0.35 to 7.0 bar)



Range: _____



2	Material
A	Aluminum Body / Stainless Steel Piston
S	316 S.S Body / Stainless Steel Piston
M	Monel Body / Monel Piston
N	Aluminum Bronze Body / Aluminum Bronze Piston
Z	Special (<i>Un-coded Options</i>)
3	Dial Size & Type
A	2-1/2" Round Uni-Directional Dial w/Engineered Plastic Dial Case
C	4-1/2" Round Uni-Directional Dial w/Engineered Plastic Dial Case
D	4-1/2" Round Bi-Directional Dial w/Engineered Plastic Dial Case
E	3-1/2" Round Uni-Directional Dial w/Anodized Aluminum Housing Dial Case
G	4-1/2" Round Uni-Directional Dial w/Anodized Aluminum Housing Dial Case
H	4-1/2" Round Bi-Directional Dial w/Anodized Aluminum Housing Dial Case
T	Non-Indicating DP Switch Only
Z	Special (<i>Un-coded Options</i>)
4	Seal Materials
0	Buna-N (Standard)
1	Viton®-A Registered Trademark of Dupont
2	Neoprene
4	Teflon®-A Registered Trademark of Dupont
5	Ethylene Propylene
6	Perfluorelastomers
9	Special (<i>Un-coded Options</i>)
5	Process Connections
0	1/4" FNPT Back Connections (Standard) (Not available on M & N body materials)
2	1/4" FNPT End Connections
3	1/4" FNPT Bottom Connections
4	1/2" FNPT End Connections
6	7/16"-20 Straight Thread "O" Ring Port (Back Connection)
9	Special (<i>Un-coded Options</i>)

Factory preset switches at no charge (Specify Setting)

Standard Model Specifications – continued Model 120

6	Additional Options
O	None
A	Reversed High / Low Process Connections. (Not available with Electrical options J & K)
C	Mounting Holes in Gauge Body for Field Mounting Electrical Configurations Options A & B
D	Mounting Holes in Gauge Body for Field Mounting Electrical Configurations Options L & M
E	Two (2) 1/4-20 Mounting Holes (not available with C, D, E or F electrical switch options)
F	Carbon Steel 2" Pipe Mounting Kit (not available with C, D, E or F electrical switch options)
G	Stainless Steel 2" Pipe Mounting Kit (not available with C, D, E or F electrical switch options)
K	1/2" FNPT S.S. Adapter (not available with E or F switch option combined w/back connections)
L	Liquid Fill (4-1/2" available with "G" option Aluminum Dial Case only) (not available with shatterproof lens)
M	Maximum Indicator Follower Pointer (not available with Liquid fill option) (not available with shatterproof lens)
N	NACE (Available for Aluminum, Stainless Steel and Monel Gauge Bodies Only)
Q	CRN (Canadian Registration Number) Available on Aluminum or S.S. Body only
S	Shatter Proof Glass Lens (Available only with option "G" 4-1/2" Aluminum Dial Case) (not available with liquid fill)
T	Oxygen Cleaning
U	Stainless Steel Tag with S.S. Wire
V	Stainless Steel Tag and S.S. Screw (Contact Factory on Switch Options) Not on Gauge Body for Hazardous Locations
W	Wall Mount Kit (not available with back connections or with C, D, E or F switch options)
Z	Special (Un-coded Options)
NOTE: Not All Options Available in Combination with other Options	
7	Electrical Configurations (CE marked, except E, F, J & K) (6)
A	One (1) Switch in standard enclosure with grommet Wire Seal
B	Two (2) Switch in standard enclosures with grommet Wire Seal
C	One (1) Switch in standard enclosure with 1/4" FNPT electrical connection NEMA 4X
D	Two (2) Switch in standard enclosures with 1/4" FNPT electrical connection NEMA 4X
E	One (1) Switch in general purpose enclosure, Division 2 Hazardous Locations (1) (3) (4) (5)
F	Two (2) Switches in general purpose enclosure, Division 2 Hazardous Locations (1) (3) (4) (5)
G	One (1) Switch & gauge in NEMA 4X plastic enclosure (Not available with end connections)
H	Two (2) Switches & gauge in NEMA 4X plastic enclosure (Not available with end connections)
J	One (1) Switch in explosion proof enclosure w/glass window cover, Div. 1 Hazardous Locations (2) (3) (4) (5)
K	Two (2) Switches in explosion proof enclosure w/glass window cover, Div.1 Hazardous Locations (2) (3) (4) (5)
L	One (1) Switch in standard enclosure with plug-in connector (DIN 43650/IP65-PG11)
M	Two (2) Switch in standard enclosures with plug-in connector (DIN 43650/IP65-PG11)
Z	Special (Un-coded Options)
(1) Complete assembly 3rd Party Certified Class I, Div.2, Groups A, B, C, & D; Class II, Div.2, Groups F and G.	
(2) Complete assembly 3rd Party Certified Class I, Div.1, Groups C & D; Class II, Div. 1, Groups E, F, & G.	
(3) 5000 PSIG SWP for Stainless Steel: 3000 PSIG SWP for Aluminum	
(4) Not available in M and N material options	
(5) 1/2" FNPT conduit connection	
(6) Contact factory for Bi-directional scales with switches	
8	Electrical Specifications (For Resistive Loads)
A	SPDT 3W, 0.25 Amp, 125 VAC/VDC (standard) (Switch adjustable range of 10-90%)
E	SPST 60W, 3.0 Amp, 240 VAC/VDC (Normally Open) (Switch adjustable range of 25-95%)
F	SPST 60W, 3.0 Amp, 240 VAC/VDC (Normally Closed) (Switch adjustable range of 25-95%)
G	SPST 60W, 3.0 Amp, 240 VAC/VDC (1) Normally Open, (1) Normally Closed (Switch adjustable range of 25-95%)
H	SPDT 60W, 1.0 Amp, 240 VAC/VDC (Switch adjustable range of 25-100%)
Z	Special (Un-coded Options)

If you are in need of additional information please visit our web site at www.midwestinstrument.com or contact us toll free at **1-800-648-5778** and one of our knowledgeable sales coordinators will be happy to assist you...



Level



Pressure



Flow



Temperature

Liquid
Analysis

Registration

Systems
Components

Services



Solutions

Technical Information

Proline Promass 80F, 80M, 83F, 83M

Coriolis Mass Flow Measuring System

The universal and multivariable flowmeter for liquids and gases



Application

The Coriolis measuring principle operates independently of the physical fluid properties, such as viscosity and density.

- Extremely accurate measurement of liquids and gases such as oils, lubricants, fuels, liquefied gases, solvents, foodstuffs and compressed gases
- Fluid temperatures up to +350 °C
- Process pressures up to 350 bar
- Mass flow measurement up to 2200 t/h

Approvals for hazardous area:

- ATEX, FM, CSA, TIIS, IECEx, NEPSI

Approvals in the food industry/hygiene sector:

- 3A, FDA, EHEDG

Connection to all common process control systems:

- HART, PROFIBUS DP/PA, FOUNDATION Fieldbus, MODBUS

Relevant safety aspects:

- Secondary containment (up to 100 bar), Pressure Equipment Directive, AD 2000, SIL-2
- Purge connections or rupture disk (optional)

Your benefits

The Promass measuring devices make it possible to simultaneously record several process variables (mass/density/temperature) for various process conditions during measuring operation.

The **Proline transmitter concept** comprises:

- Modular device and operating concept resulting in a higher degree of efficiency
- Software options for batching and concentration measurement for extended range of application
- Diagnostic ability and data back-up for increased process quality

The **Promass sensors**, tried and tested in over 100000 applications, offer:

- Best performance due to PremiumCal
- Multivariable flow measurement in compact design
- Insensitivity to vibrations thanks to balanced two-tube measuring system
- Immune from external piping forces due to robust design
- Easy installation without taking inlet and outlet runs into consideration



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Function and system design

Measuring principle

The measuring principle is based on the controlled generation of Coriolis forces. These forces are always present when both translational and rotational movements are superimposed.

$$F_C = 2 \cdot \Delta m (v \cdot \omega)$$

F_C = Coriolis force

Δm = moving mass

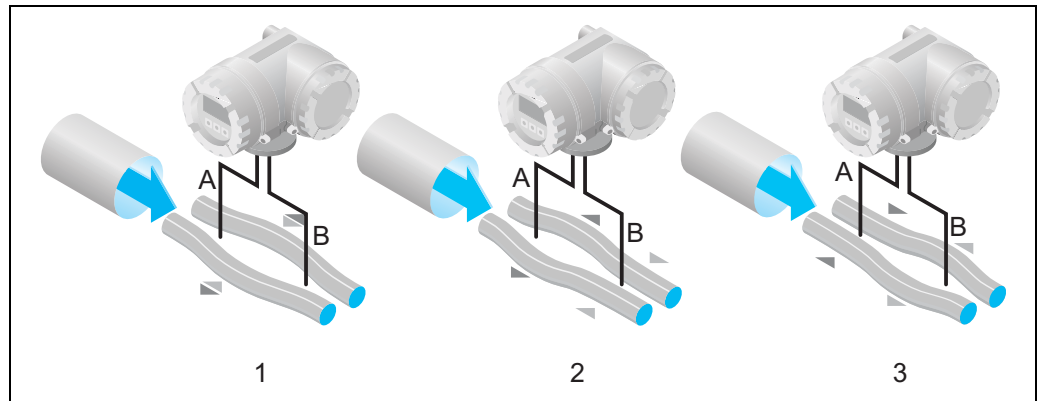
ω = rotational velocity

v = radial velocity in rotating or oscillating system

The amplitude of the Coriolis force depends on the moving mass Δm , its velocity v in the system, and thus on the mass flow. Instead of a constant angular velocity ω , the Promass sensor uses oscillation.

In the Promass F and M sensors, two parallel measuring tubes containing flowing fluid oscillate in antiphase, acting like a tuning fork. The Coriolis forces produced at the measuring tubes cause a phase shift in the tube oscillations (see illustration):

- At zero flow, in other words when the fluid is at a standstill, the two tubes oscillate in phase (1).
- Mass flow causes deceleration of the oscillation at the inlet of the tubes (2) and acceleration at the outlet (3).



The phase difference (A-B) increases with increasing mass flow. Electrodynamic sensors register the tube oscillations at the inlet and outlet.

System balance is ensured by the antiphase oscillation of the two measuring tubes. The measuring principle operates independently of temperature, pressure, viscosity, conductivity and flow profile.

Density measurement

The measuring tubes are continuously excited at their resonance frequency. A change in the mass and thus the density of the oscillating system (comprising measuring tubes and fluid) results in a corresponding, automatic adjustment in the oscillation frequency. Resonance frequency is thus a function of fluid density. The microprocessor utilizes this relationship to obtain a density signal.

Temperature measurement

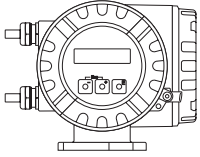
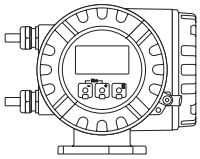
The temperature of the measuring tubes is determined in order to calculate the compensation factor due to temperature effects. This signal corresponds to the process temperature and is also available as an output.

Measuring system

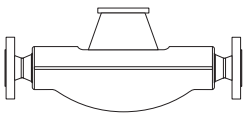
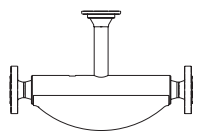
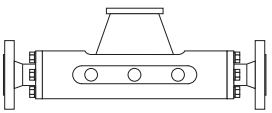
The measuring system consists of a transmitter and a sensor. Two versions are available:

- Compact version: transmitter and sensor form a mechanical unit
- Remote version: transmitter and sensor are mounted physically separate from one another

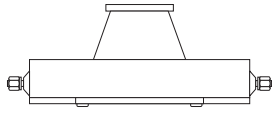
Transmitter

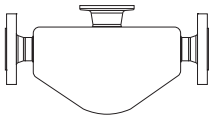
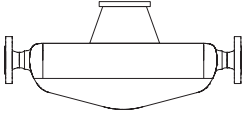
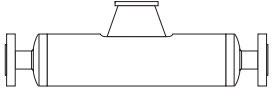
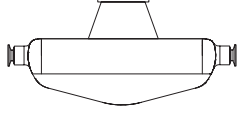
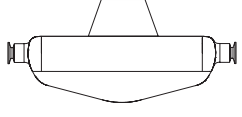
<p>Promass 80</p>  <p style="text-align: right; font-size: small;">a0003671</p>	<ul style="list-style-type: none"> ■ Two-line liquid-crystal display ■ Operation with push buttons
<p>Promass 83</p>  <p style="text-align: right; font-size: small;">a0003672</p>	<ul style="list-style-type: none"> ■ Four-line liquid-crystal display ■ Operation with "Touch control" ■ Application-specific Quick Setup ■ Mass flow, volume flow, density and temperature measurement as well as calculated variables (e.g. fluid concentrations)

Sensor

<p>F</p>  <p style="text-align: right; font-size: small;">a0003673</p>	<ul style="list-style-type: none"> ■ Universal sensor for fluid temperatures up to 200 °C ■ Nominal diameters DN 8 to 250 ■ Material: Stainless Steel EN 1.4539/ASTM 904L, EN 1.4404/ASTM 316L, Alloy C-22 DIN 2.4602 	<p>Documentation No. TI 053D/06/en</p>
<p>F (High-temperature)</p>  <p style="text-align: right; font-size: small;">a0003675</p>	<ul style="list-style-type: none"> ■ Universal high-temperature sensor for fluid temperatures up to 350 °C ■ Nominal diameters DN 25, 50, 80 ■ Material: Alloy C-22, DIN 2.4602, EN 1.4404/ASTM 316L 	
<p>M</p>  <p style="text-align: right; font-size: small;">a0003676</p>	<ul style="list-style-type: none"> ■ Robust sensor for extreme process pressures, high requirements for the secondary containment and fluid temperatures up to 150 °C ■ Nominal diameters DN 8 to 80 ■ Material: Titanium, Ti Grade 2, Ti Grade 9 	

Other sensors can be found in the separate documentation

<p>A</p>  <p style="text-align: right; font-size: small;">a0003679</p>	<ul style="list-style-type: none"> ■ Single-tube system for highly accurate measurement of very small flows ■ Nominal diameters DN 1 to 4 ■ Material: Stainless Steel EN 1.4539/ASTM 904L, EN 1.4404/ASTM 316L (process connection), Alloy C-22 DIN 2.4602 	<p>Documentation No. TI 054D/06/en</p>
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<p>E</p>  <p>a0002271</p>	<ul style="list-style-type: none"> ■ General purpose sensor, ideal replacement for volumetric flowmeters. ■ Nominal diameters DN 8 to 50 ■ Material: Stainless Steel EN 1.4539/ASTM 904L, EN 1.4404/ASTM 316L 	<p>Documentation No. TI 061D/06/en</p>
<p>H</p>  <p>a0003677</p>	<ul style="list-style-type: none"> ■ Single bent tube. Low pressure loss and chemically resistant material ■ Nominal diameters DN 8 to 50 ■ Material: Zirconium 702/R 60702 	<p>Documentation No. TI 074D/06/en</p>
<p>I</p>  <p>a0003678</p>	<ul style="list-style-type: none"> ■ Straight single-tube instrument. Minimal shear stress on fluid, hygienic design, low pressure loss ■ Nominal diameters DN 8 to 80 ■ Material: Titanium, Ti Grade 2, Ti Grade 9 	<p>Documentation No. TI 075D/06/en</p>
<p>P</p>  <p>a0006828</p>	<ul style="list-style-type: none"> ■ Single bent tube, minimal shear stress on fluid. Hygienic design with documents for Life Science Industries applications, low pressure loss, for fluid temperatures up to 200 °C ■ Nominal diameters DN 8 to 50 ■ Material: Stainless Steel EN 1.4435/ASTM 316L 	<p>Documentation No. TI 078D/06/en</p>
<p>S</p>  <p>a0006828</p>	<ul style="list-style-type: none"> ■ Single bent tube. Hygienic design, low pressure loss, for fluid temperatures up to 150 °C ■ Nominal diameters DN 8 to 50 ■ Material: Stainless Steel EN 1.4539/ASTM 904L, EN 1.4435/ASTM 316L 	<p>Documentation No. TI 076D/06/en</p>

Input

Measured variable

- Mass flow (proportional to the phase difference between two sensors mounted on the measuring tube to register a phase shift in the oscillation)
- Fluid density (proportional to resonance frequency of the measuring tube)
- Fluid temperature (measured with temperature sensors)

Measuring range

Measuring ranges for liquids

DN	Range for full scale values (liquids) $\dot{m}_{\min(F)}$ to $\dot{m}_{\max(F)}$
8	0 to 2000 kg/h
15	0 to 6500 kg/h
25	0 to 18000 kg/h
40	0 to 45000 kg/h
50	0 to 70000 kg/h
80	0 to 180000 kg/h
100 (only Promass F)	0 to 350000 kg/h
150 (only Promass F)	0 to 800000 kg/h
250 (only Promass F)	0 to 2200000 kg/h

Measuring ranges for gases

The full scale values depend on the density of the gas. Use the formula below to calculate the full scale values:

$$\dot{m}_{\max(G)} = \dot{m}_{\max(F)} \cdot \rho_{(G)} \div x \text{ [kg/m}^3\text{]}$$

$$\dot{m}_{\max(G)} = \text{max. full scale value for gas [kg/h]}$$

$$\dot{m}_{\max(F)} = \text{max. full scale value for liquid [kg/h]}$$

DN	x
8	60
15	80
25	90
40	90
50	90
80	110
100 (only Promass F)	130
150 (only Promass F)	200
250 (only Promass F)	200

Here, $\dot{m}_{\max(G)}$ can never be greater than $\dot{m}_{\max(F)}$

Calculation example for gas:

- Sensor type: Promass F, DN 50
- Gas: air with a density of 60.3 kg/m³ (at 20 °C and 50 bar)
- Measuring range (liquid): 70000 kg/h
- x = 90 (for Promass F, DN 50)

Max. possible full scale value:

$$\dot{m}_{\max(G)} = \dot{m}_{\max(F)} \cdot \rho_{(G)} \div x \text{ [kg/m}^3\text{]} = 70000 \text{ kg/h} \cdot 60.3 \text{ kg/m}^3 \div 90 \text{ kg/m}^3 = 46900 \text{ kg/h}$$

Recommended measuring ranges:

See information in the "Limiting flow" Section → Page 22 ff.

Operable flow range Greater than 1000 :1. Flow rates above the preset full scale value do not overload the amplifier, i.e. the totalizer values are registered correctly.

Input signal

Status input (auxiliary input)

$U = 3$ to 30 V DC, $R_i = 5$ k Ω , galvanically isolated.

Configurable for: totalizer reset, positive zero return, error message reset, zero point adjustment start, batching start/stop (optional), totalizer reset for batching (optional).

Status input (auxiliary input) with PROFIBUS DP

$U = 3$ to 30 V DC, $R_i = 3$ k Ω , galvanically isolated.

Switch level: $\pm 3 \dots \pm 30$ V DC, independent of polarity.

Configurable for: positive zero return, error message reset, zero point adjustment start, batching start/stop (optional), totalizer reset for batching (optional).

Status input (auxiliary input) with MODBUS RS485

$U = 3$ to 30 V DC, $R_i = 3$ k Ω , galvanically isolated.

Switch level: $\pm 3 \dots \pm 30$ V DC, independent of polarity.

Configurable for: totalizer reset, positive zero return, error message reset, zero point adjustment start.

Current input (only Promass 83)

Active/passive selectable, galvanically isolated, resolution: 2 μ A

- Active: 4 to 20 mA, $R_L < 700 \Omega$, $U_{out} = 24$ V DC, short-circuit proof
- Passive: 0/4 to 20 mA, $R_i = 150 \Omega$, $U_{max} = 30$ V DC

Output

Output signal

Promass 80

Current output:

Active/passive selectable, galvanically isolated, time constant selectable (0.05 to 100 s), full scale value selectable, temperature coefficient: typically 0.005% o.f.s./ $^{\circ}$ C, resolution: 0.5 μ A

- Active: 0/4 to 20 mA, $R_L < 700 \Omega$ (for HART: $R_L \geq 250 \Omega$)
- Passive: 4 to 20 mA; supply voltage U_S 18 to 30 V DC; $R_i \geq 150 \Omega$

Pulse/frequency output:

Passive, open collector, 30 V DC, 250 mA, galvanically isolated.

- Frequency output: full scale frequency 2 to 1000 Hz ($f_{max} = 1250$ Hz), on/off ratio 1:1, pulse width max. 2 s
- Pulse output: pulse value and pulse polarity selectable, pulse width configurable (0.5 to 2000 ms)

PROFIBUS PA interface:

- PROFIBUS PA in accordance with EN 50170 Volume 2, IEC 61158-2 (MBP), galvanically isolated
- Profile Version 3.0
- Current consumption: 11 mA
- Permitted supply voltage: 9 to 32 V
- Bus connection with integrated reverse polarity protection
- Error current FDE (Fault Disconnection Electronic) = 0 mA
- Data transmission rate: 31.25 kBit/s
- Signal encoding: Manchester II
- Function blocks: 4 \times Analog Input, 1 \times Totalizer
- Output data: Mass flow, Volume flow, Density, Temperature, Totalizer
- Input data: Positive zero return (ON/OFF), Zero point adjustment, Measuring mode, Totalizer control
- Bus address can be configured via miniature switches or via the local display (optional)

Promass 83*Current output:*

Active/passive selectable, galvanically isolated, time constant selectable (0.05 to 100 s), full scale value selectable, temperature coefficient: typically 0.005% o.f.s./°C, resolution: 0.5 μ A

- Active: 0/4 to 20 mA, $R_L < 700 \Omega$ (for HART: $R_L \geq 250 \Omega$)
- Passive: 4 to 20 mA; supply voltage U_S 18 to 30 V DC; $R_i \geq 150 \Omega$

Pulse/frequency output:

active/passive selectable, galvanically isolated

- Active: 24 V DC, 25 mA (max. 250 mA during 20 ms), $R_L > 100 \Omega$
- Passive: open collector, 30 V DC, 250 mA
- Frequency output: full scale frequency 2 to 10000 Hz ($f_{\max} = 12500$ Hz), on/off ratio 1:1, pulse width max. 2 s
- Pulse output: pulse value and pulse polarity selectable, pulse width configurable (0.05 to 2000 ms)

PROFIBUS DP interface:

- PROFIBUS DP in accordance with EN 50170 Volume 2
- Profile Version 3.0
- Data transmission rate: 9.6 kBaud to 12 MBaud
- Automatic data transmission rate recognition
- Signal encoding: NRZ Code
- Function blocks: 6 \times Analog Input, 3 \times Totalizer
- Output data: Mass flow, Volume flow, Corrected volume flow, Density, Reference density, Temperature, Totalizers 1 to 3
- Input data: Positive zero return (ON/OFF), Zero point adjustment, Measuring mode, Totalizer control
- Bus address can be configured via miniature switches or via the local display (optional)
- Available output combination \rightarrow Page 11

PROFIBUS PA interface:

- PROFIBUS PA in accordance with EN 50170 Volume 2, IEC 61158-2 (MBP), galvanically isolated
- Data transmission rate: 31.25 kBit/s
- Current consumption: 11 mA
- Permitted supply voltage: 9 to 32 V
- Bus connection with integrated reverse polarity protection
- Error current FDE (Fault Disconnection Electronic): 0 mA
- Signal encoding: Manchester II
- Function blocks: 6 \times Analog Input, 3 \times Totalizer
- Output data: Mass flow, Volume flow, Corrected volume flow, Density, Reference density, Temperature, Totalizers 1 to 3
- Input data: Positive zero return (ON/OFF), Zero point adjustment, Measuring mode, Totalizer control
- Bus address can be configured via miniature switches or via the local display (optional)
- Available output combination \rightarrow Page 11

MODBUS interface:

- MODBUS device type: slave
- Address range: 1 to 247
- Supported function codes: 03, 04, 06, 08, 16, 23
- Broadcast: supported with the function codes 06, 16, 23
- Physical interface: RS485 in accordance with EIA/TIA-485 standard
- Supported baud rate: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 Baud
- Transmission mode: RTU or ASCII
- Response times:
 - Direct data access = typically 25 to 50 ms
 - Auto-scan buffer (data range) = typically 3 to 5 ms
- Possible output combinations \rightarrow Page 11

FOUNDATION Fieldbus interface:

- FOUNDATION Fieldbus H1, IEC 61158-2, galvanically isolated
- Data transmission rate: 31.25 kBit/s
- Current consumption: 12 mA
- Permitted supply voltage: 9 to 32 V
- Error current FDE (Fault Disconnection Electronic): 0 mA
- Bus connection with integrated reverse polarity protection
- Signal encoding: Manchester II
- ITK Version 4.01
- Function blocks: 7 × Analog Input, 1 × Digital Output, 1 × PID
- Output data: Mass flow, Volume flow, Corrected volume flow, Density, Reference density, Temperature, Totalizers 1 to 3
- Input data: Positive zero return (ON/OFF), Zero point adjustment, Measuring mode, Reset totalizer
- Link Master (LM) function is supported

Signal on alarm

Current output:

Failsafe mode selectable (e.g. in accordance with NAMUR Recommendation NE 43)

Pulse/frequency output:

Failsafe mode selectable

Status output (Promass 80)

Nonconductive in the event of a fault or if the power supply fails

Relay output (Promass 83)

Dead in the event of a fault or if the power supply fails

Load

see "Output signal"

Low flow cutoff

Switch points for low flow are selectable.

Galvanic isolation

All circuits for inputs, outputs, and power supply are galvanically isolated from each other.

Switching output

Status output (Promass 80)

Open collector, max. 30 V DC / 250 mA, galvanically isolated.

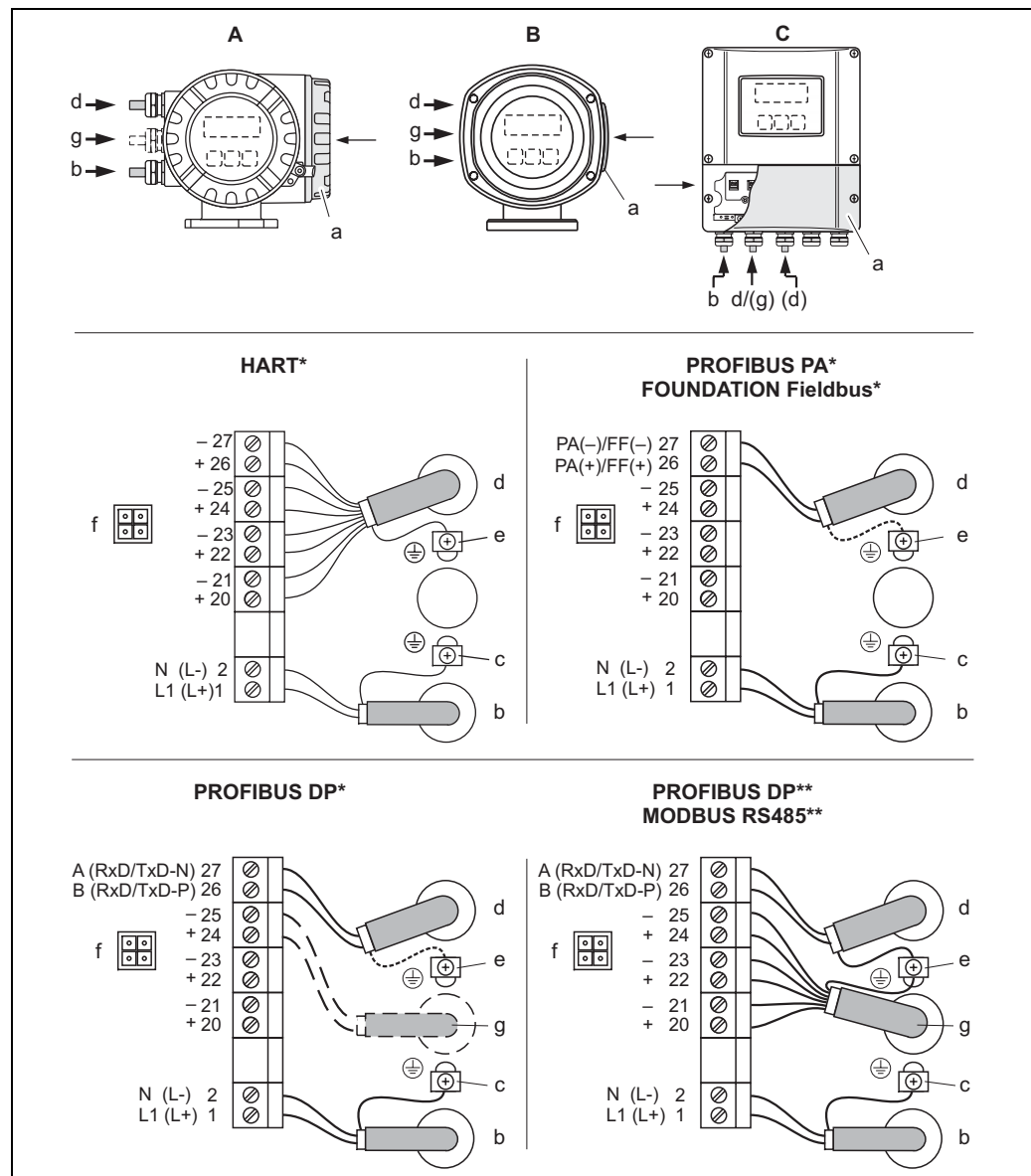
Configurable for: error messages, Empty Pipe Detection (EPD), flow direction, limit values.

Relay output (Promass 83)

Normally closed (NC or break) or normally open (NO or make) contacts available (factory setting: relay 1 = NO, relay 2 = NC), max. 30 V / 0.5 A AC; 60 V / 0.1 A DC, galvanically isolated.

Power supply

Electrical connection
Measuring unit



Connecting the transmitter, cable cross-section: max. 2.5 mm²

- A View A (field housing)
B View B (Stainless Steel field housing)
C View C (wall-mount housing)

*) fixed communication board

**) flexible communication board

a Connection compartment cover

b Cable for power supply: 85 to 260 V AC, 20 to 55 V AC, 16 to 62 V DC

Terminal No. 1: L1 for AC, L+ for DC

Terminal No. 2: N for AC, L- for DC

c Ground terminal for protective ground

d Signal cable: see Terminal assignment → Page 11

Fieldbus cable:

Terminal No. 26: DP (B) / PA (+) / FF (+) / MODBUS RS485 (B) / (PA, FF: with reverse polarity protection)

Terminal No. 27: DP (A) / PA (-) / FF (-) / MODBUS RS485 (A) / (PA, FF: with reverse polarity protection)

e Ground terminal for signal cable shield / fieldbus cable / RS485 line

f Service adapter for connecting service interface FXA 193 (Fieldcheck, FieldCare)

g Signal cable: see Terminal assignment → Page 11

g Cable for external termination (only for PROFIBUS DP with permanent assignment communication board):

Terminal No. 24: +5 V

Terminal No. 25: DGND

**Electrical connection,
terminal assignment**

Promass 80

Order version	Terminal No. (inputs/outputs)			
	20 (+) / 21 (-)	22 (+) / 23 (-)	24 (+) / 25 (-)	26 (+) / 27 (-)
80***_*****A	-	-	Frequency output	Current output, HART
80***_*****D	Status input	Status output	Frequency output	Current output, HART
80***_*****H	-	-	-	PROFIBUS PA
80***_*****S	-	-	Frequency output Ex i, passive	Current output Ex i Active, HART
80***_*****T	-	-	Frequency output Ex i, passive	Current output Ex i Passive, HART
80***_*****8	Status input	Frequency output	Current output 2	Current output 1, HART

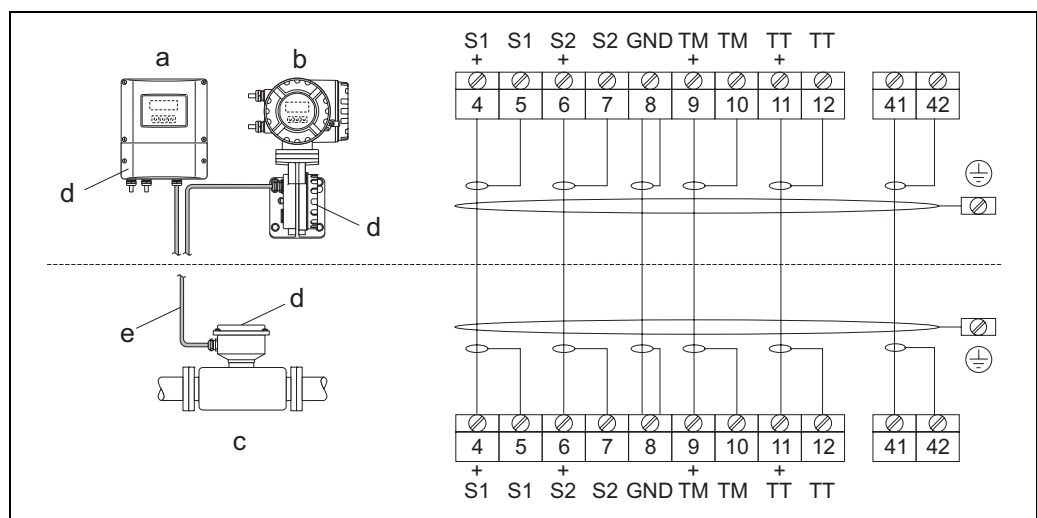
Promass 83

The inputs and outputs on the communication board can be either permanently assigned (fixed) or variable (flexible), depending on the version ordered (see table). Replacements for modules which are defective or which have to be replaced can be ordered as accessories.

Order version	Terminal No. (inputs/outputs)			
	20 (+) / 21 (-)	22 (+) / 23 (-)	24 (+) / 25 (-)	26 (+) / 27 (-)
<i>Fixed communication boards (permanent assignment)</i>				
83***_*****A	-	-	Frequency output	Current output, HART
83***_*****B	Relay output	Relay output	Frequency output	Current output, HART
83***_*****F	-	-	-	PROFIBUS PA, Ex i
83***_*****G	-	-	-	FOUNDATION Fieldbus Ex i
83***_*****H	-	-	-	PROFIBUS PA
83***_*****J	-	-	+5V (ext. termination)	PROFIBUS DP
83***_*****K	-	-	-	FOUNDATION Fieldbus
83***_*****Q	-	-	Status input	MODBUS RS485
83***_*****R	-	-	Current output 2 Ex i, active	Current output 1 Ex i active, HART
83***_*****S	-	-	Frequency output Ex i, passive	Current output Ex i Active, HART
83***_*****T	-	-	Frequency output Ex i, passive	Current output Ex i Passive, HART
83***_*****U	-	-	Current output 2 Ex i, passive	Current output 1 Ex i passive, HART
<i>Flexible communication boards</i>				
83***_*****C	Relay output 2	Relay output 1	Frequency output	Current output, HART
83***_*****D	Status input	Relay output	Frequency output	Current output, HART
83***_*****E	Status input	Relay output	Current output 2	Current output, HART
83***_*****L	Status input	Relay output 2	Relay output 1	Current output, HART
83***_*****M	Status input	Frequency output 2	Frequency output 1	Current output, HART
83***_*****N	Current output	Frequency output	Status input	MODBUS RS485
83***_*****P	Current output	Frequency output	Status input	PROFIBUS DP

Order version	Terminal No. (inputs/outputs)			
	20 (+) / 21 (-)	22 (+) / 23 (-)	24 (+) / 25 (-)	26 (+) / 27 (-)
83***_*****V	Relay output 2	Relay output 1	Status input	PROFIBUS DP
83***_*****W	Relay output	Current output 3	Current output 2	Current output 1, HART
83***_*****0	Status input	Current output 3	Current output 2	Current output 1, HART
83***_*****2	Relay output	Current output 2	Frequency output	Current output 1, HART
83***_*****3	Current input	Relay output	Current output 2	Current output 1, HART
83***_*****4	Current input	Relay output	Frequency output	Current output, HART
83***_*****5	Status input	Current input	Frequency output	Current output, HART
83***_*****6	Status input	Current input	Current output 2	Current output 1, HART
83***_*****7	Relay output 2	Relay output 1	Status input	MODBUS RS485

Electrical connection Remote version



Connecting the remote version

- a Wall-mount housing: non-hazardous area and ATEX II3G / zone 2 → see separate "Ex documentation"
- b Wall-mount housing: ATEX II2G / Zone 1 / FM/CSA → see separate "Ex documentation"
- c Remote version, flanged version
- d Cover for connection compartment or connection housing
- e Connecting cable

Terminal No.: 4/5 = gray; 6/7 = green; 8 = yellow; 9/10 = pink; 11/12 = white; 41/42 = brown

Supply voltage 85 to 260 V AC, 45 to 65 Hz
 20 to 55 V AC, 45 to 65 Hz
 16 to 62 V DC

Cable entries *Power-supply and signal cables (inputs/outputs):*

- Cable entry M20 × 1.5 (8 to 12 mm)
- Thread for cable entries, 1/2" NPT, G 1/2"

Connecting cable for remote version:

- Cable entry M20 × 1.5 (8 to 12 mm)
- Thread for cable entries, 1/2" NPT, G 1/2"

**Cable specification
Remote version**

- $6 \times 0.38 \text{ mm}^2$ (PVC cable with common shield and individually shielded cores)
- Conductor resistance: $\leq 50 \text{ } \Omega/\text{km}$
- Capacitance: core/shield: $\leq 420 \text{ pF/m}$
- Cable length: max. 20 m
- Permanent operating temperature: max. $+105 \text{ } ^\circ\text{C}$

Operation in zones of severe electrical interference:

The measuring device complies with the general safety requirements in accordance with EN 61010, the EMC requirements of IEC/EN 61326, and NAMUR recommendation NE 21/43.

Power consumption

AC: $<15 \text{ VA}$ (including sensor)

DC: $<15 \text{ W}$ (including sensor)

Switch-on current:

- Max. 13.5 A ($<50 \text{ ms}$) at 24 V DC
 - Max. 3 A ($<5 \text{ ms}$) at 260 V AC
-

Power supply failure

Promass 80

Lasting min. 1 power cycle:

- EEPROM saves measuring system data if the power supply fails
- HistoROM/S-DAT: exchangeable data storage chip with sensor specific data (nominal diameter, serial number, calibration factor, zero point, etc.)

Promass 83

Lasting min. 1 power cycle:

- EEPROM and T-DAT save the measuring system data if the power supply fails.
 - HistoROM/S-DAT: exchangeable data storage chip with sensor specific data (nominal diameter, serial number, calibration factor, zero point, etc.)
-

Potential equalization

No special measures for potential equalization are required. For instruments for use in hazardous areas, observe the corresponding guidelines in the specific Ex documentation.

Performance characteristics

Reference operating conditions

Error limits following ISO/DIS 11631:

- $20 \text{ } ^\circ\text{C}$ to $30 \text{ } ^\circ\text{C}$; 2 to 4 bar
 - Accuracy based on accredited calibration rigs according to ISO 17025
 - Zero point calibrated under operating conditions
 - Field density calibrated (or special density calibration)
-

Maximum measured error

The following values refer to the pulse/frequency output. The additional measured error at the current output is typically $\pm 5 \text{ } \mu\text{A}$.

o.r. = of reading

Mass flow (liquid)

Promass 80 F, M:

$\pm 0.15\% \pm [(\text{zero point stability} \div \text{measured value}) \cdot 100]\% \text{ o.r.}$

Optional Promass 80F: $\pm 0.10\% \pm [(\text{zero point stability} \div \text{measured value}) \cdot 100]\% \text{ o.r.}$

Promass 83 F, M:

$\pm 0.10\% \pm [(\text{zero point stability} \div \text{measured value}) \cdot 100]\% \text{ o.r.}$

PremiumCal (optional) Promass 83F: $\pm 0.05\% \pm [(\text{zero point stability} \div \text{measured value}) \cdot 100]\% \text{ o.r.}$

Mass flow (gas)*Promass 80/83 F:*

$$\pm 0.35\% \pm [(zero\ point\ stability \div measured\ value) \cdot 100]\% \text{ o.r.}$$

Promass 80/83 M:

$$\pm 0.50\% \pm [(zero\ point\ stability \div measured\ value) \cdot 100]\% \text{ o.r.}$$

Volume flow (liquid)*Promass 80 F:*

$$\pm 0.20\% \pm [(zero\ point\ stability \div measured\ value) \cdot 100]\% \text{ o.r.}$$

Promass 83 F:

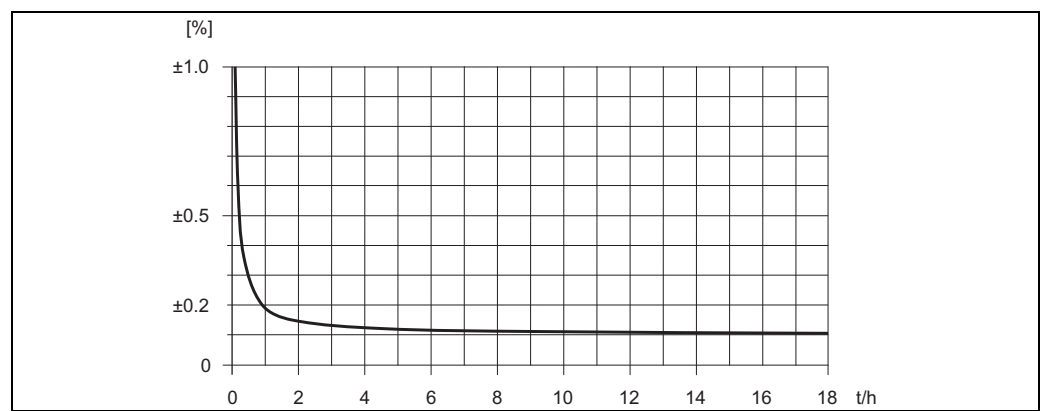
$$\pm 0.15\% \pm [(zero\ point\ stability \div measured\ value) \cdot 100]\% \text{ o.r.}$$

Promass 80/83 M:

$$\pm 0.25\% \pm [(zero\ point\ stability \div measured\ value) \cdot 100]\% \text{ o.r.}$$

Zero point stability (Promass F, M)

DN	Max. full scale value [kg/h] or [l/h]	Zero point stability		
		Promass F [kg/h] or [l/h]	Promass F (high-temperature) [kg/h] or [l/h]	Promass M [kg/h] or [l/h]
8	2000	0.030	–	0.100
15	6500	0.200	–	0.325
25	18000	0.540	1.80	0.90
40	45000	2.25	–	2.25
50	70000	3.50	7.00	3.50
80	180000	9.00	18.00	9.00
100	350000	14.00	–	–
150	800000	32.00	–	–
250	2200000	88.00	–	–

Sample calculation

Max. measured error in % of measured value (example: Promass 83 F / DN 25)

Calculation example (mass flow, liquid):

Given: Promass 83 F / DN 25, measured value flow = 8000 kg/h

Max. measured error: $\pm 0.10\% \pm [(zero\ point\ stability \div measured\ value) \cdot 100]\% \text{ o.r.}$

Max. measured error: $\pm 0.10\% \pm 0.54\text{ kg/h} \div 8000\text{ kg/h} \cdot 100\% = \pm 0.107\%$

Density (liquid)

1 g/cc = 1 kg/l

Standard calibration:

Promass F

±0.01 g/cc

Promass M

±0.02 g/cc

*Special density calibration (optional), not for high-temperature version
(calibration range = 0.8 to 1.8 g/cc, 5 °C to 80 °C):*

Promass F

±0.001 g/cc

Promass M

±0.002 g/cc

After field density calibration or under reference conditions:

Promass F

±0.0005 g/cc

Promass M

±0.0010 g/cc

Temperature

Promass F, M:

±0.5 °C ± 0.005 · T (T = medium temperature in °C)

Repeatability

Mass flow (liquid)

±0.05% ± [½ · (zero point stability ÷ measured value) · 100] % o.r.

Mass flow (gas)

±0.25% ± [½ · (zero point stability ÷ measured value) · 100] % o.r.

Volume flow (liquid)

Promass F:

±0.05% ± [½ · (zero point stability ÷ measured value) · 100] % o.r.

Promass M:

±0.10% ± [½ · (zero point stability ÷ measured value) · 100] % o.r.

o.r. = of reading

Zero point stability: see "Max. measured error" → Page 13 ff.

Calculation example (mass flow, liquid):

Given: Promass 83 F / DN 25, measured value flow = 8000 kg/h

Repeatability: ±0.05% ± [½ · (zero point stability ÷ measured value) · 100] % o.r.

Repeatability: ±0.05% ± ½ · 0.54 kg/h ÷ 8000 kg/h · 100% = ±0.053%

Density measurement (liquid)

1 g/cc = 1 kg/l

Promass F:

±0.00025 g/cc

Promass M:

±0.0005 g/cc

Temperature measurement

±0.25 °C ± 0.0025 · T (T = medium temperature in °C)

Influence of medium temperature

When there is a difference between the temperature for zero point adjustment and the process temperature, the typical measured error of the Promass sensor is ±0.0002% of the full scale value/°C.

Influence of medium pressure

The table below shows the effect on accuracy of mass flow due to a difference between calibration pressure and process pressure.

DN	Promass F Promass F high-temperature [% o.r./bar]	Promass M [% o.r./bar]	Promass M (high pressure) [% o.r./bar]
8	No influence	0.009	0.006
15	No influence	0.008	0.005
25	No influence	0.009	0.003
40	-0.003	0.005	–
50	-0.008	No influence	–
80	-0.009	No influence	–
100	-0.012	–	–
150	-0.009	–	–
250	-0.009	–	–
o.r. = of reading			

Operating conditions: Installation

Installation instructions

Note the following points:

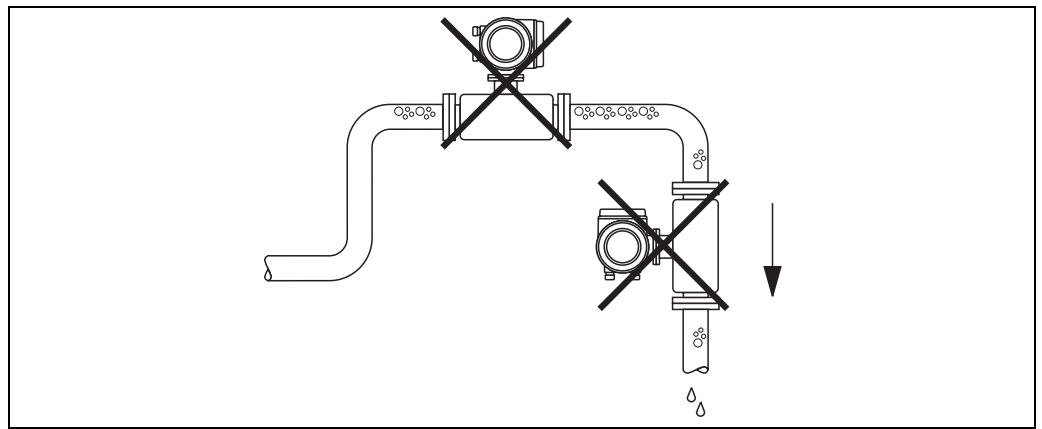
- No special measures such as supports are necessary. External forces are absorbed by the construction of the instrument, for example the secondary containment.
- The high oscillation frequency of the measuring tubes ensures that the correct operation of the measuring system is not influenced by pipe vibrations.
- No special precautions need to be taken for fittings which create turbulence (valves, elbows, T-pieces, etc.), as long as no cavitation occurs.
- For mechanical reasons and to protect the pipe, support is recommended for heavy sensors.

Mounting location

Entrained air or gas bubbles in the measuring tube can result in an increase in measuring errors.

Avoid the following mounting locations in the pipe:

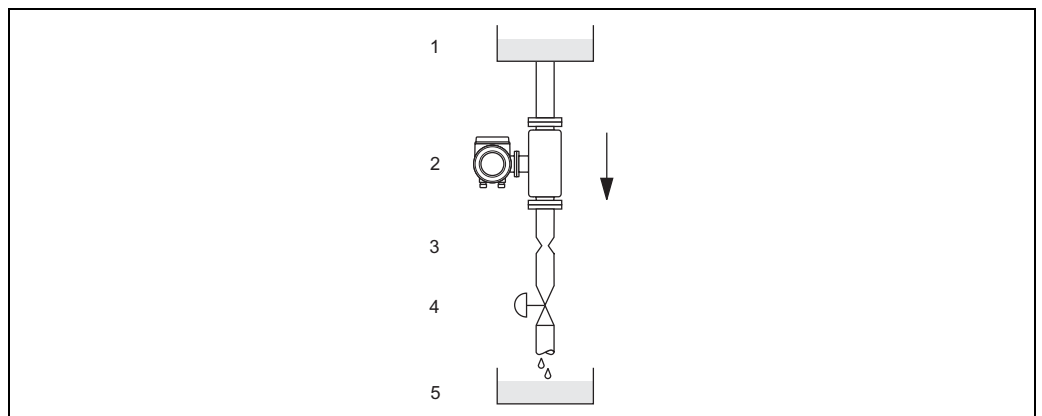
- Highest point of a pipeline. Risk of air accumulating.
- Directly upstream from a free pipe outlet in a vertical pipeline



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Mounting location

Notwithstanding the above, the installation proposal below permits installation in an open vertical pipeline. Pipe restrictions or the use of an orifice with a smaller cross-section than the nominal diameter prevent the sensor running empty while measurement is in progress.



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Installation in a down pipe (e.g. for batching applications)

1 = Supply tank, 2 = Sensor, 3 = Orifice plate, pipe restriction (see Table), 4 = Valve, 5 = Batching tank

DN	8	15	25	40	50	80	100 ¹⁾	150 ¹⁾	250 ¹⁾
Ø Orifice plate, pipe restriction [mm]	6	10	14	22	28	50	65	90	150
1) only Promass F									

Orientation

Make sure that the direction of the arrow on the nameplate of the sensor matches the direction of flow (direction of fluid flow through the pipe).

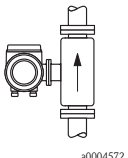
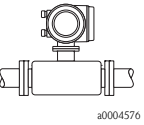
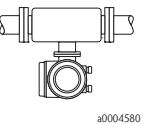
Vertical (View V)

Recommended orientation with upward direction of flow. When fluid is not flowing, entrained solids will sink down and gases will rise away from the measuring tube. The measuring tubes can be completely drained and protected against solids buildup.

Horizontal

The measuring tubes must be horizontal and beside each other. When installation is correct the transmitter housing is above or below the pipe (Views H1/H2). Always avoid having the transmitter housing in the same horizontal plane as the pipe.

Please note the special installation instructions! → Page 19

		Promass F, M Standard, compact	Promass F, M Standard, remote	Promass F High-temperature, compact	Promass F High-temperature, remote
Fig. V Vertical orientation	 a0004572	✓✓	✓✓	✓✓	✓✓
Fig. H1 Horizontal orientation Transmitter head up	 a0004576	✓✓	✓✓	✗ TM = >200 °C ①	✓ TM = >200 °C ①
Fig. H2 Horizontal orientation Transmitter head down	 a0004580	✓✓ ②	✓✓ ②	✓✓ ②	✓✓ ②
✓✓ = Recommended orientation ✓ = Orientation recommended in certain situations ✗ = Impermissible orientation					

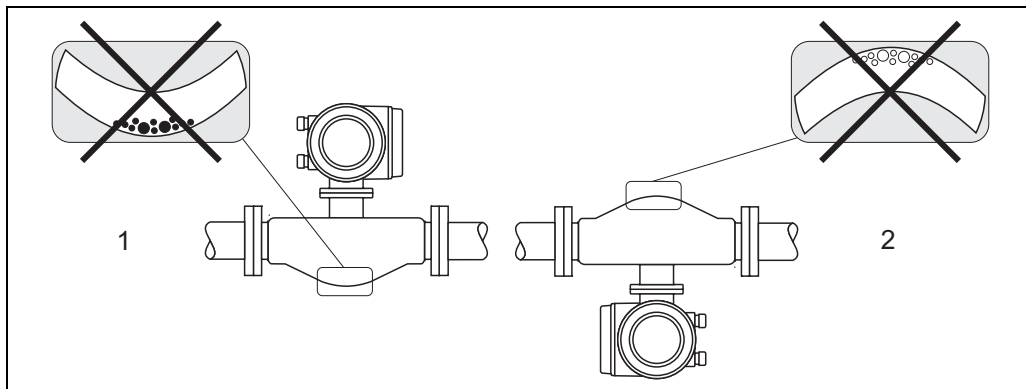
In order to ensure that the maximum permissible ambient temperature for the transmitter (-20 °C to +60 °C, optional -40 °C to +60 °C) is not exceeded, we recommend the following orientations:

① = For fluids with very high temperatures (>200 C), we recommend the horizontal orientation with the transmitter head pointing downwards (Fig. H2) or the vertical orientation (Fig. V).

② = For fluids with low temperatures, we recommend the horizontal orientation with the transmitter head pointing upwards (Fig. H1) or the vertical orientation (Fig. V).

Special installation instructions for Promass F**Caution!**

Both measuring tubes of Promass F are slightly curved. The position of the sensor, therefore, has to be matched to the fluid properties when the sensor is installed horizontally.



Horizontal installation with Promass F

- 1 Not suitable for fluids with entrained solids. Risk of solids accumulating.
- 2 Not suitable for outgassing fluids. Risk of air accumulating.

Heating

Some fluids require suitable measures to avoid heat transfer at the sensor. Heating can be electric, e.g. with heated elements, or by means of hot water or steam pipes made of copper or heating jackets.

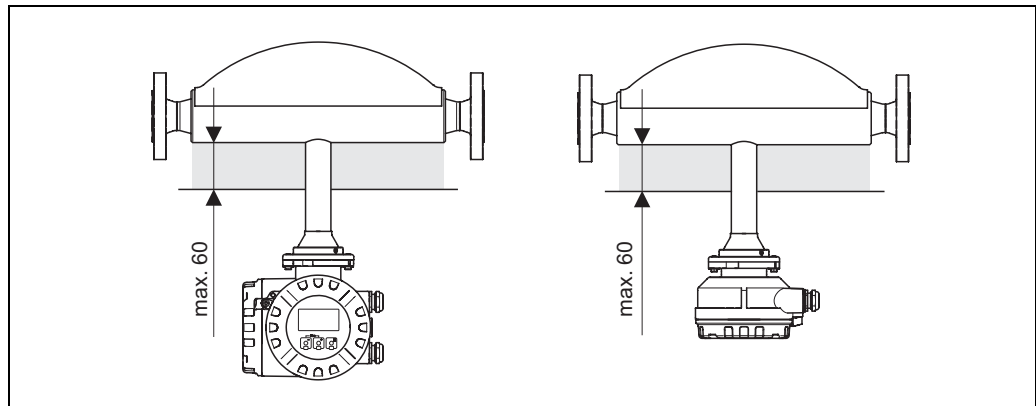
**Caution!**

- Risk of electronics overheating! Make sure that the maximum permissible ambient temperature for the transmitter is not exceeded. Consequently, make sure that the adapter between the sensor and transmitter and the connection housing of the remote version always remain free of insulating material. Note that a certain orientation might be required, depending on the fluid temperature. → Page 18
- With a fluid temperature between 200 °C to 350 °C the remote version of the high-temperature version is preferable.
- If using an electric trace heating system whose heating is regulated via phase angle control or pulse packages, influence on the measured values cannot be ruled out due to magnetic fields (i.e. for values that are greater than the values approved by the EN standard (sine 30 A/m)). In such instances, it is necessary to magnetically shield the sensor (apart from Promass M).
The secondary containment can be shielded with tin plate or electric sheets without privileged direction (e.g. V330-35A) with the following properties:
 - Relative magnetic permeability $\mu_r \geq 300$
 - Plate thickness $d \geq 0.35$ mm
- Information on permitted temperature ranges → Page 21

Special heating jackets, which can be ordered separately from Endress+Hauser as an accessory, are available for the sensors.

Thermal insulation

Some fluids require suitable measures to avoid heat transfer at the sensor. A wide range of materials can be used to provide the required thermal insulation.



In the case of the Promass F high-temperature version, a maximum insulation thickness of 60 mm must be observed in the area of the electronics/neck.

If the Promass F high-temperature version is installed horizontally (with transmitter head pointing upwards), an insulation thickness of min. 10 mm is recommended to reduce convection. The maximum insulation thickness of 60 mm must be observed.

Zero point adjustment

All Promass devices are calibrated to state-of-the-art technology. The zero point determined in this way is imprinted on the nameplate.

Calibration takes place under reference conditions. → Page 13 ff.

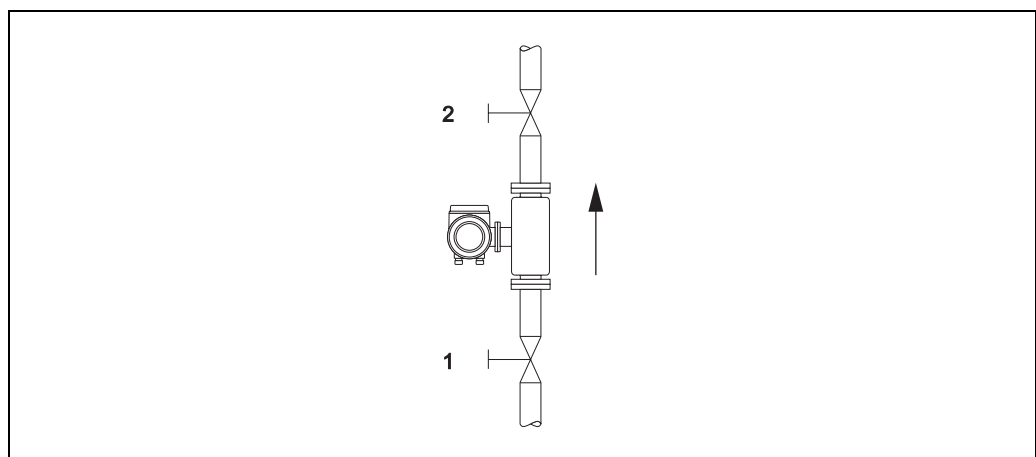
Promass therefore does **not** require zero point adjustment!

Experience shows that the zero point adjustment is advisable only in special cases:

- To achieve highest measuring accuracy also with very low flow rates
- Under extreme process or operating conditions (e.g. very high process temperatures or very high-viscosity fluids).

Please note the following before carrying out the adjustment:


- The adjustment can only be performed with fluids that have no gas or solid contents.
- Zero point adjustment is performed with the measuring tubes completely filled and at zero flow ($v = 0$ m/s). This can be achieved, for example, with shutoff valves upstream and/or downstream of the sensor or by using existing valves and gates.
 - Normal operation → valves 1 and 2 open
 - Zero point adjustment *with* pump pressure → valve 1 open / valve 2 closed
 - Zero point adjustment *without* pump pressure → valve 1 closed / valve 2 open



Zero point adjustment and shutoff valves

Inlet and outlet runs	There are no installation requirements regarding inlet and outlet runs.
Length of connecting cable	Max. 20 meters (remote version)
System pressure	<p>It is important to ensure that cavitation does not occur, because it would influence the oscillation of the measuring tube. No special measures need to be taken for fluids which have properties similar to water under normal conditions.</p> <p>In the case of liquids with a low boiling point (hydrocarbons, solvents, liquefied gases) or in suction lines, it is important to ensure that pressure does not drop below the vapor pressure and that the liquid does not start to boil. It is also important to ensure that the gases that occur naturally in many liquids do not outgas. Such effects can be prevented when system pressure is sufficiently high.</p> <p>For this reason, the following mounting locations are preferred:</p> <ul style="list-style-type: none"> ■ Downstream from pumps (no risk of partial vacuum) ■ At the lowest point in a vertical pipe

Operating conditions: Environment

Ambient temperature range	<p>Standard: -20 °C to +60 °C (sensor, transmitter) Optional: -40 °C to +60 °C (sensor, transmitter)</p> <p> Note!</p> <ul style="list-style-type: none"> ■ Install the device at a shady location. Avoid direct sunlight, particularly in warm climatic regions. ■ At ambient temperatures below -20 °C the readability of the display may be impaired.
Storage temperature	-40 °C to +80 °C (preferably +20 °C)
Degree of protection	Standard: IP 67 (NEMA 4X) for transmitter and sensor
Shock resistance	In accordance with IEC 68-2-31
Vibration resistance	Acceleration up to 1 g, 10 to 150 Hz, following IEC 68-2-6
Electromagnetic compatibility (EMC)	To IEC/EN 61326 and NAMUR Recommendation NE 21

Operating conditions: Process

Medium temperature range	<p>Sensor</p> <p><i>Promass F:</i> -50 °C to +200 °C</p> <p><i>Promass F (high-temperature version):</i> -50 °C to +350 °C</p> <p><i>Promass M:</i> -50 °C to +150 °C</p>
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Seals*Promass F:*

No internal seals

Promass M:

Viton -15 °C to +200 °C; EPDM -40 °C to +160 °C; silicone -60 °C to +200 °C; Kalrez -20 °C to +275 °C; FEP sheathed (not for gas applications): -60 °C to +200 °C

**Medium pressure range
(nominal pressure)****Flanges***Promass F:*

according to DIN PN 16 to 100 /according to ASME B16.5 Cl 150, Cl 300, Cl 600 / JIS 10K, 20K, 40K, 63K

Promass F (high-temperature version):

according to DIN PN 40, 64, 100 /according to ASME B16.5 Cl 150, Cl 300, Cl 600 / JIS 10K, 20K, 63K

Promass M:

according to DIN PN 40 to 100 /according to ASME B16.5 Cl 150, Cl 300, Cl 600 / JIS 10K, 20K, 40K, 63K

Promass M (high-pressure version)

Measuring tubes, connector, couplings: max. 350 bar

Pressure ranges of secondary containment

- Promass F
 - DN 8 to 50: 40 bar
 - DN 80: 25 bar
 - DN 100 to 150: 16 bar
 - DN 250: 10 bar
- Promass M
 - 100 bar

**Warning!**

In case a danger of measuring tube failure exists due to process characteristics, e.g. with corrosive process fluids, we recommend the use of sensors whose secondary containment is equipped with special pressure monitoring connections (ordering option). With the help of these connections, fluid collected in the secondary containment in the event of tube failure can be bled off. This is especially important in high pressure gas applications. These connections can also be used for gas circulation and/or gas detection. Dimensions → Page 31 ff.

Rupture disk (optional, only Promass F)

Further informationen → Page 56.

Limiting flow

See information in the "Measuring range" Section → Page 6

Select nominal diameter by optimizing between required flow range and permissible pressure loss. An overview of max. possible full scale values can be found in the "Measuring range" Section.

- The minimum recommended full scale value is approx. 1/20 of the max. full scale value.
- In most applications, 20 to 50% of the maximum full scale value can be considered ideal.
- Select a lower full scale value for abrasive substances such as fluids with entrained solids (flow velocity <1 m/s).
- For gas measurement the following rules apply:
 - Flow velocity in the measuring tubes should not be more than half the sonic velocity (0.5 Mach).
 - The maximum mass flow depends on the density of the gas: formula → Page 6

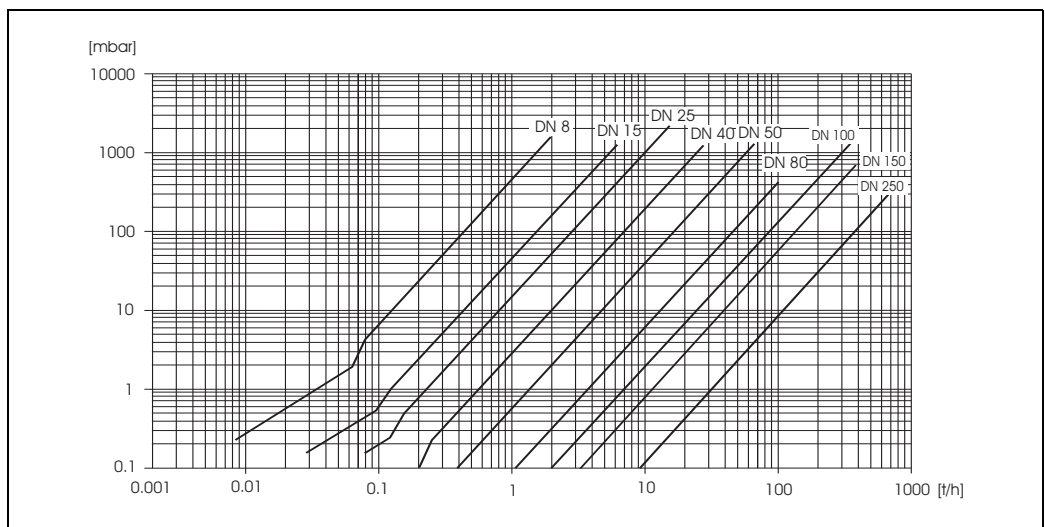
Pressure loss

Pressure loss depends on the fluid properties and on the flow rate. The following formulae can be used to approximately calculate the pressure loss:

Reynolds number	$Re = \frac{2 \cdot \dot{m}}{\pi \cdot d \cdot \nu \cdot \rho}$	a0004623
$Re \geq 2300^{1)}$	$\Delta p = K \cdot \nu^{0.25} \cdot \dot{m}^{1.85} \cdot \rho^{-0.86}$	a0004626
$Re < 2300$	$\Delta p = K1 \cdot \nu \cdot \dot{m} + \frac{K2 \cdot \nu^{0.25} \cdot \dot{m}^2}{\rho}$	a0004628
<p>Δp = pressure loss [mbar] ρ = fluid density [kg/m³] ν = kinematic viscosity [m²/s] d = inside diameter of measuring tubes [m] \dot{m} = mass flow [kg/s] K to $K2$ = constants (depending on nominal diameter)</p> <p>¹⁾ To compute the pressure loss for gases, always use the formula for $Re \geq 2300$.</p>		

Pressure loss coefficient for Promass F

DN	d [m]	K	K1	K2
8	$5.35 \cdot 10^{-3}$	$5.70 \cdot 10^7$	$9.60 \cdot 10^7$	$1.90 \cdot 10^7$
15	$8.30 \cdot 10^{-3}$	$5.80 \cdot 10^6$	$1.90 \cdot 10^7$	$10.60 \cdot 10^5$
25	$12.00 \cdot 10^{-3}$	$1.90 \cdot 10^6$	$6.40 \cdot 10^6$	$4.50 \cdot 10^5$
40	$17.60 \cdot 10^{-3}$	$3.50 \cdot 10^5$	$1.30 \cdot 10^6$	$1.30 \cdot 10^5$
50	$26.00 \cdot 10^{-3}$	$7.00 \cdot 10^4$	$5.00 \cdot 10^5$	$1.40 \cdot 10^4$
80	$40.50 \cdot 10^{-3}$	$1.10 \cdot 10^4$	$7.71 \cdot 10^4$	$1.42 \cdot 10^4$
100	$51.20 \cdot 10^{-3}$	$3.54 \cdot 10^3$	$3.54 \cdot 10^4$	$5.40 \cdot 10^3$
150	$68.90 \cdot 10^{-3}$	$1.36 \cdot 10^3$	$2.04 \cdot 10^4$	$6.46 \cdot 10^2$
250	$102.26 \cdot 10^{-3}$	$3.00 \cdot 10^2$	$6.10 \cdot 10^3$	$1.33 \cdot 10^2$

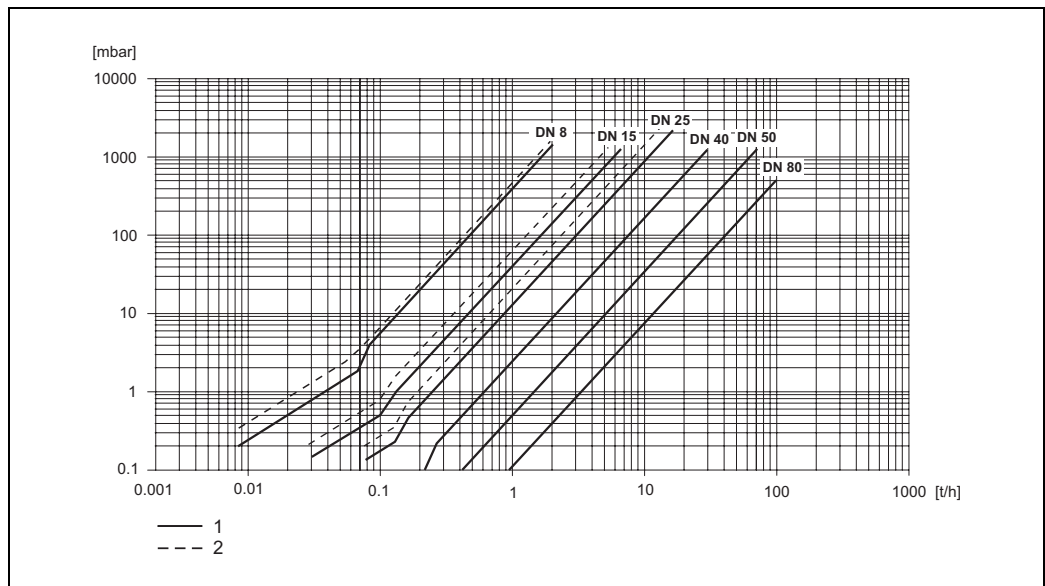


Pressure loss diagram for water

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Pressure loss coefficient for Promass M

DN	d [m]	K	K1	K2
8	$5.53 \cdot 10^{-3}$	$5.2 \cdot 10^7$	$8.6 \cdot 10^7$	$1.7 \cdot 10^7$
15	$8.55 \cdot 10^{-3}$	$5.3 \cdot 10^6$	$1.7 \cdot 10^7$	$9.7 \cdot 10^5$
25	$11.38 \cdot 10^{-3}$	$1.7 \cdot 10^6$	$5.8 \cdot 10^6$	$4.1 \cdot 10^5$
40	$17.07 \cdot 10^{-3}$	$3.2 \cdot 10^5$	$1.2 \cdot 10^6$	$1.2 \cdot 10^5$
50	$25.60 \cdot 10^{-3}$	$6.4 \cdot 10^4$	$4.5 \cdot 10^5$	$1.3 \cdot 10^4$
80	$38.46 \cdot 10^{-3}$	$1.4 \cdot 10^4$	$8.2 \cdot 10^4$	$3.7 \cdot 10^4$
High-pressure version				
8	$4.93 \cdot 10^{-3}$	$6.0 \cdot 10^7$	$1.4 \cdot 10^8$	$2.8 \cdot 10^7$
15	$7.75 \cdot 10^{-3}$	$8.0 \cdot 10^6$	$2.5 \cdot 10^7$	$1.4 \cdot 10^6$
25	$10.20 \cdot 10^{-3}$	$2.7 \cdot 10^6$	$8.9 \cdot 10^6$	$6.3 \cdot 10^5$



Pressure loss diagram for water

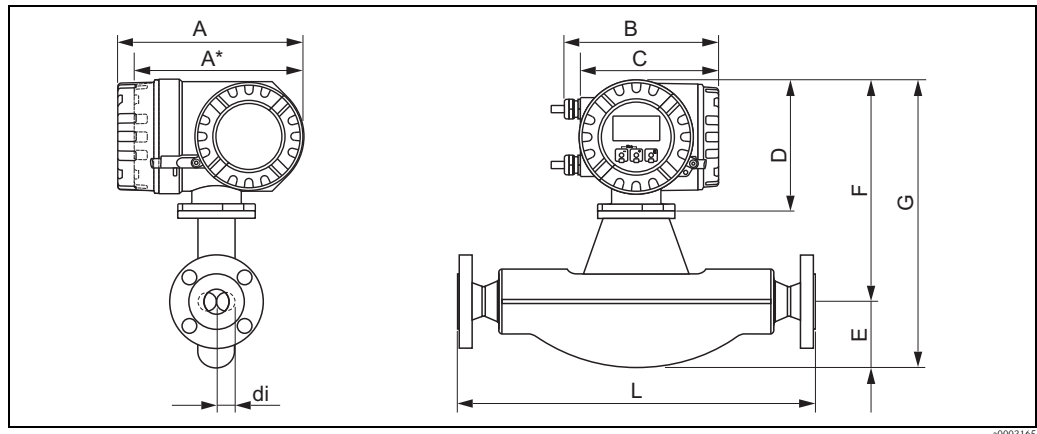
- 1 Promass M
- 2 Promass M (high-pressure version)

Mechanical construction

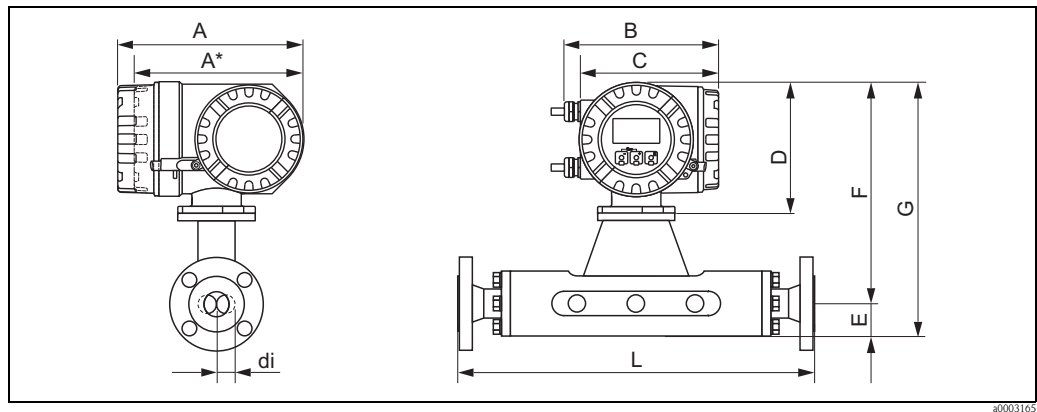
Design, dimensions

Dimensions:	
Field housing compact version, powder-coated die-cast aluminum	→ Page 26
Transmitter compact version, Stainless Steel field housing	→ Page 27
Transmitter connection housing remote version (II2G/Zone 1)	→ Page 27
Transmitter wall-mount housing (non Ex-zone and II3G/Zone 2)	→ Page 28
Connection housing remote version	→ Page 29
Connection housing remote version for heating	→ Page 29
Process connections Promass F	→ Page 31 ff.
Promass F: Flange connections EN (DIN), ASME B16.5, JIS	→ Page 31
Promass F: Tri-Clamp	→ Page 37
Promass F: DIN 11851 (threaded hygienic connection)	→ Page 38
Promass F: DIN 11864-1 Form A (threaded hygienic connection)	→ Page 39
Promass F: DIN 11864-2 Form A (flat flange with groove)	→ Page 40
Promass F: ISO 2853 (threaded hygienic connection)	→ Page 41
Promass F: SMS 1145 (threaded hygienic connection)	→ Page 42
Promass F: VCO	→ Page 43
Process connections Promass M	→ Page 44 ff.
Promass M: Flange connections EN (DIN), ASME B16.5, JIS	→ Page 44
Promass M: Tri-Clamp	→ Page 48
Promass M: DIN 11851 (threaded hygienic connection)	→ Page 49
Promass M: DIN 11864-1 Form A (threaded hygienic connection)	→ Page 49
Promass M: DIN 11864-2 Form A (flat flange with groove)	→ Page 50
Promass M: ISO 2853 (threaded hygienic connection)	→ Page 51
Promass M: SMS 1145 (threaded hygienic connection)	→ Page 51
Process connections Promass M (high pressure)	→ Page 52 ff.
Promass M (high pressure): 1/2"-NPT, 3/8"-NPT and G 3/8"	→ Page 52
Promass M (high pressure): 1/2"-SWAGelok	→ Page 53
Promass M (high pressure): Connector with internal thread 7/8-14 UNF	→ Page 53
Promass M without process connections	→ Page 54
Purge connections / secondary containment monitoring	→ Page 55
Rupture disk	→ Page 56

Field housing compact version, powder-coated die-cast aluminum



Promass F



Promass M

A	A*	B	C	D
227	207	187	168	160

All dimensions in [mm];

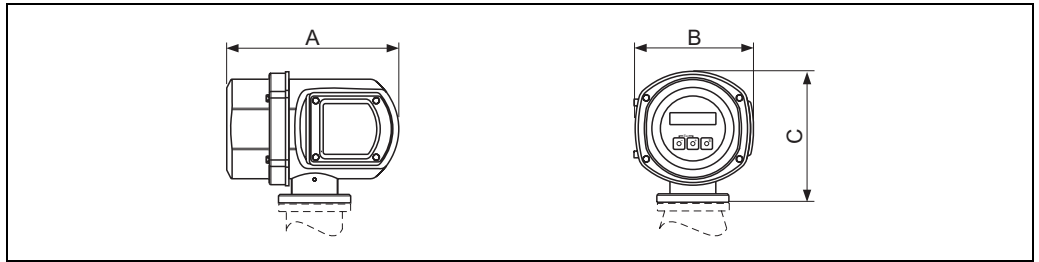
* Blind version (without local display)

Promass F						Promass M					
DN	E	F	G	L	di	DN	E	F	G	L	di
8	75	266	341	1)	1)	8	35	266	301	1)	1)
15	75	266	341	1)	1)	15	37	268	305	1)	1)
25	75	266	341	1)	1)	25	40	272	312	1)	1)
40	105	271	376	1)	1)	40	49	283	332	1)	1)
50	141	283	424	1)	1)	50	58	293	351	1)	1)
80	200	305	505	1)	1)	80	76	309	385	1)	1)
100	247	324	571	1)	1)	All dimensions in [mm]; * dependent on respective process connection → For dimensions, see the following pages					
150	378	362	740	1)	1)						
250	548	390	938	1)	1)						



Note!
Dimensions for transmitters II2G/Zone 1 → Page 27.

Transmitter compact version, Stainless Steel field housing

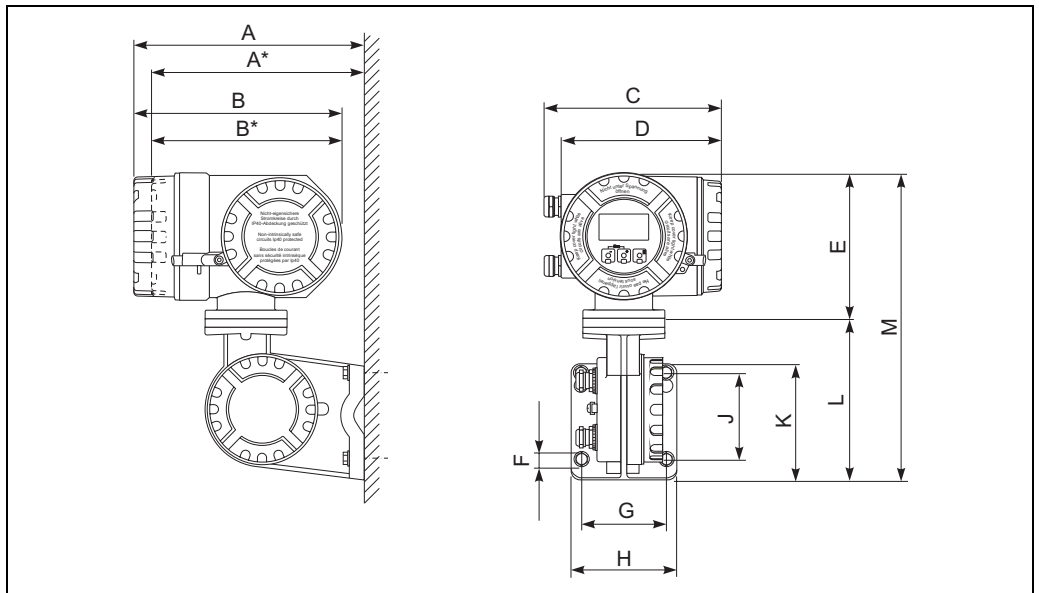


a0002245

A	B	C
225	153	168

All dimensions in [mm]

Transmitter connection housing remote version (II2G/Zone 1)



a0002128

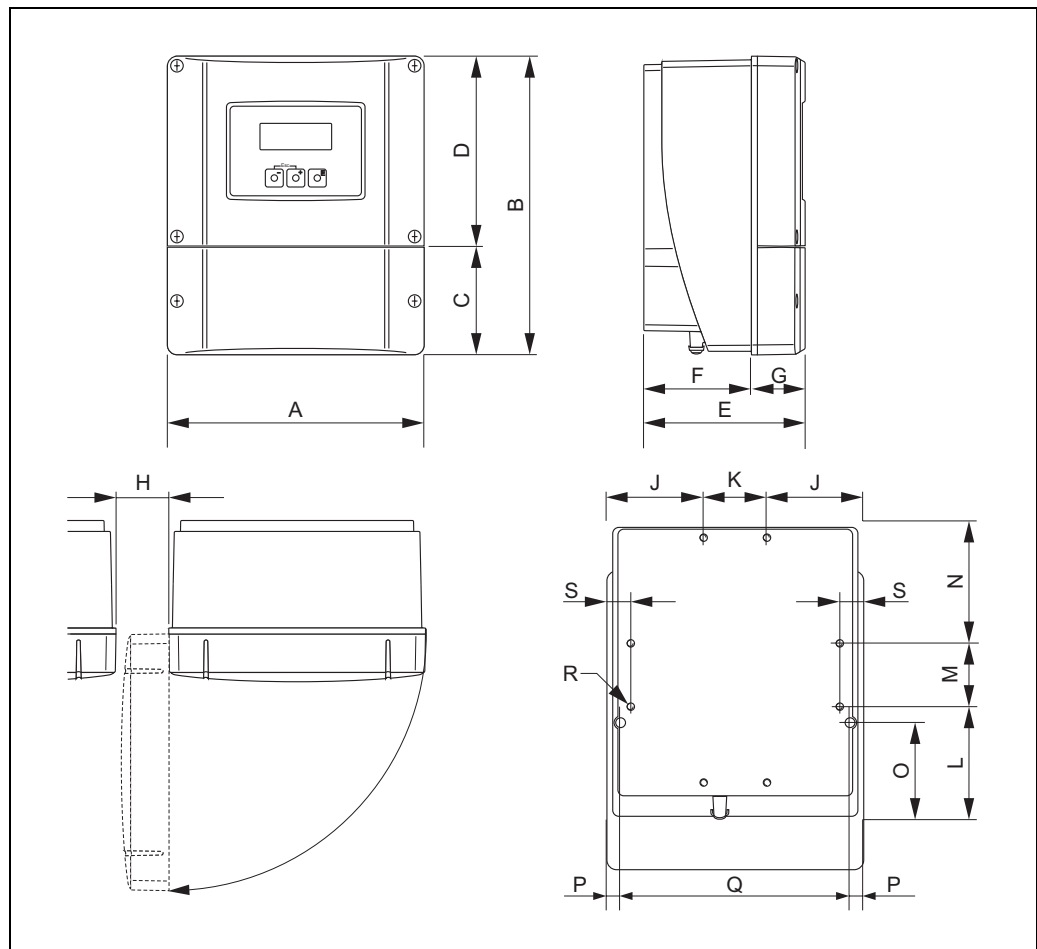
A	A*	B	B*	C	D	E
265	242	240	217	206	186	167

* Blind version (without local display)

F	G	H	J	K	L	M
∅ 8.6 (M8)	100	123	100	133	188	355

All dimensions in [mm]

Transmitter wall-mount housing (non Ex-zone and II3G/Zone 2)

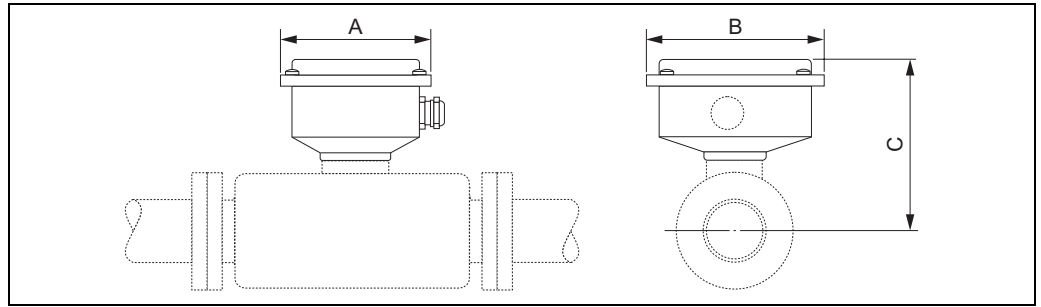


a0001150

A	B	C	D	E	F	G	H	J
215	250	90.5	159.5	135	90	45	>50	81
K	L	M	N	O	P	Q	R	S
53	95	53	102	81.5	11.5	192	8 × M5	20

All dimensions in [mm]

Connection housing remote version



a0002516

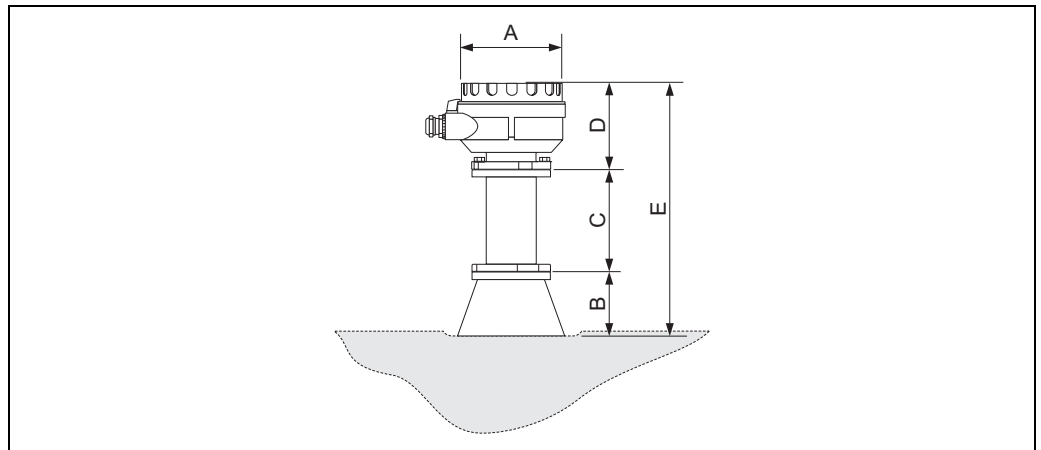
Promass F				Promass M			
DN	A	B	C	DN	A	B	C
8	118.5	137.5	113	8	118.5	137.5	113
15	118.5	137.5	113	15	118.5	137.5	115
25	118.5	137.5	113	25	118.5	137.5	119
40	118.5	137.5	118	40	118.5	137.5	130
50	118.5	137.5	130	50	118.5	137.5	140
80	118.5	137.5	152	80	118.5	137.5	156
100	118.5	137.5	171	All dimensions in [mm]			
150	118.5	137.5	209				
250	118.5	137.5	237				

Connection housing remote version for heating



Note!

Use this version in case of insulation or application of heating jacket.

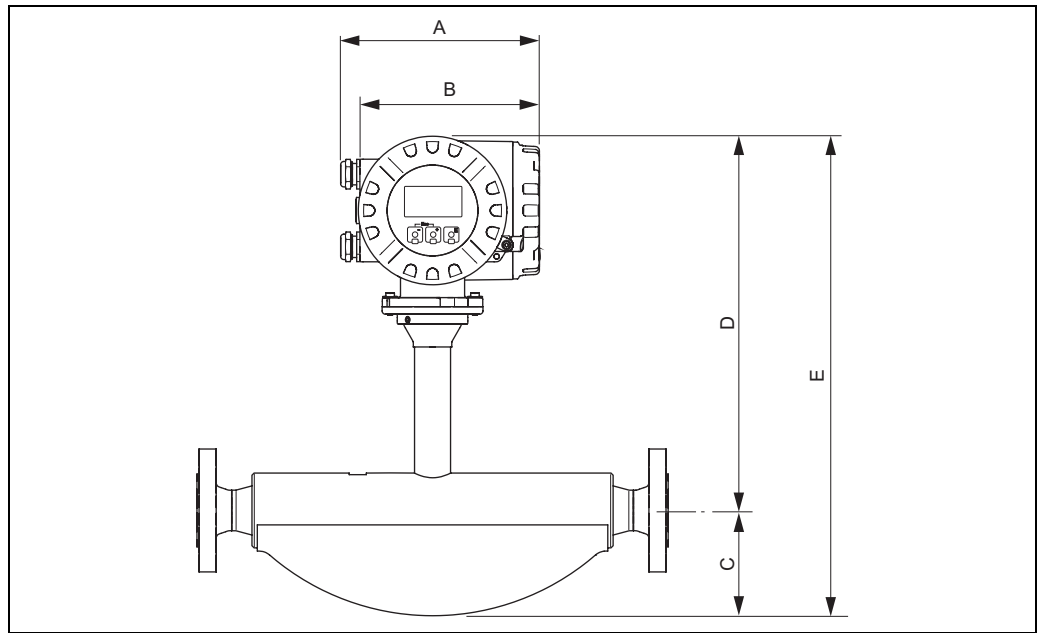


a0002517

A	B	C	D	E
129	80	110	102	292

All dimensions in [mm]

Dimensions: High-temperature version (compact)

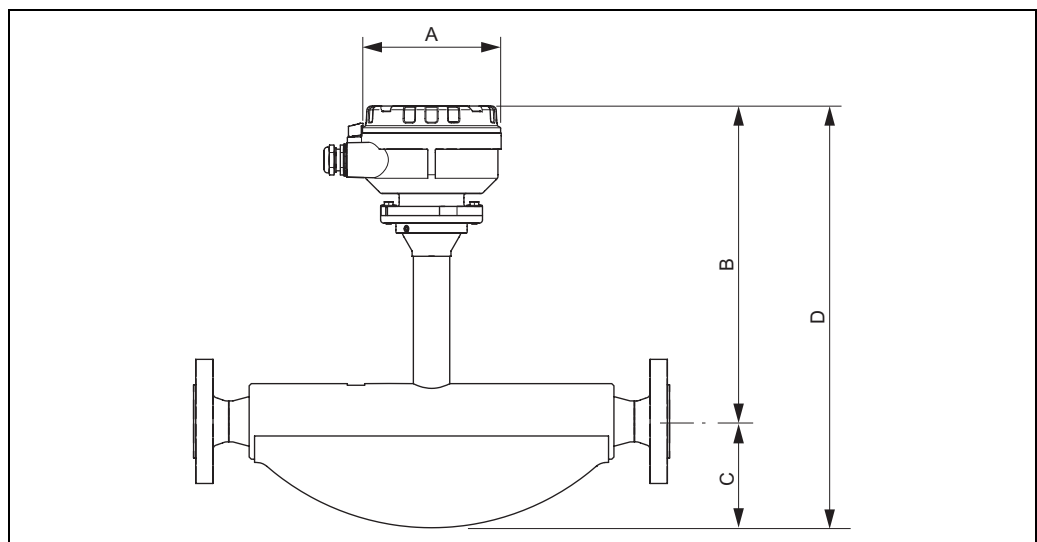


a0002518

DN	A	B	C	D	E
25	187	168	100	350	455
50	187	168	141	365	506
80	187	168	200	385	585

All dimensions in [mm]

Dimensions: High-temperature version (remote)

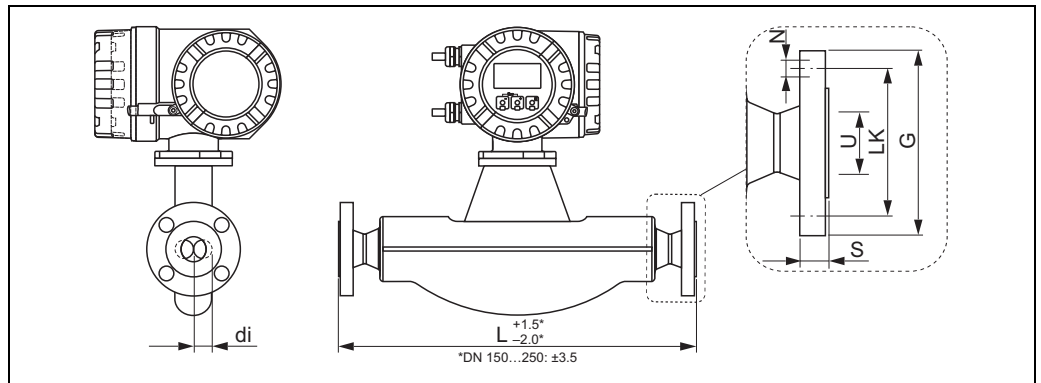


a0002519

DN	A	C	D	E
25	129	105	292	397
50	129	141	307	448
80	129	200	327	527

All dimensions in [mm]

Promass F: Flange connections EN (DIN), ASME B16.5, JIS



a0002501-en

Flange according to EN 1092-1 (DIN 2501 / DIN 2512N ¹⁾) / PN 16: 1.4404/316L

Surface roughness (flange): EN 1092-1 Form B1 (DIN 2526 Form C), Ra 3.2 to 12.5 µm

DN	G	L	N	S	LK	U	di
100	220	1128	8 × Ø18	20	180	107.1	51.20
150	285	1330	8 × Ø22	22	240	159.3	68.90
250 ²⁾	405	1780	12 × Ø26	26	355	260.4	102.26

¹⁾ Flange with groove according to EN 1092-1 Form D (DIN 2512N) available

²⁾ Not available in Alloy

All dimensions in [mm]

Flange according to EN 1092-1 (DIN 2501 / DIN 2512N ¹⁾) / PN 40: 1.4404/316L, Alloy C-22

Surface roughness (flange): EN 1092-1 Form B1 (DIN 2526 Form C), Ra 3.2 to 12.5 µm

DN	G	L	N	S	LK	U	di
8	95	370	4 × Ø14	16	65	17.3	5.35
15	95	404	4 × Ø14	16	65	17.3	8.30
25	115	440	4 × Ø14	18	85	28.5	12.00
40	150	550	4 × Ø18	18	110	43.1	17.60
50	165	715	4 × Ø18	20	125	54.5	26.00
80	200	840	8 × Ø18	24	160	82.5	40.50
100	235	1128	8 × Ø22	24	190	107.1	51.20
150	300	1370	8 × Ø26	28	250	159.3	68.90
250 ²⁾	450	1850	12 × Ø33	38	385	258.8	102.26

¹⁾ Flange with groove according to EN 1092-1 Form D (DIN 2512N) available

²⁾ Not available in Alloy

All dimensions in [mm]

Flange according to EN 1092-1 (DIN 2501) / PN 40 (mit DN 25-Flanges): 1.4404/316L

Surface roughness (flange): EN 1092-1 Form B1 (DIN 2526 Form C), Ra 3.2 to 12.5 µm

DN	G	L	N	S	LK	U	di
8	115	440	4 × Ø14	18	85	28.5	5.35
15	115	440	4 × Ø14	18	85	28.5	8.30

All dimensions in [mm]

Flange according to EN 1092-1 (DIN 2501 / DIN 2512N) extension-reduction / PN 16: 1.4404/316L							
Only for nominal diameter DN 250 (on request)							
Surface roughness (flange): Ra 0.8 to 3.2 µm							
DN	G	L	N	S	LK	U	di
150	285	1980	8 × Ø22	22	240	159.3	102.26
200	340	1940	12 × Ø22	24	295	207.3	102.26
300	460	1940	12 × Ø26	28	410	309.7	102.26
All dimensions in [mm]							

Flange according to EN 1092-1 (DIN 2501 / DIN 2512N) extension-reduction / PN 40: 1.4404/316L							
Only for nominal diameter DN 250 (on request)							
Surface roughness (flange): Ra 0.8 to 3.2 µm							
DN	G	L	N	S	LK	U	di
150	300	1980	8 × Ø26	28	250	159.3	102.26
200	375	1940	12 × Ø30	34	320	206.5	102.26
300	515	1940	16 × Ø33	42	450	307.9	102.26
All dimensions in [mm]							

Flange according to EN 1092-1 (DIN 2501 / DIN 2512N ¹⁾) / PN 63: 1.4404/316L, Alloy C-22							
Surface roughness (flange): EN 1092-1 Form B2 (DIN 2526 Form E), Ra 0.8 to 3.2 µm							
DN	G	L	N	S	LK	U	di
50	180	724	4 × Ø22	26	135	54.5	26.00
80	215	875	8 × Ø22	28	170	81.7	40.50
100	250	1128	8 × Ø26	30	200	106.3	51.20
150	345	1410	8 × Ø33	36	280	157.1	68.90
250 ²⁾	470	1890	12 × Ø36	46	400	255.4	102.26
¹⁾ Flange with groove according to EN 1092-1 Form D (DIN 2512N) available							
²⁾ Not available in Alloy							
All dimensions in [mm]							

Flange according to EN 1092-1 (DIN 2501 / DIN 2512N ¹⁾) / PN 100: 1.4404/316L, Alloy C-22							
Surface roughness (flange): EN 1092-1 Form B2 (DIN 2526 Form E), Ra 0.8 to 3.2 µm							
DN	G	L	N	S	LK	U	di
8	105	400	4 × Ø14	20	75	17.3	5.35
15	105	420	4 × Ø14	20	75	17.3	8.30
25	140	470	4 × Ø18	24	100	28.5	12.00
40	170	590	4 × Ø22	26	125	42.5	17.60
50	195	740	4 × Ø26	28	145	53.9	26.00
80	230	885	8 × Ø26	32	180	80.9	40.50
100	265	1128	8 × Ø30	36	210	104.3	51.20
150	355	1450	12 × Ø33	44	290	154.0	68.90
¹⁾ Flange with groove according to EN 1092-1 Form D (DIN 2512N) available							
All dimensions in [mm]							

Flange according to ASME B16.5 / CI 150: 1.4404/316L, Alloy C-22								
Surface roughness (flange): Ra 3.2 to 6.3 µm								
DN		G	L	N	S	LK	U	di
8	3/8"	88.9	370	4 × Ø15.7	11.2	60.5	15.7	5.35
15	½"	88.9	404	4 × Ø15.7	11.2	60.5	15.7	8.30
25	1"	108.0	440	4 × Ø15.7	14.2	79.2	26.7	12.00
40	1½"	127.0	550	4 × Ø15.7	17.5	98.6	40.9	17.60
50	2"	152.4	715	4 × Ø19.1	19.1	120.7	52.6	26.00
80	3"	190.5	840	4 × Ø19.1	23.9	152.4	78.0	40.50
100	4"	228.6	1128	8 × Ø19.1	23.9	190.5	102.4	51.20
150	6"	279.4	1398	8 × Ø22.4	25.4	241.3	154.2	68.90
250 ¹⁾	10"	406.4	1836.8	12 × Ø25.4	30.2	362	254.5	102.26
¹⁾ Not available in Alloy All dimensions in [mm]								

Flange according to ASME B16.5 / CI 300: 1.4404/316L, Alloy C-22								
Surface roughness (flange): Ra 3.2 to 6.3 µm								
DN		G	L	N	S	LK	U	di
8	3/8"	95.2	370	4 × Ø15.7	14.2	66.5	15.7	5.35
15	½"	95.2	404	4 × Ø15.7	14.2	66.5	15.7	8.30
25	1"	123.9	440	4 × Ø19	17.5	88.9	26.7	12.00
40	1½"	155.4	550	4 × Ø22.3	20.6	114.3	40.9	17.60
50	2"	165.1	715	8 × Ø19	22.3	127.0	52.6	26.00
80	3"	209.5	840	8 × Ø22.3	28.4	168.1	78.0	40.50
100	4"	254.0	1128	8 × Ø22.3	31.7	200.1	102.4	51.20
150	6"	317.5	1417	12 × Ø22.3	36.5	269.7	154.2	68.90
250 ¹⁾	10"	444.5	1868.2	16 × Ø28.4	47.4	387.3	254.5	102.26
¹⁾ Not available in Alloy All dimensions in [mm]								

Flange according to ASME B16.5 / CI 600: 1.4404/316L, Alloy C-22								
Surface roughness (flange): Ra 3.2 to 6.3 µm								
DN		G	L	N	S	LK	U	di
8	3/8"	95.3	400	4 × Ø15.7	20.6	66.5	13.9	5.35
15	½"	95.3	420	4 × Ø15.7	20.6	66.5	13.9	8.30
25	1"	124.0	490	4 × Ø19.1	23.9	88.9	24.3	12.00
40	1½"	155.4	600	4 × Ø22.4	28.7	114.3	38.1	17.60
50	2"	165.1	742	8 × Ø19.1	31.8	127.0	49.2	26.00
80	3"	209.6	900	8 × Ø22.4	38.2	168.1	73.7	40.50
100	4"	273.1	1158	8 × Ø25.4	48.4	215.9	97.3	51.20
150	6"	355.6	1467	12 × Ø28.4	47.8	292.1	154.2	68.90
250 ¹⁾	10"	508.0	1951.2	16 × Ø35.1	69.9	431.8	254.5	102.26
¹⁾ Not available in Alloy All dimensions in [mm]								

Flange according to ASME B16.5 extension-reduction / CI 150: 1.4404/316L								
Only for nominal diameter DN 250 /10" (on request)								
Surface roughness (flange): Ra 3.2 to 6.3 µm								
DN		G	L	N	S	LK	U	di
150	6"	279.4	1980	8 × Ø22.4	25.4	241.3	154.2	102.26
200	8"	342.9	1940	8 × Ø22.4	28.4	298.5	202.7	102.26
300	12"	482.6	1940	12 × Ø25.4	31.8	431.8	304.80	102.26
All dimensions in [mm]								

Flange according to ASME B16.5 extension-reduction / CI 300: 1.4404/316								
Only for nominal diameter DN 250 /10" (on request)								
Surface roughness (flange): Ra 3.2 to 6.3 µm								
DN		G	L	N	S	LK	U	di
150	6"	317.5	1980	12 × Ø22.4	36.5	269.7	154.2	102.26
200	8"	381.0	1940	12 × Ø25.4	41.1	330.2	202.7	102.26
300	12"	520.7	1940	16 × Ø31.7	50.8	450.8	304.80	102.26
All dimensions in [mm]								

Flange according to ASME B16.5 extension-reduction / CI 600: 1.4404/316L								
Only for nominal diameter DN 250 /10" (on request)								
Surface roughness (flange): Ra 3.2 to 6.3 µm								
DN		G	L	N	S	LK	U	di
150	6"	355.6	1980	12 × Ø28.4	54.2	292.1	154.2	102.26
200	8"	419.1	1940	12 × Ø31.8	62.0	349.3	202.7	102.26
All dimensions in [mm]								

Flange JIS B2220 / 10K: 1.4404/316L, Alloy C-22								
Surface roughness (flange): Ra 3.2 to 6.3 µm								
DN	G	L	N	S	LK	U	di	
50	155	715	4 × Ø19	16	120	50	26.00	
80	185	832	8 × Ø19	18	150	80	40.50	
100	210	1128	8 × Ø19	18	175	100	51.20	
150	280	1354	8 × Ø23	22	240	150	68.90	
250 ¹⁾	400	1780	12 × Ø25	24	355	250	102.26	
¹⁾ Not available in Alloy								
All dimensions in [mm]								

Flange JIS B2220 / 20K: 1.4404/316L, Alloy C-22							
Surface roughness (flange): Ra 1.6 to 3.2 µm							
DN	G	L	N	S	LK	U	di
8	95	370	4 × Ø15	14	70	15	5.35
15	95	404	4 × Ø15	14	70	15	8.30
25	125	440	4 × Ø19	16	90	25	12.00
40	140	550	4 × Ø19	18	105	40	17.60
50	155	715	8 × Ø19	18	120	50	26.00
80	200	832	8 × Ø23	22	160	80	40.50
100	225	1128	8 × Ø23	24	185	100	51.20
150	305	1386	12 × Ø25	28	260	150	68.90
250 ¹⁾	430	1850	12 × Ø27	34	380	250	102.26

¹⁾ Not available in Alloy
All dimensions in [mm]

Flange JIS B2220 / 40K: 1.4404/316L, Alloy C-22							
Surface roughness (flange): Ra 1.6 to 3.2 µm							
DN	G	L	N	S	LK	U	di
8	115	400	4 × Ø19	20	80	15	5.35
15	115	425	4 × Ø19	20	80	15	8.30
25	130	485	4 × Ø19	22	95	25	12.00
40	160	600	4 × Ø23	24	120	38	17.60
50	165	760	8 × Ø19	26	130	50	26.00
80	210	890	8 × Ø23	32	170	75	40.50
100	250	1168	8 × Ø25	36	205	100	51.20
150	355	1498	12 × Ø33	44	295	150	68.90

All dimensions in [mm]

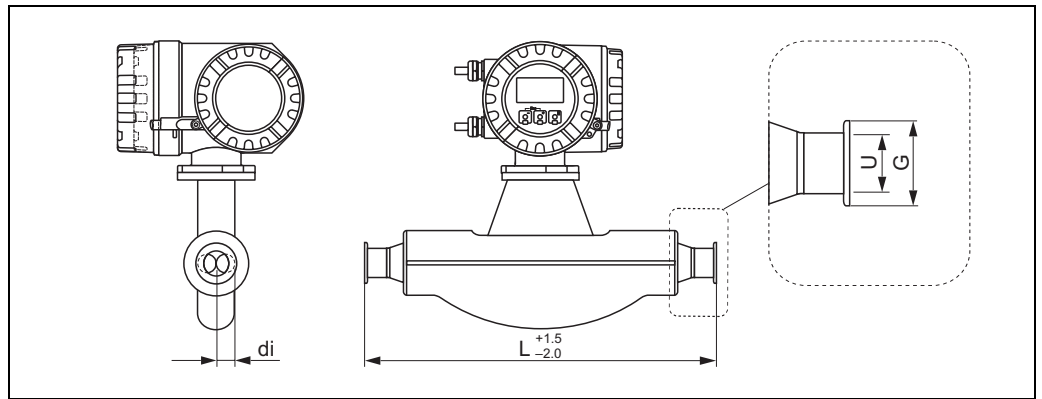
Flange JIS B2220 / 63K: 1.4404/316L, Alloy C-22							
Surface roughness (flange): Ra 1.6 to 3.2 µm							
DN	G	L	N	S	LK	U	di
8	120	420	4 × Ø19	23	85	12	5.35
15	120	440	4 × Ø19	23	85	12	8.30
25	140	494	4 × Ø23	27	100	22	12.00
40	175	620	4 × Ø25	32	130	35	17.60
50	185	775	8 × Ø23	34	145	48	26.00
80	230	915	8 × Ø25	40	185	73	40.50
100	270	1168	8 × Ø27	44	220	98	51.20
150	365	1528	12 × Ø33	54	305	146	68.90

All dimensions in [mm]

Flange JIS B2220 extension-reduction / 10K: 1.4404/316L							
Only for nominal diameter DN 250 (on request)							
Surface roughness (flange): Ra 1.6 to 3.2 µm							
DN	G	L	N	S	LK	U	di
150	280	1980	8 × Ø23	22	240	150	102.26
200	330	1940	12 × Ø23	22	290	200	102.26
300	445	1940	16 × Ø25	24	400	300	102.26
All dimensions in [mm]							

Flange JIS B2220 extension-reduction / 20K: 1.4404/316L							
Only for nominal diameter DN 250 (on request)							
Surface roughness (flange): Ra 1.6 to 3.2 µm							
DN	G	L	N	S	LK	U	di
150	305	1980	12 × Ø25	28	260	150	102.26
200	350	1940	12 × Ø25	30	305	200	102.26
300	480	1940	16 × Ø27	36	430	300	102.26
All dimensions in [mm]							

Promass F: Tri-Clamp



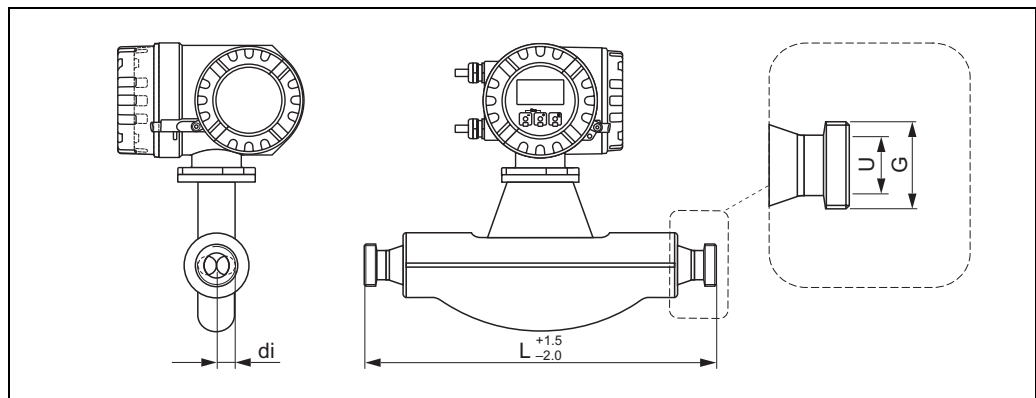
a0002515-en

Tri-Clamp: 1.4404/316L					
DN	Clamp	G	L	U	di
8	1"	50.4	367	22.1	5.35
15	1"	50.4	398	22.1	8.30
25	1"	50.4	434	22.1	12.00
40	1½"	50.4	560	34.8	17.60
50	2"	63.9	720	47.5	26.00
80	3"	90.9	900	72.9	40.50
100	4"	118.9	1128	97.4	51.20

3A version also available (Ra ≤ 0.8 µm/150 grit. Option: Ra ≤ 0.4 µm/240 grit)
All dimensions in [mm]

½"-Tri-Clamp: 1.4404/316L					
DN	Clamp	G	L	U	di
8	½"	25.0	367	9.5	5.35
15	½"	25.0	398	9.5	8.30

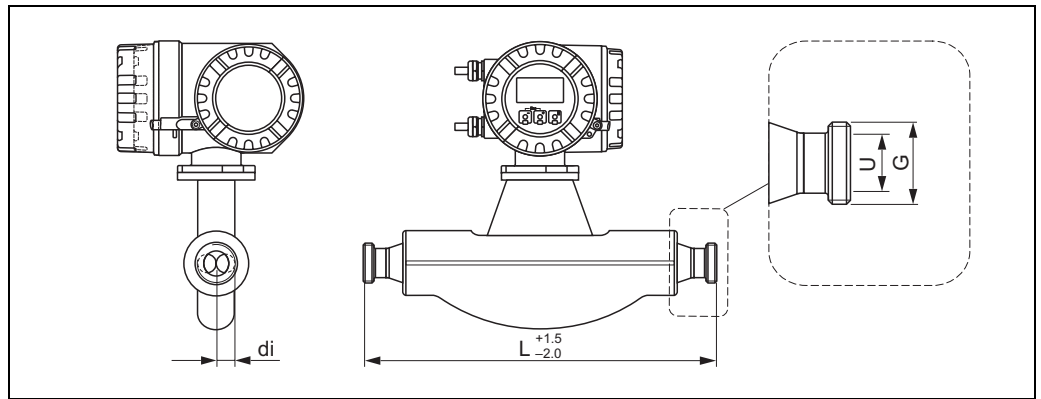
3A version also available (Ra ≤ 0.8 µm/150 grit. Option: Ra ≤ 0.4 µm/240 grit)
All dimensions in [mm]

Promass F: DIN 11851 (threaded hygienic connection)

Threaded hygienic connection DIN 11851: 1.4404/316L				
DN	G	L	U	di
8	Rd 34 × 1/8"	367	16	5.35
15	Rd 34 × 1/8"	398	16	8.30
25	Rd 52 × 1/6"	434	26	12.00
40	Rd 65 × 1/6"	560	38	17.60
50	Rd 78 × 1/6"	720	50	26.00
80	Rd 110 × 1/4"	900	81	40.50
100	Rd 130 × 1/4"	1128	100	51.20

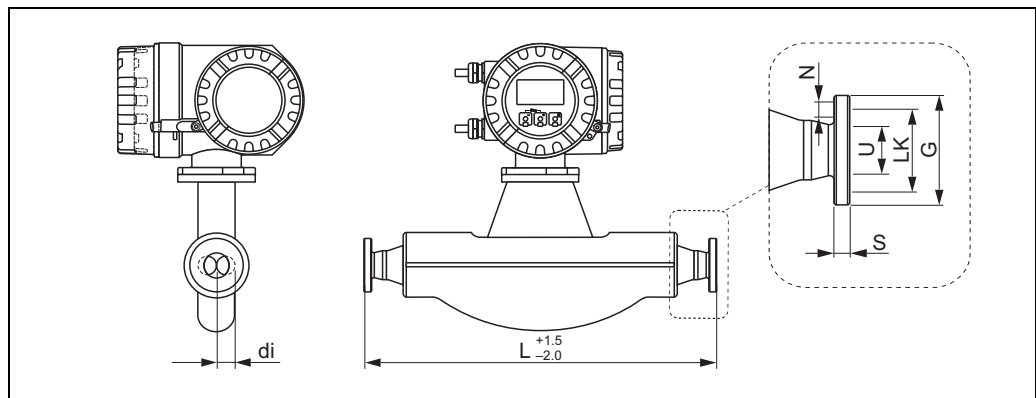
3A version also available (Ra ≤ 0.8 µm/150 grit.)
All dimensions in [mm]

Promass F: DIN 11864-1 Form A (threaded hygienic connection)



Threaded hygienic connection DIN 11864-1 Form A: 1.4404/316L				
DN	G	L	U	di
8	Rd 28 × 1/8"	367	10	5.35
15	Rd 34 × 1/8"	398	16	8.30
25	Rd 52 × 1/6"	434	26	12.00
40	Rd 65 × 1/6"	560	38	17.60
50	Rd 78 × 1/6"	720	50	26.00
80	Rd 110 × 1/4"	900	81	40.50
100	Rd 130 × 1/4"	1128	100	51.20

3A version also available (Ra ≤ 0.8 μm/150 grit.)
All dimensions in [mm]

Promass F: DIN 11864-2 Form A (flat flange with groove)

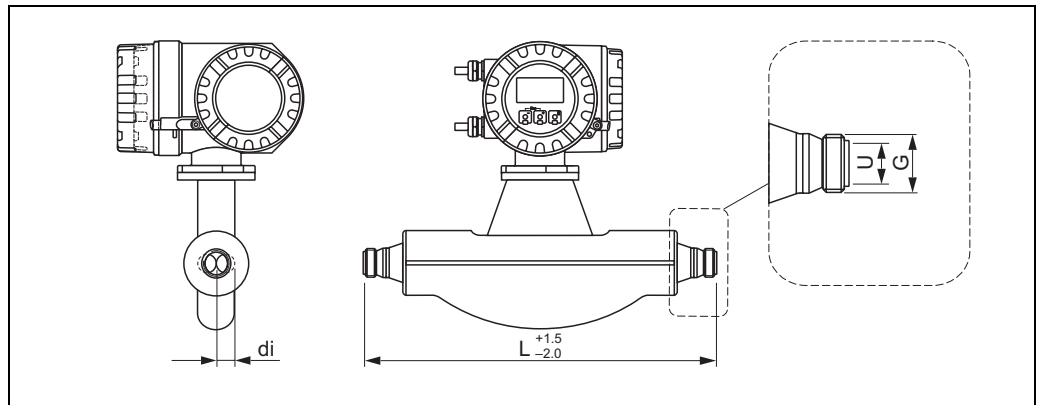
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DIN 11864-2 Form A (flat flange with groove): 1.4404/316L

DN	G	L	N	S	LK	U	di
8	54	387	4 × Ø9	10	37	10	5.35
15	59	418	4 × Ø9	10	42	16	8.30
25	70	454	4 × Ø9	10	53	26	12.00
40	82	560	4 × Ø9	10	65	38	17.60
50	94	720	4 × Ø9	10	77	50	26.00
80	133	900	8 × Ø11	12	112	81	40.50
100	159	1128	8 × Ø11	14	137	100	51.20

3A version also available ($Ra \leq 0.8 \mu\text{m}/150$ grit. Option: $Ra \leq 0.4 \mu\text{m}/240$ grit)
 All dimensions in [mm]

Promass F: ISO 2853 (threaded hygienic connection)

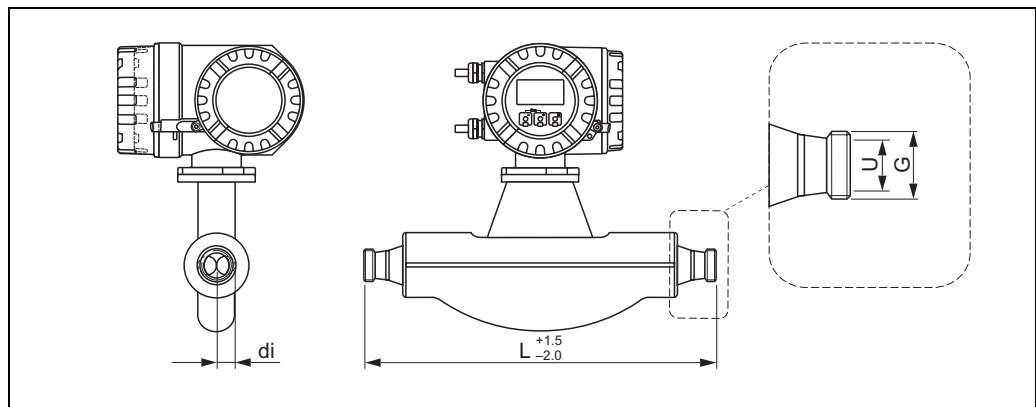


a0002523-en

Threaded hygienic connection ISO 2853: 1.4404/316L				
DN	G ¹⁾	L	N	di
8	37.13	367	22.6	5.35
15	37.13	398	22.6	8.30
25	37.13	434	22.6	12.00
40	52.68	560	35.6	17.60
50	64.16	720	48.6	26.00
80	91.19	900	72.9	40.50
100	118.21	1128	97.6	51.20

¹⁾ Max. thread diameter to ISO 2853 Annex A
 3A version also available (Ra ≤ 0.8 µm/150 grit. Option: Ra ≤ 0.4 µm/240 grit)
 All dimensions in [mm]

Promass F: SMS 1145 (threaded hygienic connection)

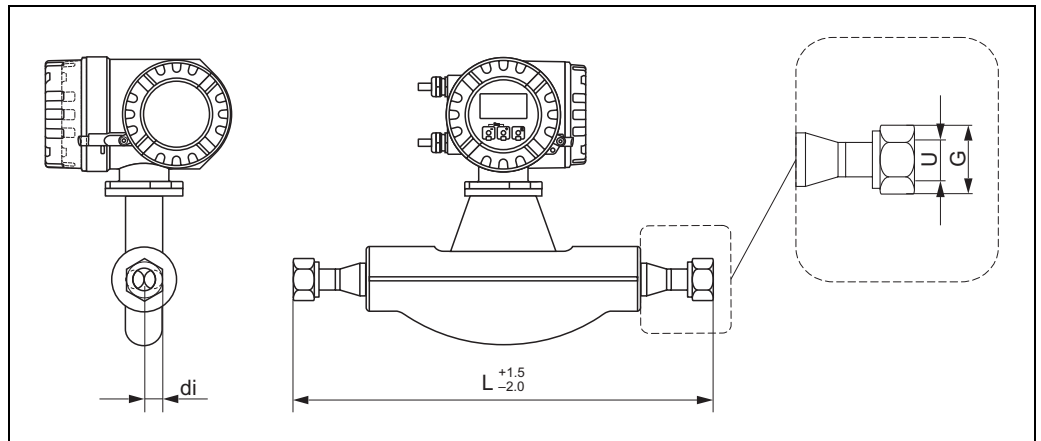


a0002524-en

Threaded hygienic connection SMS 1145: 1.4404/316L				
DN	G	L	U	di
8	Rd 40 × 1/6"	367	22.6	5.35
15	Rd 40 × 1/6"	398	22.6	8.30
25	Rd 40 × 1/6"	434	22.6	12.00
40	Rd 60 × 1/6"	560	35.6	17.60
50	Rd 70 × 1/6"	720	48.6	26.00
80	Rd 98 × 1/6"	900	72.9	40.50
100	Rd 132 × 1/6"	1128	97.6	51.20

3A version also available (Ra ≤ 0.8 μm/150 grit. Option: Ra ≤ 0.4 μm/240 grit)
 All dimensions in [mm]

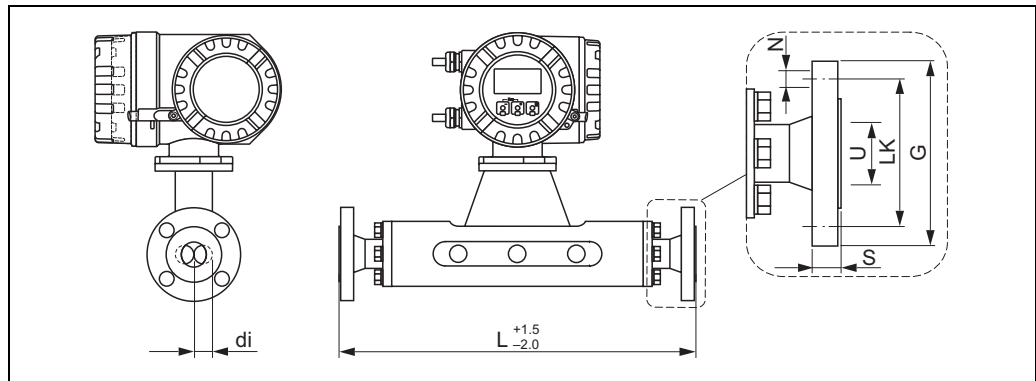
Promass F: VCO



8-VCO-4 (1/2"): 1.4404/316L				
DN	G	L	U	di
8	AF 1"	390	10.2	5.35
All dimensions in [mm]				

12-VCO-4 (3/4"): 1.4404/316L				
DN	G	L ¹⁾	U	di
15	AF 1 1/2"	430	15.7	8.30
All dimensions in [mm]				

Promass M: Flange connections EN (DIN), ASME B16.5, JIS



a0002525-en

Flange according to EN 1092-1 (DIN 2501) / PN 16: PVDF							
DN	G	L	N	S	LK	U	di
8	95	370	4 × Ø14	16	65	16.1	5.53
15	95	404	4 × Ø14	16	65	16.1	8.55
25	115	440	4 × Ø14	18	85	28.5	11.38
40	150	550	4 × Ø18	18	110	43.1	17.07
50	165	715	4 × Ø18	20	125	54.5	25.60

All dimensions in [mm]

Flange according to EN 1092-1 (DIN 2501 / DIN 2512N ¹⁾) / PN 40: 1.4404/316L, Titan							
Surface roughness (flange): EN 1092-1 Form B1 (DIN 2526 Form C), Ra 3.2 to 12.5 µm							
DN	G	L	N	S	LK	U	di
8	95	370	4 × Ø14	16	65	17.3	5.53
15	95	404	4 × Ø14	16	65	17.3	8.55
25	115	440	4 × Ø14	18	85	28.5	11.38
40	150	550	4 × Ø18	18	110	43.1	17.07
50	165	715	4 × Ø18	20	125	54.5	25.60
80	200	840	8 × Ø18	24	160	82.5	38.46

¹⁾ Flange with groove according to EN 1092-1 Form D (DIN 2512N) available
All dimensions in [mm]

Flange according to EN 1092-1 (DIN 2501) / PN 40 (mit DN 25-Flanschen): 1.4404/316L							
Surface roughness (flange): EN 1092-1 Form B1 (DIN 2526 Form C), Ra 3.2 to 12.5 µm							
DN	G	L	N	S	LK	U	di
8	115	440	4 × Ø14	18	85	28.5	5.53
15	115	440	4 × Ø14	18	85	28.5	8.55

All dimensions in [mm]

Flange according to EN 1092-1 (DIN 2501 / DIN 2512N¹⁾) / PN 63: 1.4404/316L, Titan							
Surface roughness (flange): EN 1092-1 Form B2 (DIN 2526 Form E), Ra 0.8 to 3.2 µm							
DN	G	L	N	S	LK	U	di
50	180	724	4 × Ø22	26	135	54.5	25.60
80	215	875	8 × Ø22	28	170	81.7	38.46

¹⁾ Flange with groove according to EN 1092-1 Form D (DIN 2512N) available
All dimensions in [mm]

Flange according to EN 1092-1 (DIN 2501 / DIN 2512N¹⁾) / PN 100: 1.4404/316L, Titan							
Surface roughness (flange): EN 1092-1 Form B2 (DIN 2526 Form E), Ra 0.8 to 3.2 µm							
DN	G	L	N	S	LK	U	di
8	95	400	4 × Ø14	20	65	17.3	5.53
15	95	420	4 × Ø14	20	65	17.3	8.55
25	115	470	4 × Ø14	24	85	28.5	11.38
40	150	590	4 × Ø18	26	110	43.1	17.07
50	165	740	4 × Ø18	28	125	54.5	25.60
80	230	885	8 × Ø26	32	180	80.9	38.46

¹⁾ Flange with groove according to EN 1092-1 Form D (DIN 2512N) available
All dimensions in [mm]

Flange according to ASME B16.5 / CI 150: 1.4404/316L, Titan								
Surface roughness (flange): Ra 3.2 to 6.3 µm								
DN	G	L	N	S	LK	U	di	
8	3/8"	88.9	370	4 × Ø15.7	11.2	60.5	15.7	5.53
15	1/2"	88.9	404	4 × Ø15.7	11.2	60.5	15.7	8.55
25	1"	108.0	440	4 × Ø15.7	14.2	79.2	26.7	11.38
40	1 1/2"	127.0	550	4 × Ø15.7	17.5	98.6	40.9	17.07
50	2"	152.4	715	4 × Ø19.1	19.1	120.7	52.6	25.60
80	3"	190.5	840	4 × Ø19.1	23.9	152.4	78.0	38.46

All dimensions in [mm]

Flange according to ASME B16.5 / CI 150: PVDF								
DN	G	L	N	S	LK	U	di	
8	3/8"	88.9	370	4 × Ø15.7	16	60.5	15.7	5.53
15	1/2"	88.9	404	4 × Ø15.7	16	60.5	15.7	8.55
25	1"	108.0	440	4 × Ø15.7	18	79.2	26.7	11.38
40	1 1/2"	127.0	550	4 × Ø15.7	21	98.6	40.9	17.07
50	2"	152.4	715	4 × Ø19.1	28	120.7	52.6	25.60

All dimensions in [mm]

Flange according to ASME B16.5 / Cl 300: 1.4404/316L, Titan								
Surface roughness (flange): Ra 3.2 to 6.3 μm								
DN		G	L	N	S	LK	U	di
8	3/8"	95.2	370	4 × Ø15.7	14.2	66.5	15.7	5.53
15	1/2"	95.2	404	4 × Ø15.7	14.2	66.5	15.7	8.55
25	1"	123.9	440	4 × Ø19.0	17.5	88.9	26.7	11.38
40	1 1/2"	155.4	550	4 × Ø22.3	20.6	114.3	40.9	17.07
50	2"	165.1	715	8 × Ø19.0	22.3	127.0	52.6	25.60
80	3"	209.5	840	8 × Ø22.3	28.4	168.1	78.0	38.46
All dimensions in [mm]								

Flange according to ASME B16.5 / Cl 600: 1.4404/316L, Titan								
Surface roughness (flange): Ra 3.2 to 6.3 μm								
DN		G	L	N	S	LK	U	di
8	3/8"	95.3	400	4 × Ø15.7	20.6	66.5	13.8	5.53
15	1/2"	95.3	420	4 × Ø15.7	20.6	66.5	13.8	8.55
25	1"	124.0	490	4 × Ø19.1	23.6	88.9	24.4	11.38
40	1 1/2"	155.4	600	4 × Ø22.4	28.7	114.3	38.1	17.07
50	2"	165.1	742	8 × Ø19.1	31.8	127.0	49.3	25.60
80	3"	209.6	900	8 × Ø22.4	38.2	168.1	73.7	38.46
All dimensions in [mm]								

Flange JIS B2220 / 10K: 1.4404/316L, Titan								
Surface roughness (flange): Ra 3.2 to 6.3 μm								
DN		G	L	N	S	LK	U	di
50		155	715	4 × Ø19	16	120	50	25.60
80		185	832	8 × Ø19	18	150	80	38.46
All dimensions in [mm]								

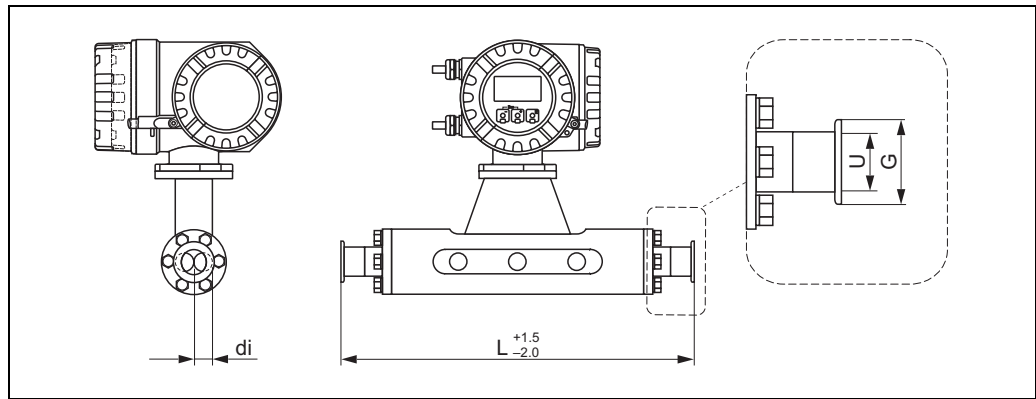
Flange JIS B2220 / 10K: 1.4404/316L, PVDF								
DN		G	L	N	S	LK	U	di
8		95	370	4 × Ø15	16	70	15	5.53
15		95	404	4 × Ø15	16	70	15	8.55
25		125	440	4 × Ø19	18	90	25	11.38
40		140	550	4 × Ø19	21	105	40	17.07
50		155	715	4 × Ø19	22	120	50	25.60
All dimensions in [mm]								

Flange JIS B2220 / 20K: 1.4404/316L, Titan							
Surface roughness (flange): Ra 3.2 to 6.3 µm							
DN	G	L	N	S	LK	U	di
8	95	370	4 × Ø15	16	70	15	5.53
15	95	404	4 × Ø15	16	70	15	8.55
25	125	440	4 × Ø19	18	90	25	11.38
40	140	550	4 × Ø19	21	105	40	17.07
50	155	715	4 × Ø19	22	120	50	25.60
80	200	832	8 × Ø23	22	160	80	38.46
All dimensions in [mm]							

Flange JIS B2220 / 40K: 1.4404/316L, Titan							
Surface roughness (flange): Ra 3.2 to 6.3 µm							
DN	G	L	N	S	LK	U	di
8	115	400	4 × Ø19	20	80	15	5.53
15	115	425	4 × Ø19	20	80	15	8.55
25	130	485	4 × Ø19	22	95	25	11.38
40	160	600	4 × Ø23	24	120	38	17.07
50	165	760	8 × Ø19	26	130	50	25.60
80	210	890	8 × Ø23	32	170	75	38.46
All dimensions in [mm]							

Flange JIS B2220 / 63K: 1.4404/316L, Titan							
Surface roughness (flange): Ra 3.2 to 6.3 µm							
DN	G	L	N	S	LK	U	di
8	120	420	4 × Ø19	23	85	12	5.53
15	120	440	4 × Ø19	23	85	12	8.55
25	140	494	4 × Ø23	27	100	22	11.38
40	175	620	4 × Ø25	32	130	35	17.07
50	185	775	8 × Ø23	34	145	48	25.60
80	230	915	8 × Ø25	40	185	73	38.46
All dimensions in [mm]							

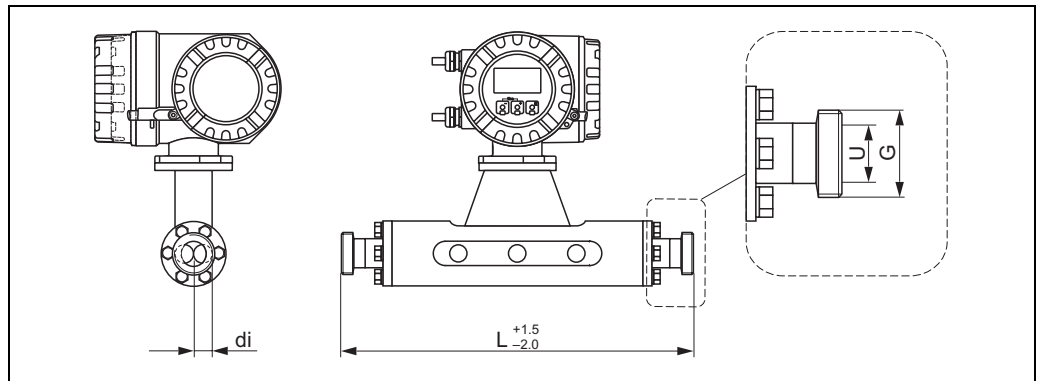
Promass M: Tri-Clamp



Tri-Clamp: 1.4404/316L					
DN	Clamp	G	L	U	di
8	1"	50.4	367	22.1	5.53
15	1"	50.4	398	22.1	8.55
25	1"	50.4	434	22.1	11.38
40	1½"	50.4	560	34.8	17.07
50	2"	63.9	720	47.5	25.60
80	3"	90.9	801	72.9	38.46
3A version also available (Ra ≤ 0.8 µm/150 grit.) All dimensions in [mm]					

½"-Tri-Clamp: 1.4404/316L					
DN	Clamp	G	L	U	di
8	½"	25.0	367	9.5	5.53
15	½"	25.0	398	9.5	8.55
3A version also available (Ra ≤ 0.8 µm/150 grit.) All dimensions in [mm]					

Promass M: DIN 11851 (threaded hygienic connection)



a0002527-en

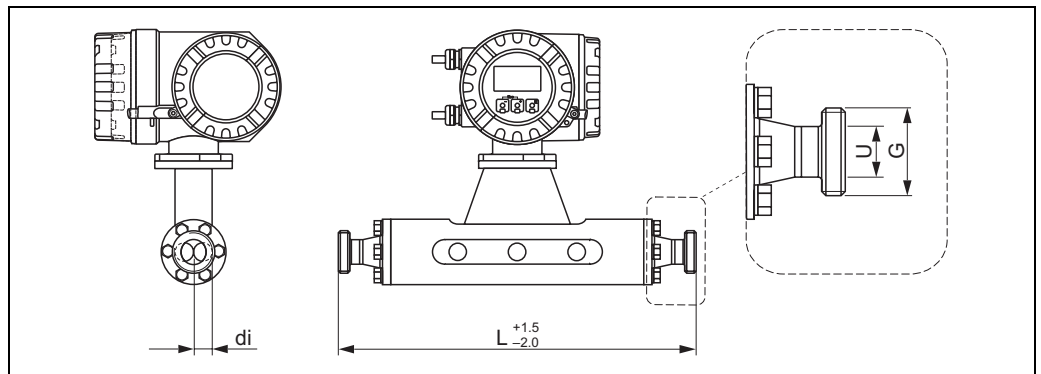
Threaded hygienic connection DIN 11851: 1.4404/316L

DN	G	L	U	d_i
8	Rd 34 × 1/8"	367	16	5.53
15	Rd 34 × 1/8"	398	16	8.55
25	Rd 52 × 1/6"	434	26	11.38
40	Rd 65 × 1/6"	560	38	17.07
50	Rd 78 × 1/6"	720	50	25.60
80	Rd 110 × 1/4"	815	81	38.46

3A version also available ($Ra \leq 0.8 \mu\text{m}/150$ grit.)

All dimensions in [mm]

Promass M: DIN 11864-1 Form A (threaded hygienic connection)



a0002528-en

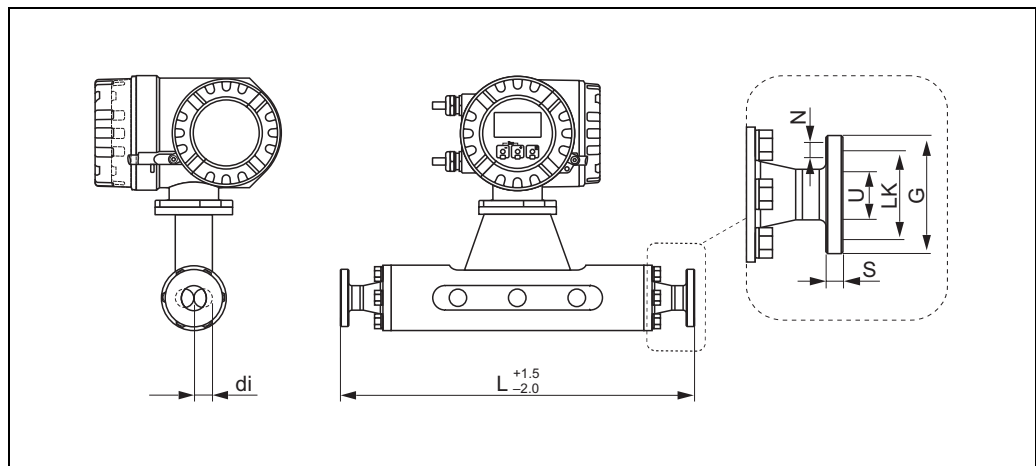
Threaded hygienic connection DIN 11864-1 Form A: 1.4404/316L

DN	G	L	U	d_i
8	Rd 28 × 1/8"	367	10	5.53
15	Rd 34 × 1/8"	398	16	8.55
25	Rd 52 × 1/6"	434	26	11.38
40	Rd 65 × 1/6"	560	38	17.07
50	Rd 78 × 1/6"	720	50	25.60
80	Rd 110 × 1/4"	815	81	38.46

3A version also available ($Ra \leq 0.8 \mu\text{m}/150$ grit.)

All dimensions in [mm]

Promass M: DIN 11864-2 Form A (flat flange with groove)

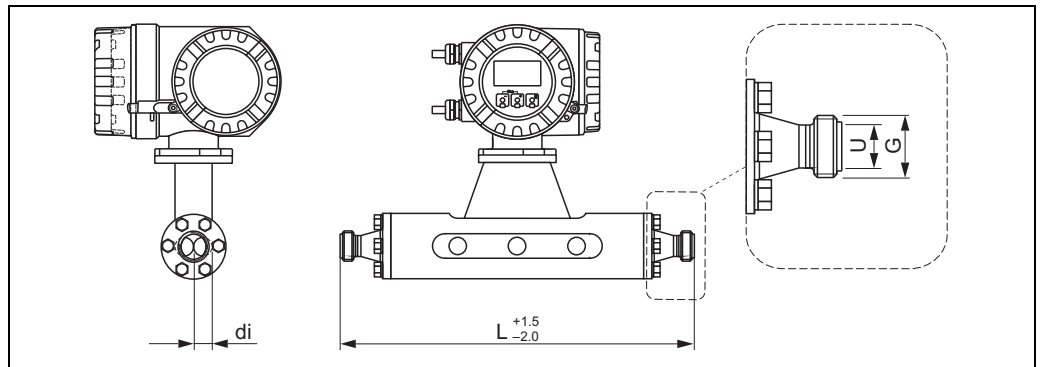


a0002529-en

DIN 11864-2 Form A (flat flange with groove): 1.4404/316L							
DN	G	L	N	S	LK	U	di
8	54	367	4 × Ø9	10	37	10	5.53
15	59	398	4 × Ø9	10	42	16	8.55
25	70	434	4 × Ø9	10	53	26	11.38
40	82	560	4 × Ø9	10	65	38	17.07
50	94	720	4 × Ø9	10	77	50	25.60
80	133	815	8 × Ø11	12	112	81	38.46

3A version also available (Ra ≤ 0.8 µm/150 grit.)
All dimensions in [mm]

Promass M: ISO 2853 (threaded hygienic connection)



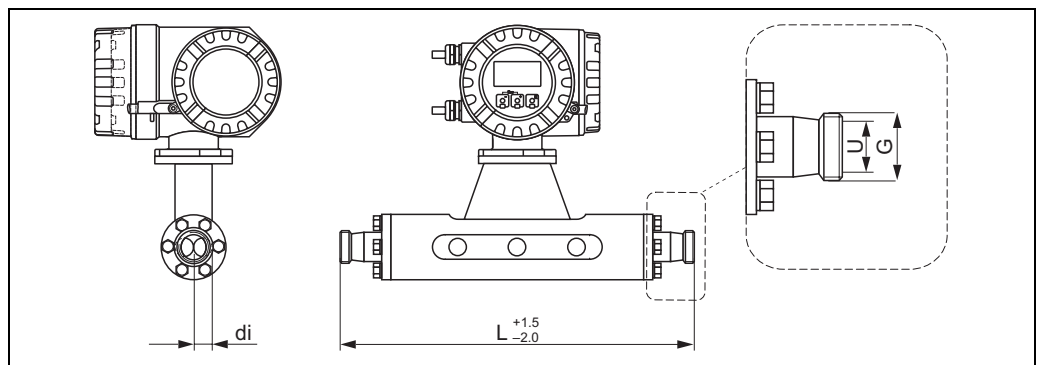
a0002530-en

Threaded hygienic connection ISO 2853: 1.4404/316L

DN	G ¹⁾	L	N	d_i
8	37.13	367	22.6	5.53
15	37.13	398	22.6	8.55
25	37.13	434	22.6	11.38
40	52.68	560	35.6	17.07
50	64.16	720	48.6	25.60
80	91.19	815	72.9	38.46

¹⁾ Max. thread diameter to ISO 2853 Annex A
 3A version also available ($R_a \leq 0.8 \mu\text{m}/150$ grit)
 All dimensions in [mm]

Promass M: SMS 1145 (threaded hygienic connection)



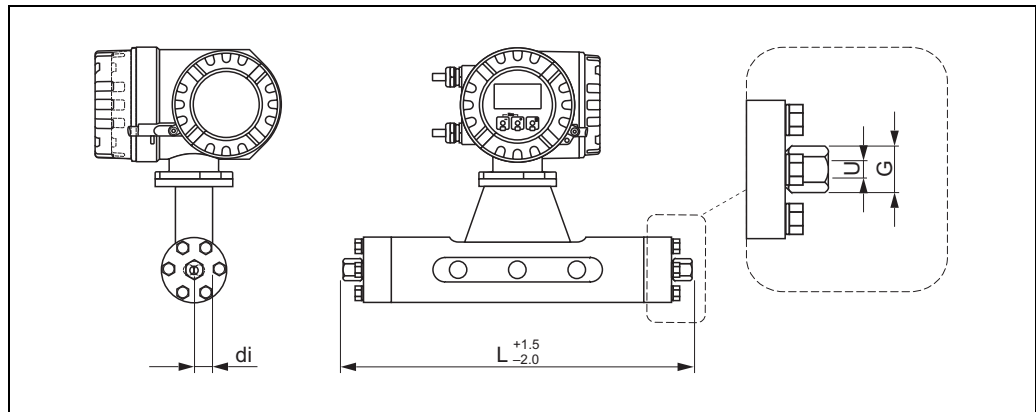
a0002531-en

Threaded hygienic connection SMS 1145: 1.4404/316L

DN	G	L	U	d_i
8	Rd 40 × 1/6"	367	22.5	5.53
15	Rd 40 × 1/6"	398	22.5	8.55
25	Rd 40 × 1/6"	434	22.5	11.38
40	Rd 60 × 1/6"	560	35.5	17.07
50	Rd 70 × 1/6"	720	48.5	25.60
80	Rd 98 × 1/6"	792	72.0	38.46

3A version also available ($R_a \leq 0.8 \mu\text{m}/150$ grit.)
 All dimensions in [mm]

Promass M (high pressure): 1/2"-NPT, 3/8"-NPT and G 3/8"



a0002532-en

1/2"-NPT: 1.4404/316L				
DN	G	L	U	di
8	AF 1 1/16"	370	10.2	4.93
15	AF 1 1/16"	400	10.2	7.75
25	AF 1 1/16"	444	10.2	10.20

3A version also available (Ra ≤ 0.8 µm/150 grit.)
All dimensions in [mm]

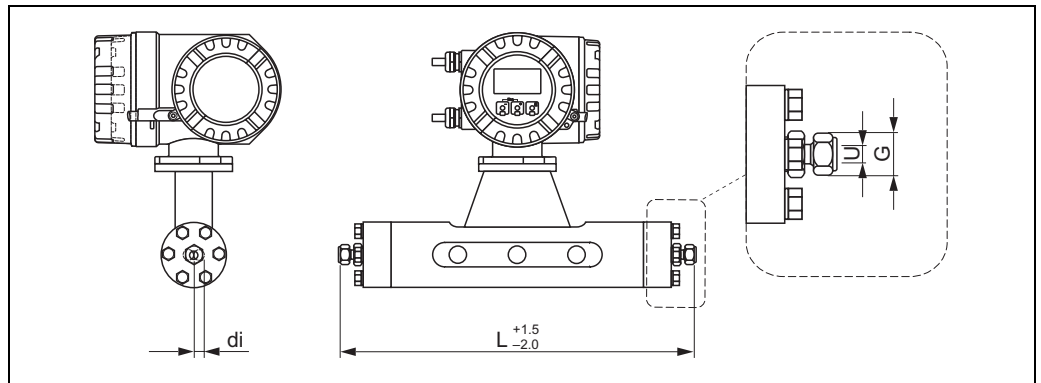
3/8"-NPT: 1.4404/316L				
DN	G	L	U	di
8	AF 1 5/16"	355.8	10.2	4.93
15	AF 1 5/16"	385.8	10.2	7.75
25	AF 1 5/16"	429.8	10.2	10.20

3A version also available (Ra ≤ 0.8 µm/150 grit.)
All dimensions in [mm]

G 3/8": 1.4404/316L				
DN	G	L	U	di
8	AF 24	355.8	10.2	4.93
15	AF 24	385.8	10.2	7.75
25	AF 24	429.8	10.2	10.20

3A version also available (Ra ≤ 0.8 µm/150 grit.)
All dimensions in [mm]

Promass M (high pressure): 1/2"-SWAGELOK



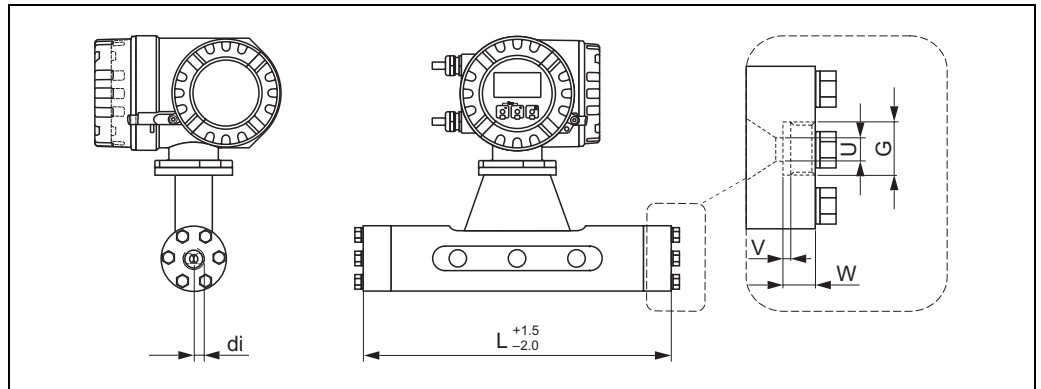
a0002533-en

1/2"-SWAGELOK: 1.4404/316L

DN	G	L	U	di
8	7/8"	366.4	10.2	4.93
15	7/8"	396.4	10.2	7.75
25	7/8"	440.4	10.2	10.20

3A version also available (Ra ≤ 0.8 μm/150 grit.)
All dimensions in [mm]

Promass M (high pressure): Connector with internal thread 7/8-14 UNF



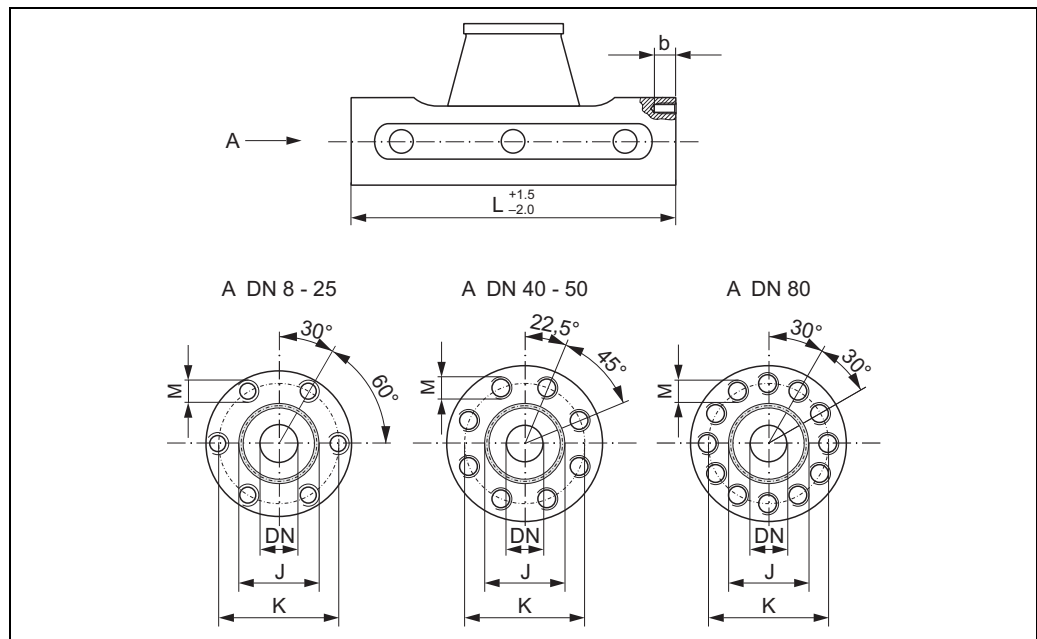
a0002534-en

Internal thread 7/8-14-UNF: 1.4404/316L

DN	G	L	U	V	W	di
8	7/8-14UNF	304	10.2	3	14	4.93
15	7/8-14UNF	334	10.2	3	14	7.75
25	7/8-14UNF	378	10.2	3	14	10.20

3A version also available (Ra ≤ 0.8 μm/150 grit.)
All dimensions in [mm]

Promass M: Without process connections



a0002535

DN	L	J	K	M	b _{max.}	b _{min.}
8	256	27	54	6 × M 8	12	10
8 ¹⁾	256	27	54	6 × M 8	12	10
15	286	35	56	6 × M 8	12	10
15 ¹⁾	286	35	56	6 × M 8	12	10
25	310	40	62	6 × M 8	12	10
25 ¹⁾	310	40	62	6 × M 8	12	10
40	410	53	80	8 × M 10	15	13
50	544	73	94	8 × M 10	15	13
80	644	102	128	12 × M 12	18	15

¹⁾ High-pressure version; permitted screws: A4 - 80; lubricant: Molykote P37
All dimensions in [mm]

DN	Tightening torque Nm	Lubricated thread YES/NO	O-ring	
			Thickness	Inside Ø
8	30.0	NO	2.62	21.89
8 ¹⁾	19.3	YES	2.62	21.89
15	30.0	NO	2.62	29.82
15 ¹⁾	19.3	YES	2.62	29.82
25	30.0	NO	2.62	34.60
25 ¹⁾	19.3	YES	2.62	34.60
40	60.0	NO	2.62	47.30
50	60.0	YES	2.62	67.95
80	100.0	YES	3.53	94.84

¹⁾ High-pressure version; permitted screws: A4 - 80; lubricant: Molykote P37
All dimensions in [mm]

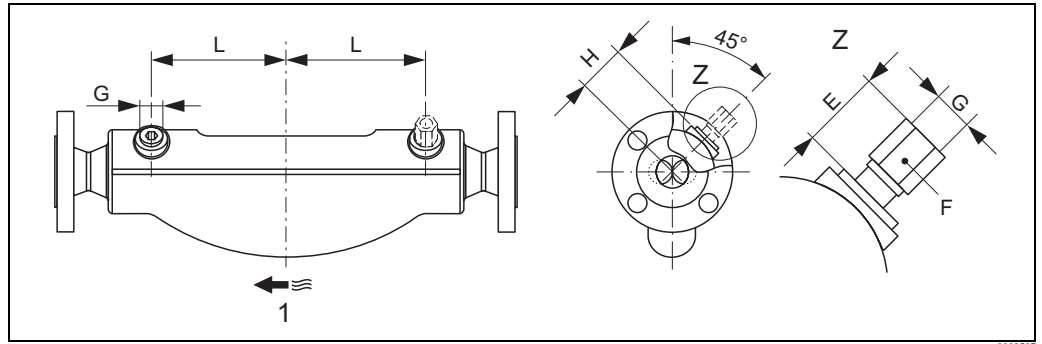
Purge connections / secondary containment monitoring



Caution!

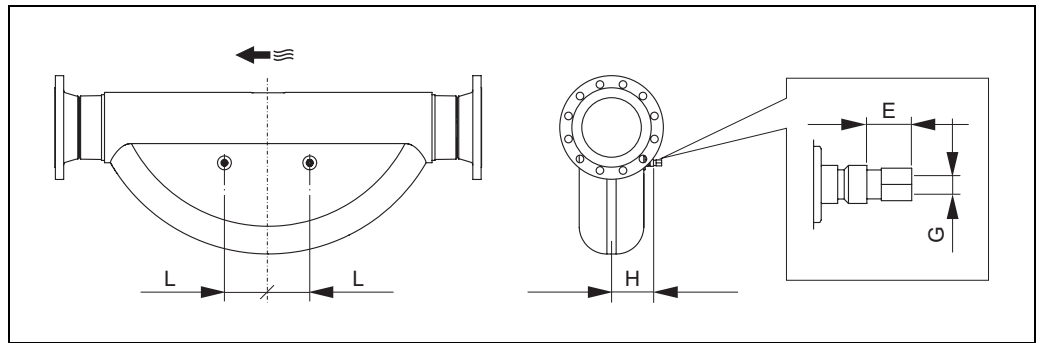
- The secondary containment is filled with dry nitrogen (N₂). Do not open the purge connections unless the containment can be filled immediately with a dry inert gas. Use only low gauge pressure to purge. Maximum pressure: 5 bar.
- Purge connections or secondary containment monitoring can not be combined with separately available heating jacket.

Promass F: (not available for the Promass F high-temperature version)



Promass F DN 8 to DN 150

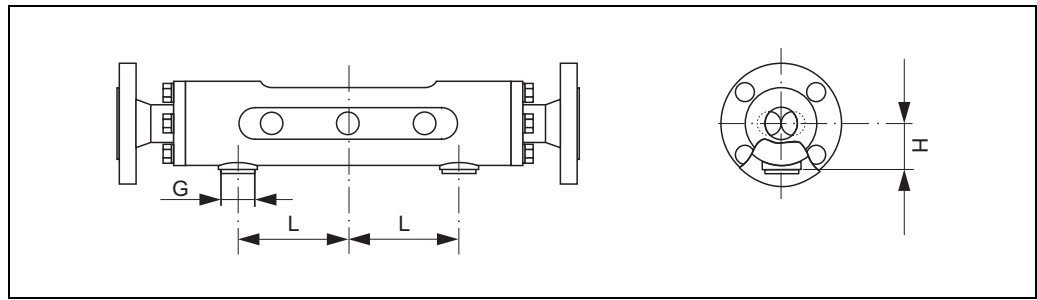
1 = Flow direction



Promass F DN 250

DN	F	G	H	L
8	AF 1"	½"-NPT	62	108
15			62	110
25			62	130
40			67	155
50			79	226
80			101	280
100			120	342
150			141	440
All dimensions in [mm]				

Promass M:



A0002530

DN	L	H	G
8	85	44.0	½"-NPT
15	100	46.5	
25	110	50.0	
40	155	59.0	
50	210	67.5	
80	210	81.5	

All dimensions in [mm]

Rupture disk

Sensor housings with integrated rupture disks are optionally available.



Warning!

- Make sure that the function and operation of the rupture disk is not impeded through the installation. Triggering overpressure in the housing as stated on the indication label. Take adequate precautions to ensure that no damage occurs, and risk to human life is ruled out, if the rupture disk is triggered. Rupture disk: Burst pressure 10 to 15 bar.
- Please note that the housing can no longer assume a secondary containment function if a rupture disk is used.
- It is not permitted to open the connections or remove the rupture disk.



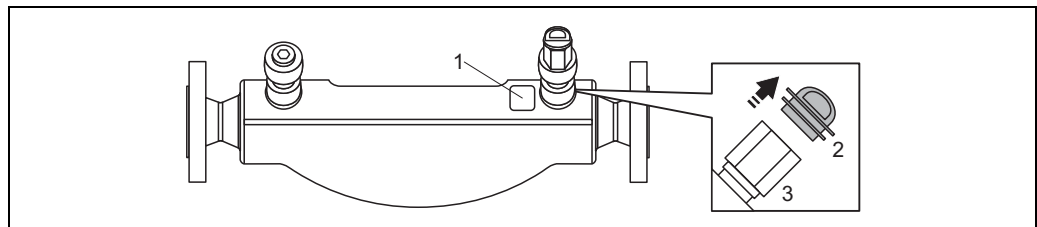
Caution!

- Rupture disks can not be combined with separately available heating jacket.
- The existing connection nozzles are not designed for a rinse or pressure monitoring function.



Note!

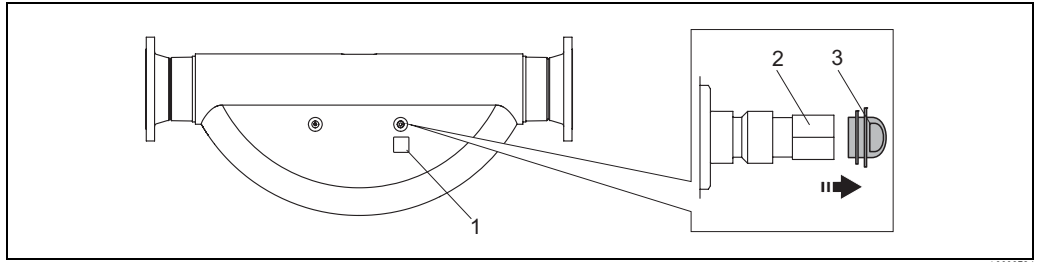
- Before commissioning, please remove the transport protection of the rupture disk.
- Please note the indication labels.



A0008361

Promass F DN 8 to DN 150

1 = Indication label for the rupture disk, 2 = Transport protection, 3 = ½" NPT internal screw thread with 1" width across flats



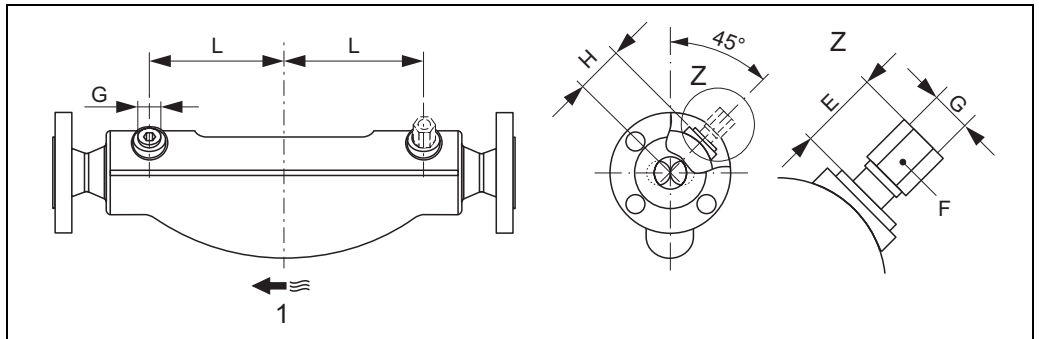
Promass F DN 250

1 = Indication label for the rupture disk, 2 = Transport protection, 3 = 1/2" NPT internal screw thread with 1" width across flats



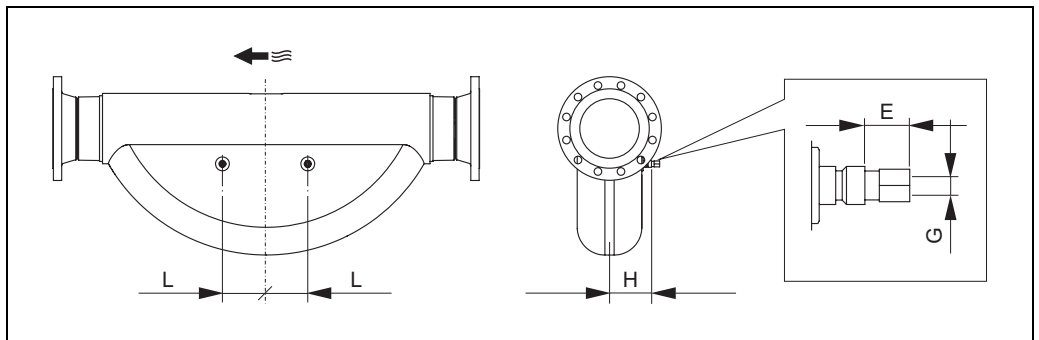
Indication label for the rupture disk

Promass F: (not available for the Promass F high-temperature version)



Promass F DN 8 to DN 150

1 = Flow direction



Promass F DN 250

DN	E	F	G	H	L
8	approx. 42	AF 1"	½"-NPT	62	108
15				62	110
25				62	130
40				67	155
50				79	226
80				101	280
100				120	342
150				141	440
All dimensions in [mm]					

Weight

- Compact version: see table below
- Remote version
 - Sensor: see table below
 - Wall-mount housing: 5 kg

Promass F / DN	8	15	25	40	50	80	100	150	250 ¹⁾
Compact version	11	12	14	19	30	55	96	154	400
High-temperature compact version	–	–	14.7	–	30.7	55.7	–	–	–
Compact version Ex d	20	21	23	28	39	64	105	163	409
Remote version	9	10	12	17	28	53	94	152	398
High-temperature remote version	–	–	13.5	–	29.5	54.5	–	–	–
¹⁾ With 10" according to ASME B16.5 Cl 300 flanges									

Promass M / DN	8	15	25	40	50	80
Compact version	11	12	15	24	41	67
Remote version	9	10	13	22	39	65

Weight information in [kg].

All values (weight) refer to devices with EN/DIN PN 40 flanges.

Material

Transmitter housing

- Compact housing: stainless steel 1.4301/304
- Compact housing: powder coated die-cast aluminum
- Compact housing Ex d: stainless steel CF3M
- Wall-mount housing: powder coated die-cast aluminum
- Remote field housing: powder-coated die-cast aluminum

Sensor housing / containment

Promass F:

Acid and alkali-resistant outer surface
Stainless steel 1.4301/1.4307/304L

Promass M:

Acid and alkali-resistant outer surface
DN 8 to 50: steel, chemically nickel-plated
DN 80: stainless steel

Connection housing, sensor (remote version)

- Stainless steel 1.4301/304 (standard)
- Powder coated die-cast aluminum (high-temperature version and version for heating)

Process connections

Promass F:

- Flanges according to EN 1092-1 (DIN 2501) / according to ASME B16.5 / JIS B2220
→ Stainless Steel 1.4404/316L
- Flanges according to EN 1092-1 (DIN 2501) /according to ASME B16.5 / JIS B2220
→ Alloy C-22 2.4602/N 06022
- DIN 11864-2 Form A (flat flange with groove) → Stainless Steel 1.4404/316L
- Threaded hygienic connection DIN 11851 / threaded hygienic connection SMS 1145
→ Stainless Steel 1.4404/316L
- Threaded hygienic connection ISO 2853 / threaded hygienic connection DIN 11864-1
→ Stainless Steel 1.4404/316L
- Tri-Clamp (OD-Tubes)→ Stainless Steel 1.4404/316L
- VCO connection → Stainless Steel 1.4404/316L

Promass F (high-temperature version):

- Flanges according to EN 1092-1 (DIN 2501) /according to ASME B16.5 / JIS B2220
→ Stainless Steel 1.4404/316L
- Flanges according to EN 1092-1 (DIN 2501) /according to ASME B16.5 / JIS B2220
→ Alloy C-22 2.4602 (N 06022)

Promass M:

- Flanges according to EN 1092-1 (DIN 2501) /according to ASME B16.5 / JIS B2220
→ Stainless Steel 1.4404/316L, titanium Grade 2
- Flange according to DIN 11864-2 Form A (flat flange with groove) → Stainless Steel 1.4404/316L
- PVDF coupling to DIN /according to ASME B16.5 / JIS
- Threaded hygienic connection DIN 11851 / threaded hygienic connection SMS 1145
→ Stainless Steel 1.4404/316L
- Threaded hygienic connection ISO 2853 / threaded hygienic connection DIN 11864-1
→ Stainless Steel 1.4404/316L
- Tri-Clamp (OD-Tubes) → Stainless Steel 1.4404/316L

Promass M (high-pressure version):

- Connector → Stainless steel 1.4404/316L
- Coupling → Stainless steel 1.4401/316

Measuring tubes

Promass F:

- DN 8 to 100: stainless steel 1.4539 (904L)
- DN 150: stainless steel 1.4404/316L
- DN 250: stainless steel 1.4404/316L; manifold: CF3M
- DN 8 to 150: Alloy C-22 2.4602/N 06022

Promass F (high-temperature version):

- DN 25, 50, 80: Alloy C-22 2.4602/N 06022

Promass M:

- DN 8 to 50: Titanium grade 9
- DN 80: Titanium grade 2

Promass M (high-pressure version):

- Titanium Grade 9

Seals

Promass F:

Welded process connections without internal seals

Promass M:

Viton, EPDM, silicone, Kalrez 6375, FEP sheathing (not for gas applications)

Material load diagram

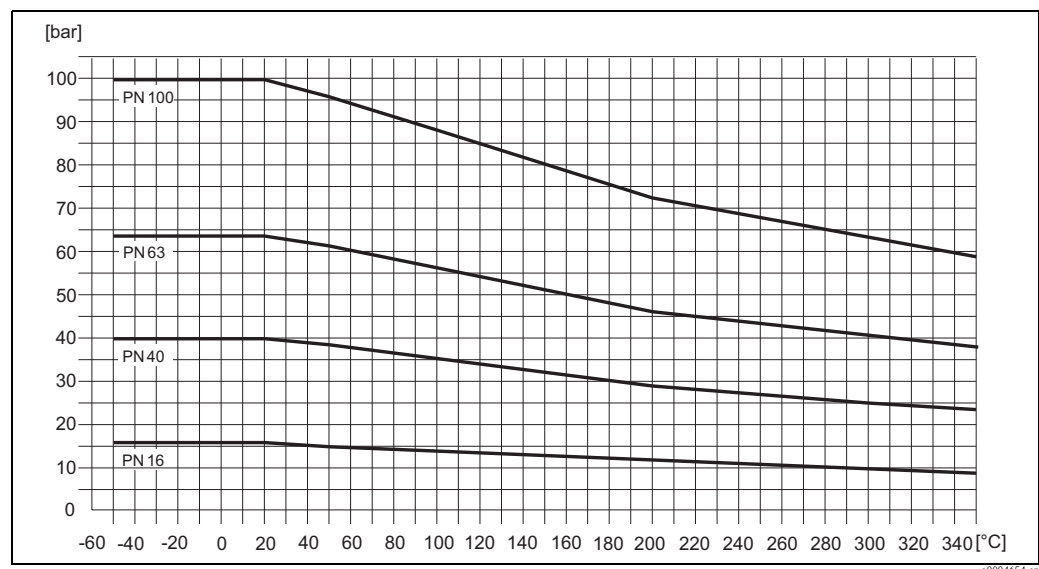


Warning!

The following material load curves refer to the entire sensor and not just the process connection.

Promass F with flange connection according to EN 1092-1 (DIN 2501)

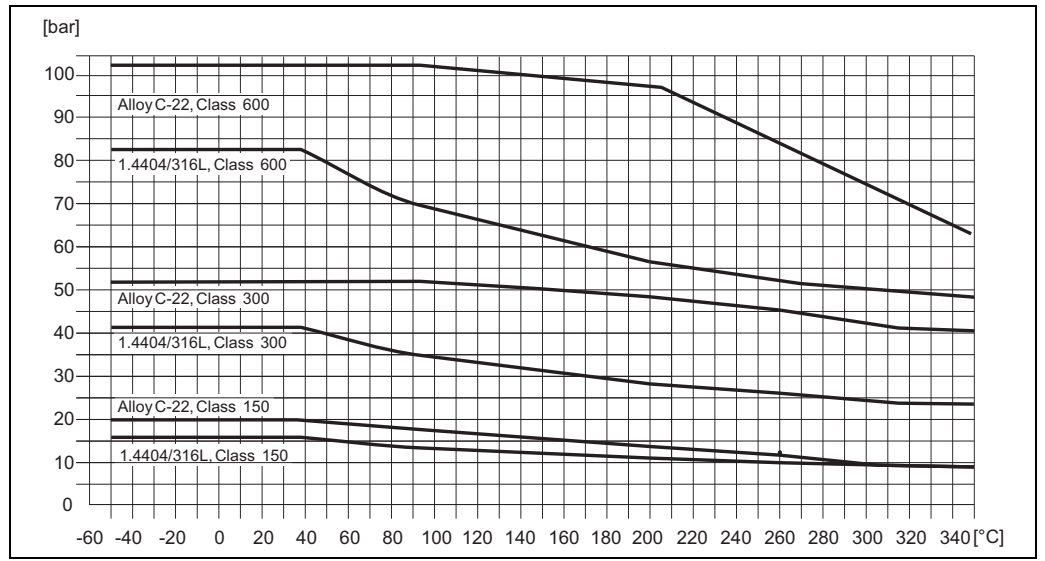
Flange material: 1.4404/316L, Alloy C-22



The values for the temperature range from 200 °C to 350 °C are exclusively valid for Promass F (HT) high-temperature version.

Promass F with flange connection according to ASME B16.5

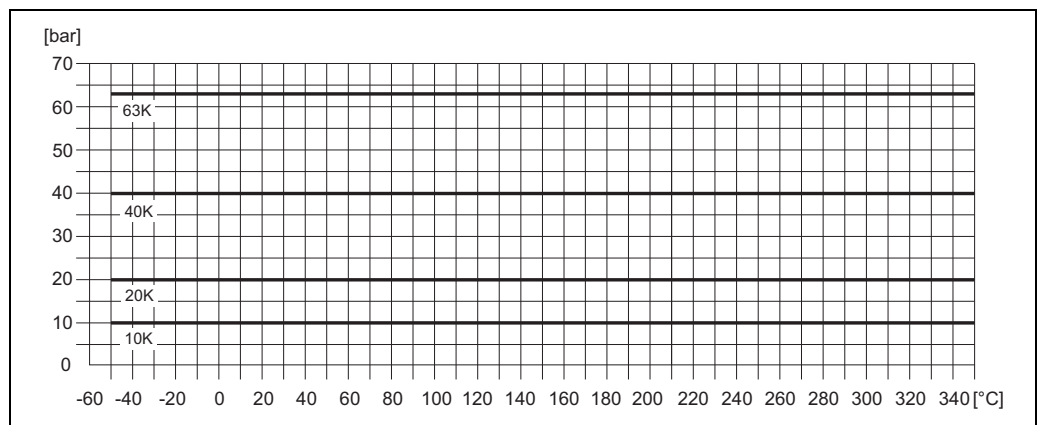
Flange material: 1.4404/316L, Alloy C-22



The values for the temperature range from 200 °C to 350 °C are exclusively valid for Promass F (HT) high-temperature version.

Promass F with flange connection to JIS B2220

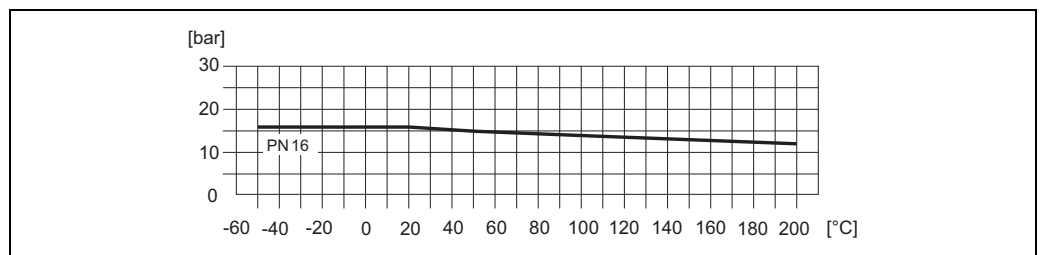
Flange material: 1.4404/316L, Alloy C-22



The values for the temperature range from 200 °C to 350 °C are exclusively valid for Promass F (HT) high-temperature version.

Promass F with threaded hygienic connection to DIN 11851 / SMS 1145

Connection material: 1.4404/316L

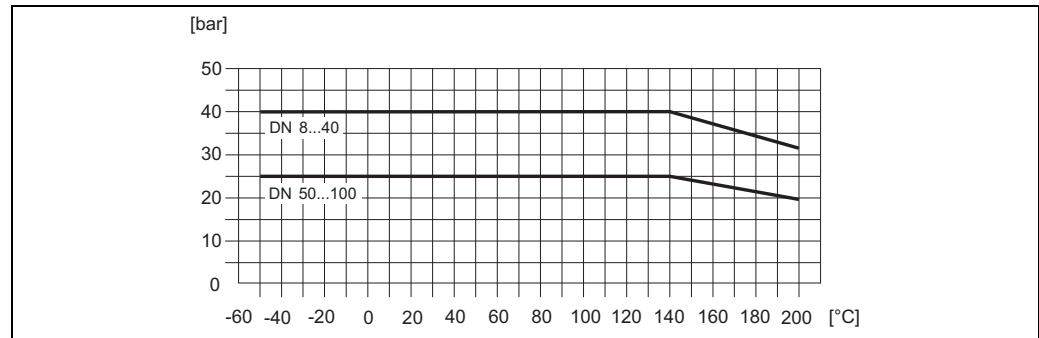


Promass F with Tri-Clamp process connection

The Clamp connections (e.g. Tri-Clamp ISO2852, DIN32676) are suited up to a maximum pressure of 16 bar. As these operating limits also depend on the clamp and the seal used, their specifications have to be observed. The clamp and the seal are not included in the scope of supply.

Promass F with threaded hygienic connection to DIN 11864-1

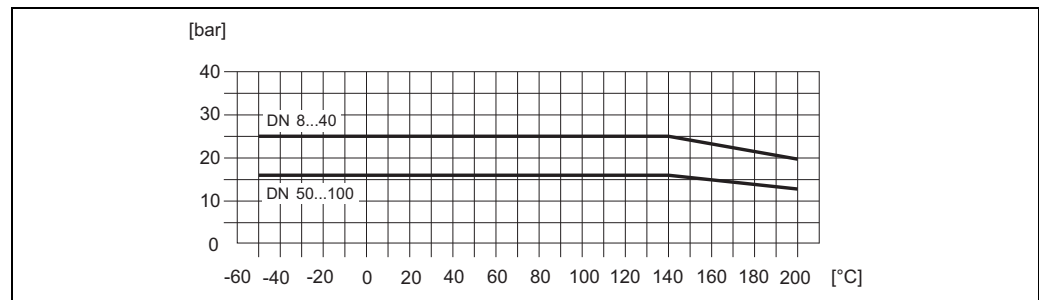
Connection material: 1.4404/316L



a0004658-en

Promass F with flange connection to DIN 11864-2 Form A (flat flange with groove)

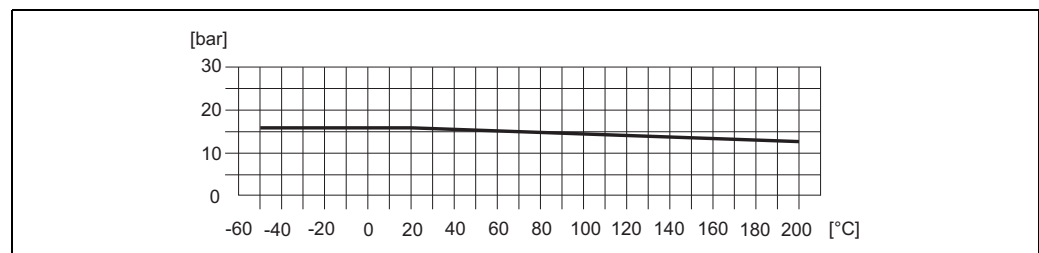
Flange material: 1.4404/316L



a0004659-en

Promass F with threaded hygienic connection to ISO 2853

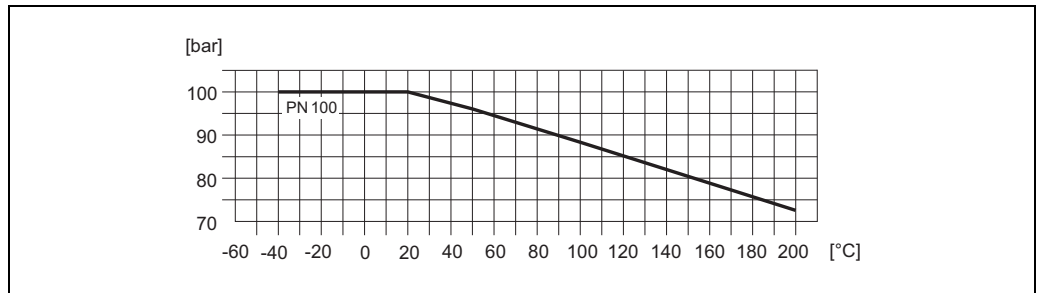
Connection material: 1.4404/316L



a0004660-en

Promass F with VCO process connection

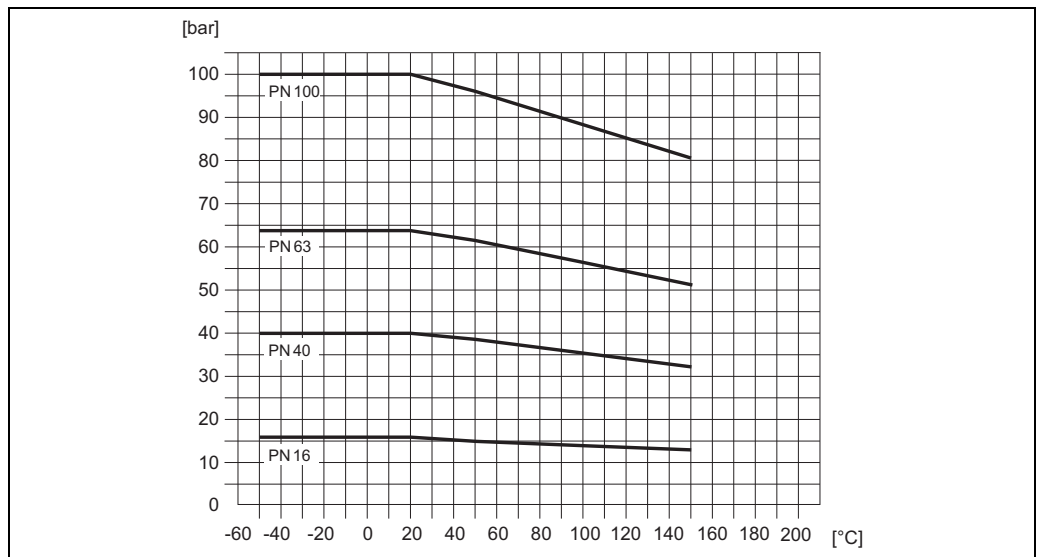
Connection material: 1.4404/316L



a0004553-en

Promass M with flange connection according to EN 1092-1 (DIN 2501)

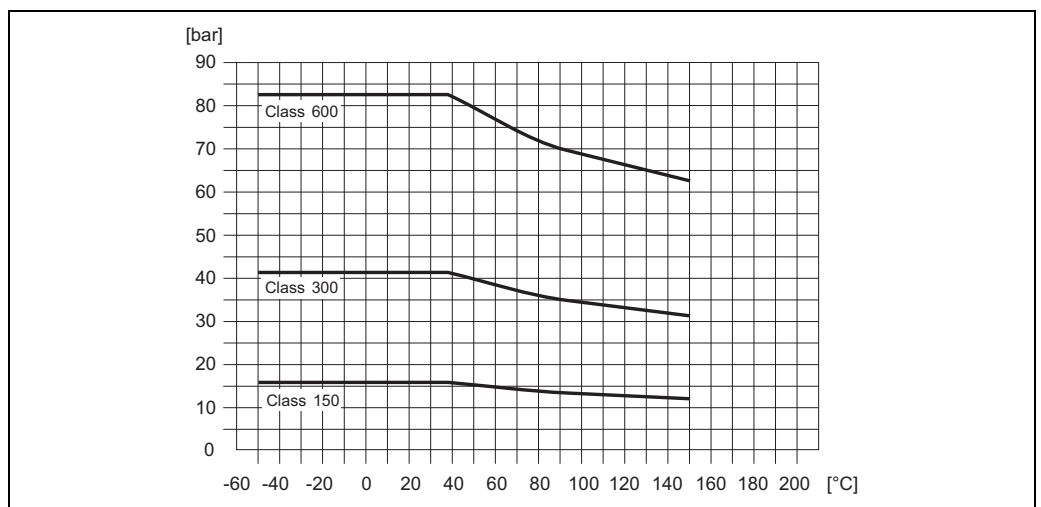
Flange material: 1.4404/316L, titanium grade 2



a0003293-en

Promass M with flange connection according to ASME B16.5

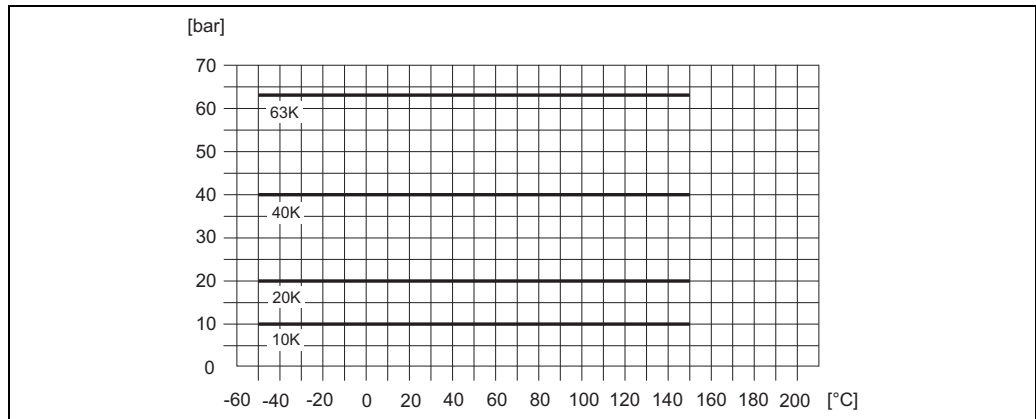
Flange material: 1.4404/316L, titanium grade 2



a0003297-en

Promass M with flange connection to JIS B2220

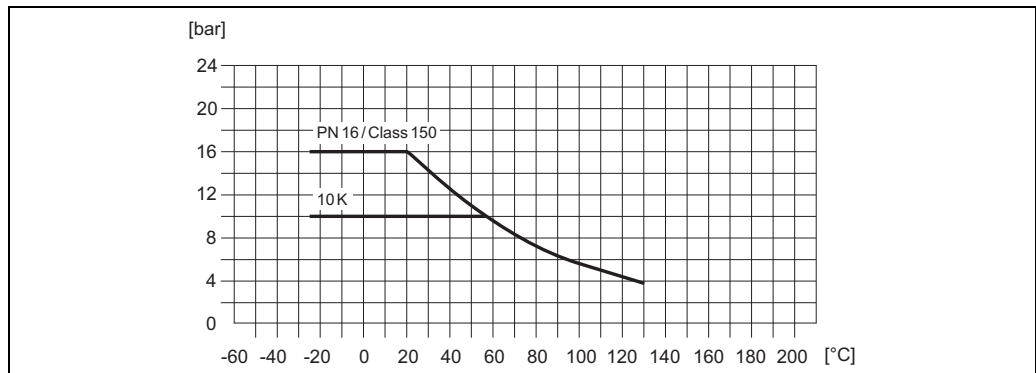
Flange material: 1.4404/316L, titanium grade 2



a0003304-en

Promass M with PVDF flange connection (to DIN 2501, according to ASME B16.5, JIS B2220)

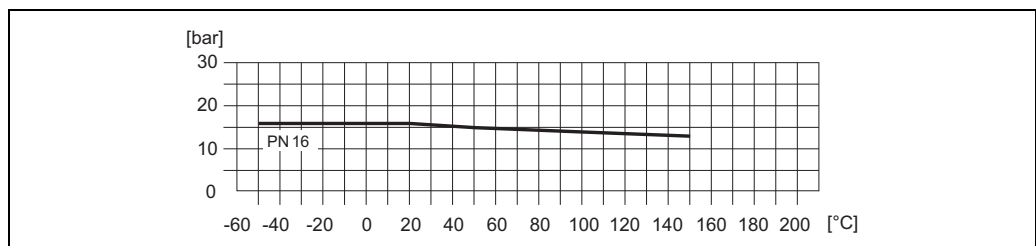
Flange material: PVDF



a000461-en

Promass M with threaded hygienic connection to DIN 11851 / SMS 1145

Connection material: 1.4404/316L

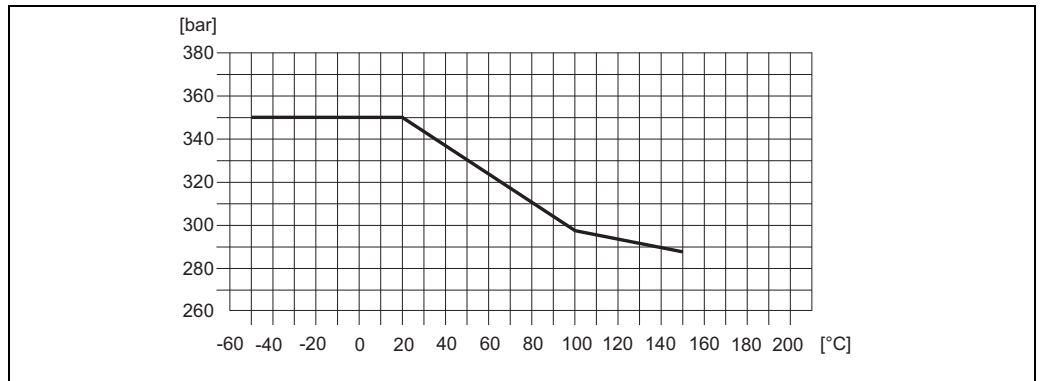


a0003305-en

Promass M with process connections for high-pressure version

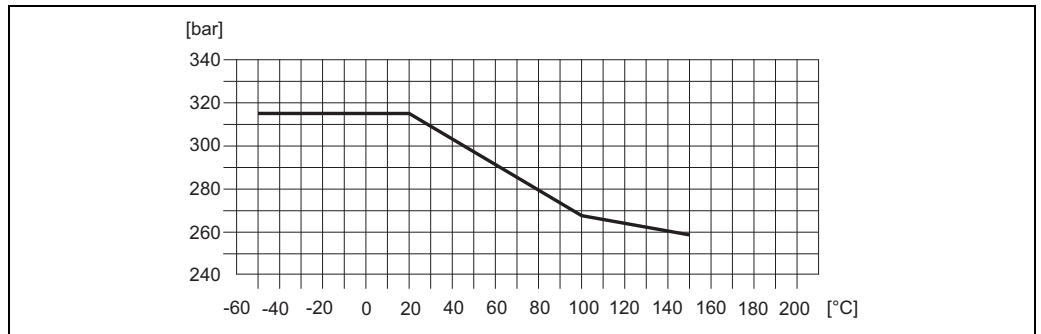
Connector material: 1.4404/316L

Material of thread connections (G 3/8", VCO with 1/2" SWAGELOK, NPT 3/8"): 14401/316



a0004662-en

Material of thread connections (NPT 1/2"): 1.4401/316



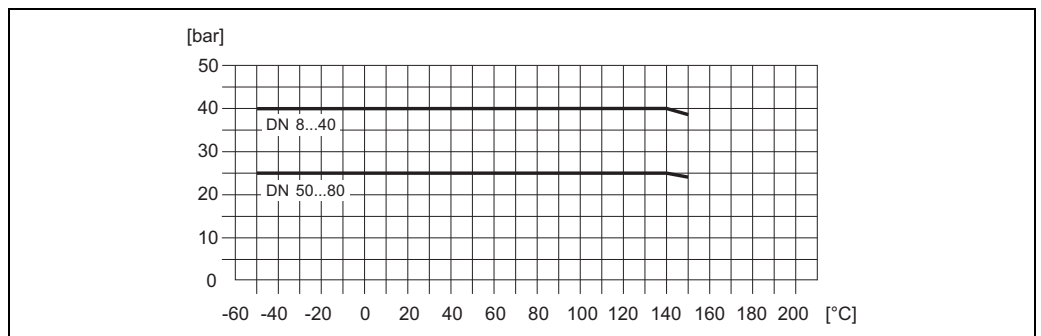
a0004663-en

Promass M with Tri-Clamp process connection

The Clamp connections (e.g. Tri-Clamp ISO2852, DIN32676) are suited up to a maximum pressure of 16 bar. As these operating limits also depend on the clamp and the seal used, their specifications have to be observed. The clamp and the seal are not included in the scope of supply.

Promass M with threaded hygienic connection to DIN 11864-1

Connection material: 1.4404/316L



a0004664-en

Human interface

Display elements

- Liquid-crystal display: backlit, two lines (Promass 80) or four lines (Promass 83) with 16 characters per line
- Selectable display of different measured values and status variables
- At ambient temperatures below -20 °C the readability of the display may be impaired.

Unified control concept for both types of transmitter

Promass 80

- Local operation with three keys (-, +, E)
- Quick Setup menus for straightforward commissioning

Promass 83

- Local operation with three optical keys ($\square/\square/\square$)
- Application-specific Quick Setup menus for straightforward commissioning

Language group



Note!

The language group is changed using the "FieldCare" operating program.

Language groups available for operation in different countries:

- Western Europe and America (WEA):
English, German, Spanish, Italian, French, Dutch and Portuguese
- Eastern Europe/Scandinavia (EES):
English, Russian, Polish, Norwegian, Finnish, Swedish and Czech
- South and Eastern Asia (SEA):
English, Japanese, Indonesian

Only Promass 83

- China (CN):
English, Chinese

Remote operation

Promass 80

Remote operation via HART, PROFIBUS PA

Promass 83

Remote operation via HART, PROFIBUS DP/PA, FOUNDATION Fieldbus

Certificates and approvals

CE mark	The measuring system is in conformity with the statutory requirements of the EC Directives. Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.
C-Tick symbol	The measuring system complies with the EMC requirements of the "Australian Communications and Media Authority (ACMA)"
Ex approval	Information about currently available Ex versions (ATEX, FM, CSA, IECEx, NEPSI) can be supplied by your Endress+Hauser Sales Center on request. All explosion protection data are contained in separate explosion protection documentation which you can order if required.
Sanitary compatibility	<ul style="list-style-type: none"> ■ 3A approval ■ EHEDG-tested
FOUNDATION Fieldbus certification	<p>The flowmeter has passed all the test procedures implemented and has been certified and registered by the Fieldbus Foundation. The flowmeter thus meets all the requirements of the specifications listed below:</p> <ul style="list-style-type: none"> ■ Certified to FOUNDATION Fieldbus specification ■ The flowmeter meets all the specifications of the FOUNDATION Fieldbus-H1. ■ Interoperability Test Kit (ITK), revision status 5.0: The device can also be operated in conjunction with other-make certified devices ■ Physical Layer Conformance Test of the Fieldbus Foundation
PROFIBUS DP/PA certification	<p>The flow device has successfully passed all the test procedures carried out and is certified and registered by the PNO (PROFIBUS User Organization). The device thus meets all the requirements of the following specifications:</p> <ul style="list-style-type: none"> ■ Certified to PROFIBUS Profile Version 3.0 (device certification number: on request) ■ The device can also be operated with certified devices of other manufacturers (interoperability)
MODBUS certification	The measuring device meets all the requirements of the MODBUS/TCP conformity and integration test and has the "MODBUS/TCP Conformance Test Policy, Version 2.0". The measuring device has successfully passed all the test procedures carried out and is certified by the "MODBUS/TCP Conformance Test Laboratory" of the University of Michigan.
Other standards and guidelines	<ul style="list-style-type: none"> ■ EN 60529 Degrees of protection by housing (IP code) ■ EN 61010 Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures. ■ IEC/EN 61326 "Emission in accordance with Class A requirements". Electromagnetic compatibility (EMC requirements). ■ NAMUR NE 21 Electromagnetic compatibility (EMC) of industrial process and laboratory control equipment. ■ NAMUR NE 43 Standardization of the signal level for the breakdown information of digital transmitters with analog output signal. ■ NAMUR NE 53 Software of field devices and signal-processing devices with digital electronics
Pressure measuring device approval	<p>Flowmeters with a nominal diameter smaller or equal DN 25 are covered by Art. 3(3) of the European directive 97/23/EC (Pressure Equipment Directive) and are designed according to sound engineering practice. For larger nominal diameters, optional approvals according to Cat. II/III are available if required (depends on fluid and process pressure).</p> <p>Optionally flowmeters in accordance to the guidelines AD 2000 are available on request.</p>

Functional safety

SIL -2:
accordance IEC 61508/IEC 61511-1 (FDIS)
"4–20 mA" - output according to the following order code:

Promass 80

Promass80***_*****A
Promass80***_*****D
Promass80***_*****S
Promass80***_*****T
Promass80***_*****8

Promass 83

Promass83***_*****A	Promass83***_*****M	Promass83***_*****Ø
Promass83***_*****B	Promass83***_*****R	Promass83***_*****2
Promass83***_*****C	Promass83***_*****S	Promass83***_*****3
Promass83***_*****D	Promass83***_*****T	Promass83***_*****4
Promass83***_*****E	Promass83***_*****U	Promass83***_*****5
Promass83***_*****L	Promass83***_*****W	Promass83***_*****6

Ordering information

The Endress+Hauser service organization can provide detailed ordering information and information on the order codes on request.

Accessories

Various accessories, which can be ordered separately from Endress+Hauser, are available for the transmitter and the sensor.

Documentation

- Flow measuring technology (FA005D/06/en)
- Technical Information Promass 80E, 83E (TI061D/06/en)
- Technical Information Promass 80A, 83A (TI054D/06/en)
- Technical Information Promass 80H, 83H (TI074D/06/en)
- Technical Information Promass 80I, 83I (TI075D/06/en)
- Technical Information Promass 80P, 83P (TI078D/06/en)
- Technical Information Promass 80S, 83S (TI076D/06/en)
- Operating Instructions Promass 80 (BA057D/06/en)
- Operating Instructions Promass 80 PROFIBUS PA (BA072D/06/en)
- Operating Instructions Promass 83 (BA059D/06/en)
- Operating Instructions Promass 83 FOUNDATION Fieldbus (BA065D/06/en)
- Operating Instructions Promass 83 PROFIBUS DP/PA (BA063D/06/en)
- Operating Instructions Promass 83 MODBUS (BA107D/06/en)
- Description of Device Functions Promass 80 (BA 058D/06/en)
- Description of Device Functions Promass 80 PROFIBUS PA (BA073D/06/en)
- Description of Device Functions Promass 83 (BA 060D/06/en)
- Description of Device Functions Promass 83 FOUNDATION Fieldbus (BA066D/06/en)
- Description of Device Functions Promass 83 PROFIBUS DP/PA (BA064D/06/en)
- Description of Device Functions Promass 83 MODBUS (BA108D/06/en)
- Supplementary documentation on Ex-ratings: ATEX, FM, CSA, IECEx, NEPSI
- Functional Safety Manual for Promass 80, 83 (SD077D/06/en)

Registered trademarks

KALREZ® and VITON®

Registered trademarks of E.I. Du Pont de Nemours & Co., Wilmington, USA

TRI-CLAMP®

Registered trademark of Ladish & Co., Inc., Kenosha, USA

SWAGELOK®

Registered trademark of Swagelok & Co., Solon, USA

HART®

Registered trademark of HART Communication Foundation, Austin, USA

PROFIBUS®

Registered trademark of the PROFIBUS User Organization, Karlsruhe, Germany

FOUNDATION™ Fieldbus

Registered trademark of the Fieldbus FOUNDATION, Austin, USA

MODBUS®

Registered trademark of the MODBUS Organization

HistoROM™, S-DAT®, T-DAT™, F-CHIP®, Fieldcheck®, FieldCare®, Applicator®

Registered or registration-pending trademarks of Endress+Hauser Flowtec AG, Reinach, CH

Instruments International

Endress+Hauser
Instruments International AG
Kaegenstrasse 2
4153 Reinach
Switzerland

Tel. +41 61 715 81 00
Fax +41 61 715 25 00
www.endress.com
info@ii.endress.com

Endress+Hauser 
People for Process Automation

Rosemount® 3144P Temperature Transmitter



For every responsibility you have, you are confronted with a number of challenges. You have aggressive production and quality targets, but inaccurate or unavailable temperature measurements create unscheduled downtime and off-spec products. Loops may be running in manual because you don't trust your temperature measurement, requiring the attention of your maintenance staff and costing money in lost production. Additionally, improving safety and complying with government and company regulations is made more difficult when you don't have the information or tools needed to prove your compliance.

That's why companies are coming to Emerson™ – because they know they need reliable measurements and visibility into their temperature measurements in order to address these challenges and achieve their business objectives. With the Rosemount 3144P Temperature Transmitter, you gain greater visibility into your temperature processes so you can improve safety, comply with regulations, make the most of your limited resources, and reach your production and quality targets. By leveraging the diagnostic capabilities and the unparalleled reliability and accuracy of the Rosemount 3144P, you can minimize off-spec product, reduce maintenance and downtime, improve the usage of your limited resources, and meet regulatory demands.

Rosemount 3144P Temperature Transmitter

Industry-leading temperature transmitter delivers unmatched field reliability and innovative process measurement solutions

- Superior accuracy and stability
- Dual and single sensor capability with universal sensor inputs (RTD, T/C, mV, ohms)
- Comprehensive sensor and process diagnostics offering
- SIL3 Capable: IEC 61508 certified by an accredited 3rd party agency for use in safety instrumented systems up to SIL 3 [Minimum requirement of single use (1oo1) for SIL 2 and redundant use (1oo2) for SIL 3]
- Dual-compartment housing
- Large LCD display
- 4-20 mA /HART® with Selectable Revisions (5 and 7)
- FOUNDATION™ fieldbus, compliant to ITK 6.0 and NE107 standards



Improve efficiency with best-in-class product specifications and capabilities

- Reduce maintenance and improve performance with industry leading accuracy and stability
- Improve measurement accuracy by 75% with Transmitter-Sensor Matching
- Ensure process health with system alerts and easy to use Device Dashboards
- Easily check device status and values on local LCD display with large percent range graph
- Achieve high reliability and installation ease with the industry's most rugged dual compartment design



Optimize measurement reliability with diagnostics designed for any protocol on any host system

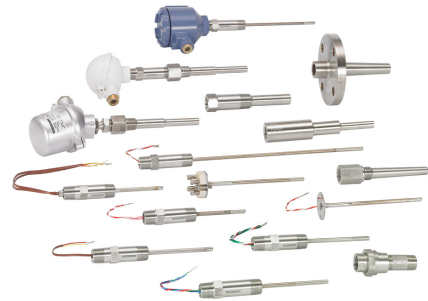
- Thermocouple Degradation Diagnostic monitors the health of a thermocouple loop, enabling preventative maintenance
- Minimum and Maximum Temperature Tracking tracks and records temperature extremes of the process sensors and the ambient environment
- Sensor Drift Alert detects sensor drift and alerts the user
- The Hot Backup™ feature provides temperature measurement redundancy

Content

Rosemount 3144P Temperature Transmitter	2	Product Certifications	16
Transmitter Specifications	8	Dimensional drawings	21

Explore the benefits of a complete point solution from Rosemount Temperature

- An “Assemble To Sensor” option enables Emerson to provide a complete point temperature solution, delivering an installation-ready transmitter and sensor assembly
- Emerson offers a selection of RTDs, thermocouples, and thermowells that bring superior durability and Rosemount reliability to temperature sensing, complementing the Rosemount Transmitter portfolio



Experience global consistency and local support from numerous worldwide Rosemount Temperature manufacturing sites



- World-class manufacturing provides globally consistent product from every factory and the capacity to fulfill the needs of any project, large or small
- Experienced Instrumentation Consultants help select the right product for any temperature application and advise on best installation practices
- An extensive global network of Emerson service and support personnel can be on-site when and where they are needed

- Looking for a wireless temperature solution? For wireless applications that require superior performance and unmatched reliability, consider the **Rosemount 648 Wireless** Temperature Transmitter.
- A demanding high temperature application requires an innovative temperature solution. Pair the Rosemount 3144P Thermocouple Diagnostic with the **Rosemount 1075 High Temperature Thermocouple**.

Rosemount 3144P Temperature Transmitter



The industry-leading Rosemount 3144P Single Point Temperature Transmitter delivers unmatched field reliability and innovative process measurement solutions and diagnostics

Transmitter features include:

- Dual and Single Sensor Input Capabilities
- Transmitter-Sensor Matching (Option Code C2)
- Integral Transient Protector (Option Code T1)
- IEC 61508 Safety Certificate of Compliance (Option Code QT)
- Advanced Sensor and Process Diagnostics (Option Codes D01 and DA1)
- Large, Easy to Read LCD Display (Option Code M5)
- “Assemble to Sensor” option (Option Code XA)

Specification and selection of product materials, options, or components must be made by the purchaser of the equipment. See [page 8](#) for more information on Material Selection.

Table 1. Rosemount 3144P Temperature Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

Model	Product description			
3144P	Temperature Transmitter			
Housing style		Material	Conduit entry size	
D1	Field Mount Housing, Dual-Compartment Housing	Aluminum	1/2-14 NPT	★
D2	Field Mount Housing, Dual-Compartment Housing	Aluminum	M20 × 1.5 (CM20)	★
D3	Field Mount Housing, Dual-Compartment Housing	Aluminum	PG 13.5 (PG11)	★
D4	Field Mount Housing, Dual-Compartment Housing	Aluminum	JIS G 1/2	★
D5	Field Mount Housing, Dual-Compartment Housing	Stainless Steel	1/2-14 NPT	★
D6	Field Mount Housing, Dual-Compartment Housing	Stainless Steel	M20 × 1.5 (CM20)	★
D7	Field Mount Housing, Dual-Compartment Housing	Stainless Steel	PG 13.5 (PG11)	★
D8	Field Mount Housing, Dual-Compartment Housing	Stainless Steel	JIS G 1/2	★
Transmitter output				
A	4-20 mA with digital signal based on HART protocol			★
F	FOUNDATION fieldbus digital signal (includes 3 AI function block and Backup Link Active Scheduler)			★
Measurement configuration				
1	Single-Sensor Input			★
2	Dual-Sensor Input			★

Table 1. Rosemount 3144P Temperature Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

Product certifications		
NA	No Approval	★
E5	FM Explosion-proof, Dust Ignition-Proof, and Non-incendive approval	★
I5 ⁽¹⁾	FM Intrinsically Safe and Non-incendive (includes standard IS and FISCO for fieldbus units)	★
K5 ⁽¹⁾	FM IS, Non-incendive & Explosion-proof combo (includes standard IS and FISCO for fieldbus units)	★
KB ⁽¹⁾	FM and CSA IS, Explosion-proof, and Non-incendive combo (includes standard IS and FISCO for FF units)	★
I6 ⁽¹⁾	CSA Intrinsically Safe/FISCO and Division 2 (includes standard IS and FISCO for fieldbus units)	★
K6 ⁽¹⁾	CSA IS, FISCO Division 2 and Explosion-proof combo (includes standard IS, FISCO for fieldbus units)	★
E1	ATEX Flameproof approval	★
N1	ATEX type n approval	★
I1 ⁽¹⁾	ATEX intrinsic safety approval (includes standard IS and FISCO for fieldbus units)	★
K1 ⁽¹⁾	ATEX IS, Flameproof, Dust Ignition-Proof and type n combo (includes standard IS and FISCO for fieldbus units)	★
ND	ATEX Dust Ignition-Proof approval	★
KA ⁽¹⁾	ATEX/CSA intrinsic safety, Explosion-proof combo (includes standard IS and FISCO for fieldbus units)	★
E7	IECEx Flameproof approval	★
N7	IECEx Type 'n' approval	★
I7 ⁽¹⁾⁽²⁾	IECEx Intrinsic Safety	★
K7 ⁽¹⁾⁽²⁾	IECEx Intrinsic Safety, Flameproof, Dust Ignition-Proof and Type n combination	★
E2 ⁽²⁾	INMETRO Flameproof	★
I2 ⁽²⁾⁽⁶⁾	INMETRO Intrinsic safety	★
E4 ⁽²⁾	TIIS Flameproof approval	★
E3 ⁽²⁾	NEPSI Flameproof approval	★
I3 ⁽¹⁾⁽²⁾	NEPSI Intrinsic safety	★
KM	Technical Regulations Customs Union (EAC) Flameproof, Intrinsic Safety	★
IM	Technical Regulations Customs Union (EAC) Intrinsic Safety	★
EM	Technical Regulations Customs Union (EAC) Flameproof	★

Options (include with selected model number)

PlantWeb[®] control functionality		
A01	FOUNDATION fieldbus Advanced Control Function Block Suite	★
PlantWeb advanced diagnostic functionality		
D01	FOUNDATION fieldbus Sensor and Process Diagnostic Suite: Thermocouple Diagnostic, Min/Max Tracking	★
DA1	HART Sensor and Process Diagnostic Suite: Thermocouple Diagnostic, Min/Max Tracking	★
Enhanced performance		
P8 ⁽³⁾	Enhanced Transmitter Accuracy	★

Table 1. Rosemount 3144P Temperature Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

Mounting bracket		
B4	“U” Mounting Bracket for 2-inch pipe mounting - All SST	★
B5	“L” Mounting Bracket for 2-inch pipe or panel mounting - All SST	★
Display		
M5	LCD Display	★
External ground		
G1	External Ground Lug Assembly	★
Transient protector		
T1 ⁽⁴⁾	Integral Transient Protector	★
Software configuration		
C1 ⁽⁵⁾	Custom Configuration of Date, Descriptor and Message (requires CDS with order)	★
Line filter		
F5	50 Hz Line Voltage Filter	★
Alarm level configuration		
A1 ⁽⁴⁾	NAMUR Alarm and Saturation Levels, High Alarm	★
CN	NAMUR Alarm and Saturation Levels, Low Alarm	★
Low alarm		
C8	Low Alarm (Standard Rosemount Alarm and Saturation Values)	★
Sensor trim		
C2	Transmitter-Sensor Matching – Trim to PT100 RTD Calibration Schedule (CVD constants)	★
C7	Trim to Non-Standard Sensor (Special Sensor–Customer must provide sensor information)	
5-point calibration		
C4	5-Point Calibration (requires the Q4 option code to generate a Calibration Certificate)	★
Calibration certification		
Q4	Calibration Certificate (3-Point Calibration)	★
QG	Calibration Certificate and GOST Verification Certificate	★
QP	Calibration Certificate and Tamper Evident Seal	★
Dual-input custom configuration (only with measurement type option code 2)		
U1 ⁽⁵⁾	Hot Backup	★
U2 ⁽⁵⁾	Average temperature with Hot Backup and Sensor Drift Alert – warning mode	★
U3 ⁽⁶⁾	Average temperature with Hot Backup and Sensor Drift Alert – alarm mode	★
U5	Differential temperature	★
U6 ⁽⁵⁾	Average temperature	★

Table 1. Rosemount 3144P Temperature Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

Dual-input custom configuration (only with measurement type option code 2)		
U7 ⁽⁵⁾	First good temperature	★
U4	Two independent sensors	
Customer transfer		
D3 ⁽⁵⁾⁽⁶⁾	Custody Transfer Approval (Canada)	
D4 ⁽⁶⁾	MID Custody Transfer (Europe)	
Quality certification for safety		
QS	Prior-use certificate of FMEDA data (HART only)	★
QT	Safety-certified to IEC 61508 with certificate of FMEDA data (HART only)	★
Shipboard certification		
SBS	American Bureau of Shipping (ABS) Type Approval	★
SBV	Bureau Veritas (BV) Type Approval	★
SDN	Det Norske Veritas (DNV) Type Approval	★
SLL	Lloyd's Register (LR) Type Approval	★
Conduit electrical connector		
GE ⁽⁶⁾	M12, 4-pin, Male Connector (eurofast [®])	★
GM ⁽⁶⁾	A size Mini, 4-pin, Male Connector (minifast [®])	★
HART revision configuration		
HR7	Configured for HART Revision 7	★
Assemble to options		
XA	Sensor Specified Separately and Assembled to Transmitter	★
Extended product warranty		
WR3	3-year limited warranty	★
WR5	5-year limited warranty	★
Typical model number: 3144P D1 A 1 E5 B4 M5		

(1) When IS approval is ordered on a FOUNDATION fieldbus, both standard IS and FISCO IS approvals apply. The device label is marked appropriately.

(2) Consult factory for availability when ordering with HART or FOUNDATION fieldbus models.

(3) Enhanced accuracy only applies to RTDs, however the option can be ordered with any sensor type.

(4) Ambient temperature effect specification valid over minimum temperature span of 28 °C (50 °F).

(5) Consult factory for availability when ordering with FOUNDATION fieldbus models.

(6) Available with Intrinsically Safe approvals only. For FM Intrinsically Safe or non-incendive approval (option code I5), install in accordance with Rosemount drawing 03151-1009 to maintain 4X rating.

Transmitter Specifications

HART and FOUNDATION fieldbus

Functional specifications

Inputs

User-selectable. See [Table 2 on page 9](#) for sensor options.

Output

2-wire device with either 4–20 mA/HART, linear with temperature or input, or completely digital output with FOUNDATION fieldbus communication (ITK 6.0.1 compliant).

Isolation

Input/output isolation specified to 500 Vdc (500 Vrms 707 V peak) at 50/60 Hz.

Humidity limits

0–99% relative humidity.

Update time

Approximately 0.5 seconds for a single sensor (1 second for dual sensors).

Physical specifications

Material selection

Emerson provides a variety of Rosemount product with various product options and configurations including materials of construction that can be expected to perform well in a wide range of applications. The Rosemount product information presented is intended as a guide for the purchaser to make an appropriate selection for the application. It is the purchaser's sole responsibility to make a careful analysis of all process parameters (such as all chemical components, temperature, pressure, flow rate, abrasives, contaminants, etc.), when specifying product, materials, options and components for the particular application. Emerson Process Management is not in a position to evaluate or guarantee the compatibility of the process fluid or other process parameters with the product, options, configuration or materials of construction selected.

Conformance to specification ($\pm 3\sigma$ [Sigma])

Technology leadership, advanced manufacturing techniques, and statistical process control ensure specification conformance to at least $\pm 3\sigma$.

Conduit connections

The standard field mount housing has $1/2$ –14 NPT conduit entries. Additional conduit entry types are available, including PG13.5 (PG11), M20 \times 1.5 (CM20), or JIS G $1/2$. When any of these additional entry types are ordered, adapters are placed in the standard field housing so these alternative conduit types fit correctly. See “[Dimensional drawings](#)” on [page 21](#) for dimensions.

Materials of construction

Electronics housing

Low-copper aluminum or CF-8M (cast version of 316 Stainless Steel)

Paint

Polyurethane

Cover O-rings

Buna-N

Mounting

Transmitters may be attached directly to the sensor. Optional mounting brackets (codes B4 and B5) allow for remote mounting. See “[Optional Transmitter Mounting Brackets](#)” on [page 23](#).

Weight

Aluminum ⁽¹⁾	Stainless steel ⁽¹⁾
3.1 lb (1.4 kg)	7.8 lb (3.5 kg)

(1) Add 0.5 lb (0.2 kg) for local display or 1.0 lb (0.5 kg) for bracket options.

Enclosure ratings

Type 4X

IP66 and IP68

Stability

- RTDs: - $\pm 0.1\%$ of reading or 0.1 °C, whichever is greater, for 24 months.
- Thermocouples: - $\pm 0.1\%$ of reading or 0.1 °C, whichever is greater, for 12 months.

5 Year stability

- RTDs: - $\pm 0.25\%$ of reading or $0.25\text{ }^{\circ}\text{C}$, whichever is greater, for 5 years.
- Thermocouples: - $\pm 0.5\%$ of reading or $0.5\text{ }^{\circ}\text{C}$, whichever is greater, for 5 years.

Vibration effect

Tested to the following with no effect on performance per IEC 60770-1, 1999:

Frequency	Acceleration
10–60 Hz	0.21 mm peak displacement
60–2000 Hz	3 g

Self calibration

The analog-to-digital measurement circuitry automatically self-calibrates for each temperature update by comparing the dynamic measurement to extremely stable and accurate internal reference elements.

RFI effect

Worst case RFI effect is equivalent to the transmitter's nominal accuracy specification, according to [Table 2 on page 9](#), when tested in accordance with IEC 61000-4-3, 30 V/m (HART)/20 V/m (HART T/C)/10 V/m (FOUNDATION fieldbus), 80 to 1000 MHz, with unshielded cable.

CE electromagnetic compatibility compliance testing

The Rosemount 3144P meets or exceeds all requirements listed under IEC 61326: 2006.

Table 2. Transmitter Accuracy

Sensor options	Sensor reference	Input ranges		Minimum span ⁽¹⁾		Digital accuracy ⁽²⁾		Enhanced accuracy ⁽³⁾	D/A accuracy ⁽⁴⁾⁽⁵⁾
		$^{\circ}\text{C}$	$^{\circ}\text{F}$	$^{\circ}\text{C}$	$^{\circ}\text{F}$	$^{\circ}\text{C}$	$^{\circ}\text{F}$	$^{\circ}\text{C}$	
2-, 3-, 4-wire RTDs									
Pt 100 ($\alpha = 0.00385$)	IEC 751	-200 to 850	-328 to 1562	10	18	± 0.10	± 0.18	± 0.08	$\pm 0.02\%$ of span
Pt 200 ($\alpha = 0.00385$)	IEC 751	-200 to 850	-328 to 1562	10	18	± 0.22	± 0.40	± 0.176	$\pm 0.02\%$ of span
Pt 500 ($\alpha = 0.00385$)	IEC 751	-200 to 850	-328 to 1562	10	18	± 0.14	± 0.25	± 0.112	$\pm 0.02\%$ of span
Pt 1000 ($\alpha = 0.00385$)	IEC 751	-200 to 300	-328 to 572	10	18	± 0.10	± 0.18	± 0.08	$\pm 0.02\%$ of span
Pt 100 ($\alpha = 0.003916$)	JIS 1604	-200 to 645	-328 to 1193	10	18	± 0.10	± 0.18	± 0.08	$\pm 0.02\%$ of span
Pt 200 ($\alpha = 0.003916$)	JIS 1604	-200 to 645	-328 to 1193	10	18	± 0.22	± 0.40	± 0.176	$\pm 0.02\%$ of span
Ni 120	Edison Curve No. 7	-70 to 300	-94 to 572	10	18	± 0.08	± 0.14	± 0.064	$\pm 0.02\%$ of span
Cu 10	Edison Copper Winding No. 15	-50 to 250	-58 to 482	10	18	± 1.00	± 1.80	± 0.8	$\pm 0.02\%$ of span
Pt 50 ($\alpha = 0.00391$)	GOST 6651-94	-200 to 550	-328 to 1022	10	18	± 0.20	± 0.36	± 0.16	$\pm 0.02\%$ of span
Pt 100 ($\alpha = 0.00391$)	GOST 6651-94	-200 to 550	-328 to 1022	10	18	± 0.10	± 0.18	± 0.08	$\pm 0.02\%$ of span

External ground screw assembly

The external ground screw assembly can be ordered by specifying code G1. However, some approvals include the ground screw assembly in the transmitter shipment, hence it is not necessary to order code G1. The table below identifies which approval options include the external ground screw assembly.

Approval type	External ground screw assembly included? ⁽¹⁾
E5, I1, I2, I5, I6, I7, K5, K6, KB, NA	No—Order option code G1
E1, E2, E3, E4, E7, K1, K7, KA, N1, N7, ND, NF	Yes

(1) The parts contained with the G1 option are included with the Integral Protector option code T1. When ordering T1, the G1 option code does not need to be ordered separately.

Hardware tag

- No charge
- 2 lines of 28 characters (56 characters total)
- Tags are stainless steel
- Permanently attached to transmitter
- Character height is $1/16$ -in. (1.6mm)
- A wire-on tag is available upon request. 5 lines of 12 characters (60 characters total)

Software tag

- HART transmitter can store up to 8 characters in HART 5 mode and 32 characters in HART 7 mode. FOUNDATION fieldbus transmitters can store up to 32 characters.
- Can be ordered with different software and hardware tags.
- If no software tag characters are specified, the first 8 characters of the hardware tag are the default.

Table 2. Transmitter Accuracy

Sensor options	Sensor reference	Input ranges		Minimum span ⁽¹⁾		Digital accuracy ⁽²⁾		Enhanced accuracy ⁽³⁾	D/A accuracy ⁽⁴⁾⁽⁵⁾
		°C	°F	°C	°F	°C	°F	°C	
2-, 3-, 4-wire RTDs									
Cu 50 ($\alpha=0.00426$)	GOST 6651-94	-50 to 200	-58 to 392	10	18	± 0.34	± 0.61	± 0.272	$\pm 0.02\%$ of span
Cu 50 ($\alpha=0.00428$)	GOST 6651-94	-185 to 200	-301 to 392	10	18	± 0.34	± 0.61	± 0.272	$\pm 0.02\%$ of span
Cu 100 ($\alpha=0.00426$)	GOST 6651-94	-50 to 200	-58 to 392	10	18	± 0.17	± 0.31	± 0.136	$\pm 0.02\%$ of span
Cu 100 ($\alpha=0.00428$)	GOST 6651-94	-185 to 200	-301 to 392	10	18	± 0.17	± 0.31	± 0.136	$\pm 0.02\%$ of span
Thermocouples⁽⁶⁾									
Type B ⁽⁷⁾	NIST Monograph 175, IEC 584	100 to 1820	212 to 3308	25	45	± 0.75	± 1.35	N/A	$\pm 0.02\%$ of span
Type E	NIST Monograph 175, IEC 584	-50 to 1000	-58 to 1832	25	45	± 0.20	± 0.36	N/A	$\pm 0.02\%$ of span
Type J	NIST Monograph 175, IEC 584	-180 to 760	-292 to 1400	25	45	± 0.25	± 0.45	N/A	$\pm 0.02\%$ of span
Type K ⁽⁸⁾	NIST Monograph 175, IEC 584	-180 to 1372	-292 to 2501	25	45	± 0.25	± 0.45	N/A	$\pm 0.02\%$ of span
Type N	NIST Monograph 175, IEC 584	-200 to 1300	-328 to 2372	25	45	± 0.40	± 0.72	N/A	$\pm 0.02\%$ of span
Type R	NIST Monograph 175, IEC 584	0 to 1768	32 to 3214	25	45	± 0.60	± 1.08	N/A	$\pm 0.02\%$ of span
Type S	NIST Monograph 175, IEC 584	0 to 1768	32 to 3214	25	45	± 0.50	± 0.90	N/A	$\pm 0.02\%$ of span
Type T	NIST Monograph 175, IEC 584	-200 to 400	-328 to 752	25	45	± 0.25	± 0.45	N/A	$\pm 0.02\%$ of span
DIN Type L	DIN 43710	-200 to 900	-328 to 1652	25	45	± 0.35	± 0.63	N/A	$\pm 0.02\%$ of span
DIN Type U	DIN 43710	-200 to 600	-328 to 1112	25	45	± 0.35	± 0.63	N/A	$\pm 0.02\%$ of span
Type W5Re/W26Re	ASTM E 988-96	0 to 2000	32 to 3632	25	45	± 0.70	± 1.26	N/A	$\pm 0.02\%$ of span
GOST Type L	GOST R 8.585-2001	-200 to 800	-392 to 1472	25	45	± 0.25	± 0.45	N/A	$\pm 0.02\%$ of span
Other input types									
Millivolt Input		-10 to 100 mV		3 mV		± 0.015 mV		N/A	$\pm 0.02\%$ of span
2-, 3-, 4-wire Ohm Input		0 to 2000 ohms		20 ohm		± 0.35 ohm		N/A	$\pm 0.02\%$ of span

(1) No minimum or maximum span restrictions within the input ranges. Recommended minimum span will hold noise within accuracy specification with damping at zero seconds.

(2) Digital accuracy: Digital output can be accessed by the Field Communicator.

(3) Enhanced accuracy can be ordered using the P8 Model Code.

(4) Total Analog accuracy is the sum of digital and D/A accuracies.

(5) Applies to HART/4-20 mA devices.

(6) Total digital accuracy for thermocouple measurement: sum of digital accuracy $+0.25$ °C (0.45 °F) (cold junction accuracy).

(7) Digital accuracy for NIST Type B is ± 3.0 °C (± 5.4 °F) from 100 to 300 °C (212 to 572 °F).

(8) Digital accuracy for NIST Type K is ± 0.50 °C (± 0.9 °F) from -180 to -90 °C (-292 to -130 °F).

Reference accuracy example (HART only)

When using a Pt 100 ($\alpha = 0.00385$) sensor input with a 0 to 100 °C span: Digital Accuracy would be ± 0.10 °C, D/A accuracy would be $\pm 0.02\%$ of 100 °C or ± 0.02 °C, Total = ± 0.12 °C.

Differential capability exists between any two sensor types (dual-sensor option)

For all differential configurations, the input range is X to Y where:

- X = Sensor 1 minimum – Sensor 2 maximum and
- Y = Sensor 1 maximum – Sensor 2 minimum

Digital accuracy for differential configurations (dual-sensor option, HART only)

- Sensor types are similar (e.g., both RTDs or both T/Cs): Digital Accuracy = 1.5 times worst case accuracy of either sensor type
- Sensor types are dissimilar (e.g., one RTD, one T/C): Digital Accuracy = Sensor 1 Accuracy + Sensor 2 Accuracy

Ambient temperature effect

Transmitters may be installed in locations where the ambient temperature is between -40 and 85 °C (-40 and 185 °F). To maintain excellent accuracy performance, each transmitter is individually characterized over this ambient temperature range at the factory.

Table 3. Ambient Temperature Effect on Digital Accuracy

Sensor options	Sensor reference	Effect per 1.0 °C (1.8 °F) change in ambient ⁽¹⁾⁽²⁾	Input temperature (T)	D/A effect ⁽³⁾
2-, 3-, or 4-wire RTDs				
Pt 100 ($\alpha = 0.00385$)	IEC 751	0.0015 °C (0.0027 °F)	Entire Sensor Input Range	0.001% of span
Pt 200 ($\alpha = 0.00385$)	IEC 751	0.0023 °C (0.00414 °F)	Entire Sensor Input Range	0.001% of span
Pt 500 ($\alpha = 0.00385$)	IEC 751	0.0015 °C (0.0027 °F)	Entire Sensor Input Range	0.001% of span
Pt 1000 ($\alpha = 0.00385$)	IEC 751	0.0015 °C (0.0027 °F)	Entire Sensor Input Range	0.001% of span
Pt 100 ($\alpha = 0.003916$)	JIS 1604	0.0015 °C (0.0027 °F)	Entire Sensor Input Range	0.001% of span
Pt 200 ($\alpha = 0.003916$)	JIS 1604	0.0023 °C (0.00414 °F)	Entire Sensor Input Range	0.001% of span
Ni 120	Edison Curve No. 7	0.0010 °C (0.0018 °F)	Entire Sensor Input Range	0.001% of span
Cu 10	Edison Copper Winding No. 15	0.015 °C (0.027 °F)	Entire Sensor Input Range	0.001% of span
Pt 50 ($\alpha = 0.00391$)	GOST 6651-94	0.003 °C (0.0054 °F)	Entire Sensor Input Range	0.001% of span
Pt 100 ($\alpha = 0.00391$)	GOST 6651-94	0.0015 °C (0.0027 °F)	Entire Sensor Input Range	0.001% of span
Cu 50 ($\alpha = 0.00426$)	GOST 6651-94	0.003 °C (0.0054 °F)	Entire Sensor Input Range	0.001% of span
Cu 50 ($\alpha = 0.00428$)	GOST 6651-94	0.003 °C (0.0054 °F)	Entire Sensor Input Range	0.001% of span
Cu 100 ($\alpha = 0.00426$)	GOST 6651-94	0.0015 °C (0.0027 °F)	Entire Sensor Input Range	0.001% of span
Cu 100 ($\alpha = 0.00428$)	GOST 6651-94	0.0015 °C (0.0027 °F)	Entire Sensor Input Range	0.001% of span
Thermocouples				
Type B	NIST Monograph 175, IEC 584	0.014 °C 0.029 °C – 0.0021% of (T – 300) 0.046 °C – 0.0086% of (T – 100)	$T \geq 1000$ °C $300 \text{ °C} \leq T < 1000$ °C $100 \text{ °C} \leq T < 300$ °C	0.001% of span
Type E	NIST Monograph 175, IEC 584	0.004 °C + 0.00043% of T	N/A	0.001% of span
Type J	NIST Monograph 175, IEC 584	0.004 °C + 0.00029% of T 0.004 °C + 0.0020% of abs. val. T	$T \geq 0$ °C $T < 0$ °C	0.001% of span
Type K	NIST Monograph 175, IEC 584	0.005 °C + 0.00054% of T 0.005 °C + 0.0020% of abs. val. T	$T \geq 0$ °C $T < 0$ °C	0.001% of span
Type N	NIST Monograph 175, IEC 584	0.005 °C + 0.00036% of T	All	0.001% of span
Types R	NIST Monograph 175, IEC 584	0.015 °C 0.021 °C – 0.0032% of T	$T \geq 200$ °C $T < 200$ °C	0.001% of span
Types S	NIST Monograph 175, IEC 584	0.015 °C 0.021 °C – 0.0032% of T	$T \geq 200$ °C $T < 200$ °C	0.001% of span
Type T	NIST Monograph 175, IEC 584	0.005 °C 0.005 °C + 0.0036% of abs. val. T	$T \geq 0$ °C $T < 0$ °C	0.001% of span
DIN Type L	DIN 43710	0.0054 °C + 0.00029% of R 0.0054 °C + 0.0025% of abs. val. T	$T \geq 0$ °C $T < 0$ °C	0.001% of span
DIN Type U	DIN 43710	0.0064 °C 0.0064 °C + 0.0043% of abs. val. T	$T \geq 0$ °C $T < 0$ °C	0.001% of span

Table 3. Ambient Temperature Effect on Digital Accuracy

Thermocouples				
Type W5Re/W26Re	ASTM E 988-96	0.016 °C 0.023 °C + 0.0036% of T	T ≥ 200 °C T < 200 °C	0.001% of span
GOST Type L	GOST R 8.585-2001	0.005 > 0 °C 0.005 - 0.003% < 0 °C	N/A	0.001% of span
Other input types				
Millivolt Input		0.00025 mV	Entire Sensor Input Range	0.001% of span
2-, 3-, 4-wire Ohm Input		0.007 Ω	Entire Sensor Input Range	0.001% of span

- (1) Change in ambient is in reference to the calibration temperature of the transmitter (20 °C [68 °F]).
- (2) Ambient temperature effect specification valid over minimum temperature span of 28°C (50°F)
- (3) Applies to HART / 4-20 mA devices.

Temperature effects example

When using a Pt 100 ($\alpha = 0.00385$) sensor input with a 0 to 100 °C span at 30 °C ambient temperature, the following statements would be true:

Digital temp effects

- $0.0015 \frac{^{\circ}\text{C}}{^{\circ}\text{C}} \times (30^{\circ}\text{C} - 20^{\circ}\text{C}) = 0.015^{\circ}\text{C}$

D/A effects (HART / 4–20 mA only)%

- $[0.001\% / ^{\circ}\text{C of span}] \times |(\text{Ambient temp} - \text{Calibrated temp})|$
= D/A Effects
- $[0.001\% / ^{\circ}\text{C} \times 100] \times |(30 - 20)| = 0.01^{\circ}\text{C}$

Worst case error

- Digital + D/A + Digital Temp Effects + D/A Effects
= $0.10^{\circ}\text{C} + 0.02^{\circ}\text{C} + 0.015^{\circ}\text{C} + 0.01^{\circ}\text{C} = 0.145^{\circ}\text{C}$

Total probable error

$$\sqrt{0.10^2 + 0.02^2 + 0.015^2 + 0.01^2} = 0.10^{\circ}\text{C}$$

HART/4–20 mA specifications

Power supply

External power supply required. Transmitters operate on 12.0 to 42.4 Vdc transmitter terminal voltage (with 250 ohm load, 18.1 Vdc power supply voltage is required). Transmitter power terminals rated to 42.4 Vdc.

Wiring diagram

See [Figure 5 on page 24](#).

Alarms

Custom factory configurations of alarm and saturation levels are available for valid values with option code C1. These values can also be configured in the field using a Field Communicator.

Transient protection (option code T1)

The transient protector helps to prevent damage to the transmitter from transients induced on the loop wiring by lightning, welding, heavy electrical equipment, or switch gears. The transient protection electronics are contained in an add-on assembly that attaches to the standard transmitter terminal block. The external ground lug assembly (code G1) is included with the Transient Protector. The transient protector has been tested per the following standard:

- IEEE C62.41-1991 (IEEE 587)/ Location Categories B3.
6kV/3kA peak (1.2 × 50 μS Wave 8 × 20 μS Combination Wave) 6kV/0.5kA peak (100 kHz Ring Wave)
EFT, 4kVpeak, 2.5kHz, 5*50nS
- Loop resistance added by protector: 22 ohms max.
- Nominal clamping voltages: 90 V (common mode), 77 V (normal mode)

Local display

Optional five-digit LCD display includes 0–100% bar graph. Digits are 0.4 inches (8 mm) high. Display options include engineering units (°F, °C, °R, K, ohms, and millivolts), percent, and milliamperes. The display can also be set to alternate between engineering units/milliamperes, Sensor 1/Sensor 2, Sensor 1/Sensor 2/Differential Temperature, and Sensor 1/Sensor 2/Average Temperature. All display options, including the decimal point, may be reconfigured in the field using a Field Communicator or AMS[®] Device Manager.

Turn-on time

Performance within specifications is achieved less than 6 seconds after power is applied to the transmitter when the damping value is set to 0 seconds.

Power supply effect

Less than ±0.005% of span per volt.

SIS safety transmitter failure values

IEC 61508 Safety Certified SIL 2 and SIL 3 Claim Limit

- Safety accuracy: Span ≥ 100 °C: ± 2% of process variable span
- Span < 100 °C: ± 2 °C
- Safety response time: 5 seconds
- Safety specifications and FMEDA Report available at www.rosemount.com/safety
- Software suitable for SIL3 Applications

Temperature limits

Description	Operating limit	Storage limit
Without LCD display	–40 to 185 °F –40 to 85 °C	–60 to 250 °F –50 to 120 °C
With LCD display ⁽¹⁾	–40 to 185 °F –40 to 85 °C	–40 to 185 °F –40 to 85 °C

(1) LCD display may not be readable and LCD display updates will be slower at temperatures below -4 °F (-20 °C).

Field Communicator connections

Field Communicator connections are permanently fixed to power/signal block.

Failure mode

The Rosemount 3144P features software and hardware failure mode detection. An independent circuit is designed to provide backup alarm output if the microprocessor hardware or software fails.

The alarm level is user-selectable using the failure mode switch. If failure occurs, the position of the hardware switch determines the direction in which the output is driven (HIGH or LOW). The switch feeds into the digital-to-analog (D/A) converter, which drives the proper alarm output even if the microprocessor fails. The values at which the transmitter drives its output in failure mode depends on whether it is configured to standard, or NAMUR-compliant (NAMUR recommendation NE 43) operation. The values for standard and NAMUR-compliant operation are as follows:

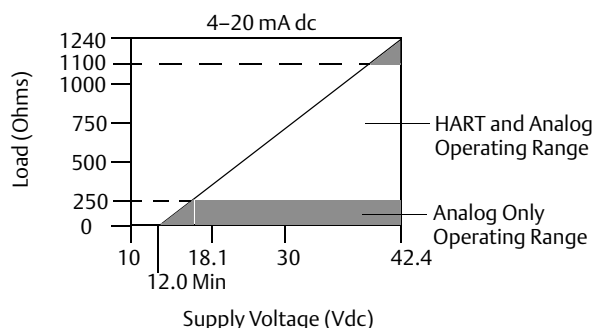
Table 4. Operation Parameters

	Standard ⁽¹⁾	NAMUR-compliant ⁽¹⁾
Linear Output	3.9 ≤ I ≤ 20.5	3.8 ≤ I ≤ 20.5
Fail HIGH	21.75 ≤ I ≤ 23 (default)	21.5 ≤ I ≤ 23 (default)
Fail Low	I ≤ 3.75	I ≤ 3.6

(1) Measured in milliamperes.

Load limitations

Maximum load = 40.8 × (supply voltage - 12.0)⁽¹⁾



(1) Without transient protection (optional).

Note

HART communication requires a loop resistance between 250 and 1100 ohms. Do not communicate with the transmitter when power is below 12 Vdc at the transmitter terminals.

FOUNDATION fieldbus specifications

Fieldbus Foundation device registration

Device tested and registered to ITK 6.0.1

Power supply

Powered over FOUNDATION fieldbus with standard fieldbus power supplies. Transmitters operate on 9.0 to 32.0 Vdc, 12 mA maximum. Transmitter power terminals are rated to 42.4 Vdc.

Wiring diagram

See [Figure 6 on page 24](#).

Alarms

The AI function block allows the user to configure the alarms to HIGH-HIGH, HIGH, LOW, or LOW-LOW with a variety of priority levels and hysteresis settings.

Transient protection (option code T1)

The transient protector helps to prevent damage to the transmitter from transients induced on the loop wiring by lightning, welding, heavy electrical equipment, or switch gears. The transient protection electronics are contained in an add-on assembly that attaches to the standard transmitter terminal block. The transient terminal block is not polarity insensitive. The transient protector has been tested to the following standard:

- IEEE C62.41-1991 (IEEE 587)/ Location Categories B3.
6kV/3kA peak ($1.2 \times 50 \mu\text{S}$ Wave $8 \times 20 \mu\text{S}$ Combination Wave)
6kV/0.5kA peak (100 kHz Ring Wave)
EFT, 4kVpeak, 2.5kHz, $5 \times 50\text{nS}$
- Loop resistance added by protector: 22 ohms maximum
- Nominal clamping voltages: 90 V (common mode), 77 V (normal mode)

Diagnostics suite for FOUNDATION fieldbus (option code D01)

The 3144P Diagnostics Suite for FOUNDATION fieldbus provides advanced functionality in the form of Statistical Process Monitoring (SPM), a thermocouple Diagnostic, and Sensor Drift Alert. SPM technology calculates the mean and standard deviation of the process variable and makes them available to the user. This may be used to detect abnormal process situations.

The Thermocouple Diagnostic enables the 3144P to measure and monitor the resistance of thermocouple loops in order to detect drift or changing wiring connections.

Sensor Drift Alert allows the user to monitor the difference in measurement between two sensors installed in one process point. A change in this differential value may indicate drifting sensors.

Local display

Displays all DS_65 measurements in the Transducer and Function Blocks including Sensor 1, Sensor 2, differential, and terminal temperatures. The display alternates up to four selected items. The meter can display up to five digits in engineering units ($^{\circ}\text{F}$, $^{\circ}\text{C}$, $^{\circ}\text{R}$, K, Ω , and millivolts). Display settings are configured at the factory according to the transmitter configuration (standard or custom). These settings can be reconfigured in the field using a Field Communicator or DeltaV™. In addition, the LCD display provides the ability to display DS_65 parameters from other devices. In addition to the configuration of the meter, sensor diagnostic data is displayed. If the measurement status is Good, the measured value is shown. If the measurement status is Uncertain, the status indicating uncertain is shown in addition to the measured value. If the measurement status is Bad, the reason for the bad measurement is shown.

Note

When ordering a spare electronics module assembly, the LCD display transducer block will display the default parameter.

Turn-on time

Performance within specifications is achieved less than 20 seconds after power is applied to the transmitter when the damping value is set to 0 seconds.

Status

The device is compliant to NAMUR NE 107, ensuring consistent, reliable and standardized device diagnostic information.

The new standard is designed to improve the way device status and diagnostic information is communicated to operators and maintenance personnel in order to increase productivity and reduce costs.

If self-diagnostics detect a sensor burnout or a transmitter failure, the status of the measurement will be updated accordingly. The status may also send the PID output to a safe value.

FOUNDATION fieldbus parameters

Schedule Entries	25 (max.)
Links	30 (max.)
Virtual Communications Relationships (VCR)	20 (max.)

Backup Link Active Scheduler (LAS)

The transmitter is classified as a device link master, which means it can function as a Link Active Scheduler (LAS) if the current link master device fails or is removed from the segment. The host or other configuration tool is used to download the schedule for the application to the link master device. In the absence of a primary link master, the transmitter will claim the LAS and provide permanent control for the H1 segment.

Function blocks

- All blocks will ship with unique block names, e.g. AI_1400_XXXX.
- All blocks shall be instantiated to avoid invalid defaults.
- All Rosemount 3144P FF have parameter COMPATIBILITY_REV for backward compatibility.
- Parameters will be initialized to common values for easier bench configuration.
- All default block tags are less than or equal to 16 characters in length to avoid inconvenience of apparently identical tags.
- Default block tags include underscores, “_”, instead of whitespaces for easier configuration.

Resource block

- Contains physical transmitter information including available memory, manufacture identification, device type, software tag, and unique identification.
- PlantWeb Alerts enable the full power of the PW digital architecture by diagnosing instrumentation issues, communicating the details, and recommending a solution.

Transducer block

- Contains the actual temperature measurement data, including sensor 1, sensor 2, and terminal temperature
- Includes information about sensor type and configuration, engineering units, linearization, range, damping, and diagnostics
- Device Revision 3 and above includes Hot Backup functionality in the transducer block

LCD display block (when an LCD display is used)

- Configures the local display.

Analog input (AI)

- Processes the measurement and makes it available on the fieldbus segment.
- Allows filtering, engineering unit, and alarm changes.
- All devices ship with the AI blocks scheduled, meaning no configuration is needed if the factory default channels are used

PID block (provides control functionality)

- Performs single loop, cascade, or feedforward control in the field.

Block	Execution time
Resource	N/A
Transducer	N/A
LCD display Block	N/A
Advanced Diagnostics	N/A
Analog Input 1, 2, 3, 4	60 milliseconds
PID 1 and 2 with Autotune	90 milliseconds
Input Selector	65 milliseconds
Signal Characterizer	60 milliseconds
Arithmetic	60 milliseconds
Output Splitter	60 milliseconds

Product Certifications

Rev 1.1

European Directive Information

A copy of the EC Declaration of Conformity can be found at the end of the Quick Start Guide. The most recent revision of the EC Declaration of Conformity can be found at www.rosemount.com.

Ordinary Location Certification

As standard, the transmitter has been examined and tested to determine that the design meets the basic electrical, mechanical, and fire protection requirements by a nationally recognized test laboratory (NRTL) as accredited by the Federal Occupational Safety and Health Administration (OSHA).

North America

E5 FM Explosionproof, Dust-Ignitionproof, and Nonincendive Certificate: 3012752

Standards: FM Class 3600: 1998, FM Class 3611: 2004, FM Class 3615: 1989, FM Class 3810: 2005, NEMA-250: 1991, ANSI/ISA 60079-0: 2009, ANSI/ISA 60079-11: 2009

Markings: XP CL I, DIV 1, GP A, B, C, D; T5(-50 °C ≤ T_a ≤ +85 °C); DIP CL II/III, DIV 1, GP E, F, G; T5(-50 °C ≤ T_a ≤ +75 °C); T6(-50 °C ≤ T_a ≤ +60 °C); when installed per Rosemount drawing 03144-0320; NI CL I, DIV 2, GP A, B, C, D; T5(-60 °C ≤ T_a ≤ +75 °C); T6(-60 °C ≤ T_a ≤ +50 °C); when installed per Rosemount drawing 03144-0321, 03144-5075;

I5 FM Intrinsic Safety and Nonincendive Certificate: 3012752

Standards: FM Class 3600: 1998, FM Class 3610: 2010, FM Class 3611: 2004, FM Class 3810: 2005, NEMA-250: 1991, ANSI/ISA 60079-0: 2009, ANSI/ISA 60079-11: 2009

Markings: IS CL I / II / III, DIV 1, GP A, B, C, D, E, F, G; T4(-60 °C ≤ T_a ≤ +60 °C); IS [Entity] CL I, Zone 0, AEx ia IIC T4(-60 °C ≤ T_a ≤ +60 °C); NI CL I, DIV 2, GP A, B, C, D; T5(-60 °C ≤ T_a ≤ +75 °C); T6(-60 °C ≤ T_a ≤ +50 °C); when installed per Rosemount drawing 03144-0321, 03144-5075;

I6 CSA Intrinsic Safety and Division 2

Certificate: 1242650

Standards: CAN/CSA C22.2 No. 0-M91 (R2001), CAN/CSA-C22.2 No. 94-M91, CSA Std C22.2 No. 142-M1987, CAN/CSA-C22.2 No. 157-92, CSA Std C22.2 No. 213-M1987;

Markings: Intrinsically Safe for Class I Groups A, B, C, D; Class II, Groups E, F, G; Class III; [HART only zone markings]: Intrinsically Safe for Class I Zone 0 Group IIC; T4(-50 °C ≤ T_a ≤ +60 °C); Type 4X; Suitable for Class I, Div. 2, Groups A, B, C, D; [HART only zone markings]: Suitable for Class I Zone 2 Group IIC; T6(-60 °C ≤ T_a ≤ +60 °C); T5(-60 °C ≤ T_a ≤ +85 °C); when installed per Rosemount drawing 03144-5076;

K6 CSA Explosionproof, Intrinsic Safety and Division 2

Certificate: 1242650

Standards: CAN/CSA C22.2 No. 0-M91 (R2001), CSA Std C22.2 No. 30-M1986; CAN/CSA-C22.2 No. 94-M91, CSA Std C22.2 No. 142-M1987, CAN/CSA-C22.2 No. 157-92, CSA Std C22.2 No. 213-M1987;


Markings: Explosionproof for Class I, Groups A, B, C, D; Class II, Groups E, F, G; Class III; [HART only zone markings]: Suitable for Class I Zone 1 Group IIC; Intrinsically Safe for Class I Groups A, B, C, D; Class II, Groups E, F, G; Class III; [HART only zone markings]: Suitable for Class I Zone 0 Group IIC; T4(-50 °C ≤ T_a ≤ +60 °C); Type 4X; Suitable for Class I, Div. 2, Groups A, B, C, D; [HART only zone markings]: Suitable for Class I Zone 2 Group IIC; T6(-60 °C ≤ T_a ≤ +60 °C); T5(-60 °C ≤ T_a ≤ +85 °C); when installed per Rosemount drawing 03144-5076;

Europe

E1 ATEX Flameproof

Certificate: FM12ATEX0065X

Standards: EN 60079-0: 2012, EN 60079-1: 2007, EN 60529:1991 +A1:2000

Markings:  II 2 G Ex d IIC T6...T1 Gb, T6(-50 °C ≤ T_a ≤ +40 °C), T5...T1(-50 °C ≤ T_a ≤ +60 °C);

See [Table 5](#) at the end of the Product Certifications section for Process Temperatures.

Special Conditions for Safe Use (X):

1. See certificate for ambient temperature range.
2. The non-metallic label may store an electrostatic charge and become a source of ignition in Group III environments.
3. Guard the LCD display cover against impact energies greater than 4 joules.
4. Consult the manufacturer if dimensional information on the flameproof joints is necessary.

I1 ATEX Intrinsic Safety

Certificate: BAS01ATEX1431X [HART];
 Baseefa03ATEX0708X [Fieldbus];
 Standards: EN 60079-0: 2012; EN 60079-11:2012;
 Markings: HART: Ⓢ II 1 G Ex ia IIC T5/T6 Ga;
 T6(-60 °C ≤ T_a ≤ +50 °C),
 T5(-60 °C ≤ T_a ≤ +75 °C);
 Fieldbus: Ⓢ II 1 G Ex ia IIC T4 Ga;
 T4(-60 °C ≤ T_a ≤ +60 °C),
 See [Table 6](#) at the end of the Product Certifications section for Entity Parameters

Special Conditions for Safe Use (X):

1. When fitted with the transient terminal options, the equipment is not capable of passing the 500 V insulation test. This must be taken into account during installation.
2. The enclosure may be made from aluminum alloy with a protective polyurethane paint finish; however, care should be taken to protect it from impact or abrasion when located in Zone 0.

N1 ATEX Type n

Certificate: BAS01ATEX3432X [HART];
 Baseefa03ATEX0709X [Fieldbus]
 Standards: EN 60079-0:2012, EN 60079-15:2010
 Markings: HART: Ⓢ II 3 G Ex nA IIC T5/T6 Gc;
 T6(-40 °C ≤ T_a ≤ +50 °C),
 T5(-40 °C ≤ T_a ≤ +75 °C);
 Fieldbus: Ⓢ II 3 G Ex nA IIC T5 Gc;
 T5(-40 °C ≤ T_a ≤ +75 °C);

Special Condition for Safe Use (X):

1. When fitted with the transient terminal options, the equipment is not capable of withstanding the 500 V electrical strength test as defined in clause 6.5.1 of EN 60079-15: 2010. This must be taken into account during installation.

ND ATEX Dust

Certificate: FM12ATEX0065X
 Standards: EN 60079-0: 2012, EN 60079-31: 2009,
 EN 60529:1991 +A1:2000
 Markings: Ⓢ II 2 D Ex tb IIIC T130 °C Db,
 (-40 °C ≤ T_a ≤ +70 °C); IP66
 See [Table 5](#) at the end of the Product Certifications section for Process Temperatures.

Special Conditions for Safe Use (X):

1. See certificate for ambient temperature range
2. The non-metallic label may store an electrostatic charge and become a source of ignition in Group III environments.
3. Guard the LCD display cover against impact energies greater than 4 joules.
4. Consult the manufacturer if dimensional information on the flameproof joints is necessary.

International**E7** IECEx Flameproof

Certificate: IECEx FMG 12.0022X
 Standards: IEC 60079-0:2011, IEC 60079-1:2007-04,
 IEC 60079-31:2008
 Markings: Ex d IIC T6...T1 Gb, T6(-50 °C ≤ T_a ≤ +40 °C),
 T5...T1(-50 °C ≤ T_a ≤ +60 °C);
 Ex tb IIIC T130 °C Db, (-40 °C ≤ T_a ≤ +70 °C);
 IP66;

See [Table 5](#) at the end of the Product Certifications section for Process Temperatures.

Special Conditions for Safe Use (X):

1. See certificate for ambient temperature range
2. The non-metallic label may store an electrostatic charge and become a source of ignition in Group III environments
3. Guard the LCD display cover against impact energies greater than 4 joules
4. Consult the manufacturer if dimensional information on the flameproof joints is necessary

I7 IECEx Intrinsic Safety

Certificate: IECEx BAS 07.0002X [HART];
 IECEx BAS 07.0004X [Fieldbus]
 Standards: IEC 60079-0: 2011; IEC 60079-11: 2011;
 Markings: HART: Ex ia IIC T5/T6 Ga;
 T6(-60 °C ≤ T_a ≤ +50 °C),
 T5(-60 °C ≤ T_a ≤ +75 °C);
 Fieldbus: Ex ia IIC T4 Ga;
 T4(-60 °C ≤ T_a ≤ +60 °C),

See [Table 6](#) at the end of the Product Certifications section for Entity Parameters.

Special Conditions for Safe Use (X):

1. When fitted with the transient terminal options, the apparatus is not capable of withstanding the 500 V electrical strength test as defined in Clause 6.3.13 of IEC 60079-11: 2011. This must be taken into account during installation.
2. The enclosure may be made from aluminum alloy with a protective polyurethane paint finish; however, care should be taken to protect it from impact or abrasion when located in Zone 0.

- N7** IECEx Type n
 Certificate: IECEx BAS 070003X [HART];
 IECEx BAS 07.0005X [Fieldbus]
 Standards: IEC 60079-0:2011, IEC 60079-15:2010
 Markings: HART: Ex nA IIC T5/T6 Gc;
 T6(-40 °C ≤ T_a ≤ +50 °C),
 T5(-40 °C ≤ T_a ≤ +75 °C);
 Fieldbus: Ex nA IIC T5 Gc;
 T5(-40 °C ≤ T_a ≤ + 75 °C),

Brazil

- E2** INMETRO Flameproof
 Certificate: UL-BR 13.0535X
 Standards: ABNT NBR IEC 60079-0:2008 + corrigendum
 1:2011, ABNT NBR IEC 60079-1:2009 +
 corrigendum 1:2011
 Markings: Ex d IIC T6...T1* Gb; T6...T1*:
 -50 °C ≤ T_a ≤ +40 °C,
 T5...T1* : - 50 °C ≤ T_a ≤ +60 °C)

Special Conditions for Safe Use (X):

1. See product description for ambient temperature limits and process temperature limits.
 2. The non-metallic label may store an electrostatic charge and become a source of ignition in Group III environments.
 3. Guard the LCD cover against impact energies greater than 4 joules.
 4. Consult the manufacturer if dimensional information on the flameproof joints is necessary.
- I2** INMETRO Intrinsic Safety [HART]
 Certificate: UL-BR 15.0088X
 Standards: ABNT NBR IEC 60079-0:2008 + corrigendum
 1:2011, ABNT NBR IEC 60079-11:2009
 Markings: Ex ia IIC T6 Ga (-60 °C ≤ T_a ≤ +50 °C),
 Ex ia IIC T6 Ga (-60 °C ≤ T_a ≤ +75 °C)
 See [Table 6](#) at the end of the Product Certifications section for Entity Parameters.

Special Conditions for Safe Use (X):

1. When fitted with the transient terminal options, the equipment is not capable of withstanding the 500 V electrical strength test as defined in ABNT NBR IEC60079-11. This must be taken into account during installation.
2. The enclosure may be made from aluminum alloy with a protective polyurethane paint finish; however, care should be taken to protect it from impact and abrasion when located in areas that require EPL Ga (Zone 0).
 INMETRO Intrinsic Safety [Fieldbus/FISCO]
 Certificate: UL-BR 15.0030X
 Standards: ABNT NBR IEC 60079-0:2008 + corrigendum
 1:2011, ABNT NBR IEC 60079-11:2009
 Markings: Ex ia IIC T4 Ga (-60 °C ≤ T_a ≤ +60 °C),
 See [Table 6](#) at the end of the Product Certifications section for Entity Parameters.

Special Condition for Safe Use (X):

1. When mounted with the terminal options with transient protection, the equipment is not capable of withstanding the dielectric strength test with 500 V as defined in ISO IEC 60079-11. This feature should be taken into account during installation.

China

- E3** China Flameproof
 Certificate: GYJ11.1650X
 Standards: GB3836.1-2000, GB3836.2-2010
 Markings: Ex d IIC T5/T6 Gb

Special Conditions for Safe Use (X):

1. Symbol “X” is used to denote specific conditions of use: For information on the dimensions of the flameproof joints the manufacturer shall be contacted. This shall be mentioned in the manual.
2. Relation between T code and ambient temperature range is:

T code	Ambient temperature
T6	-40 °C ≤ T _a ≤ +70 °C
T5	-40 °C ≤ T _a ≤ +80 °C

3. The earth connection facility in the enclosure should be connected reliably.
4. During installation, there should be no mixture harmful to flameproof housing.
5. During installation in hazardous location. Cable glands, conduits and blanking plugs, certified by state-appointed inspection bodies with Ex d IIC Gb degree, should be used.
6. During installation, use and maintenance in explosive gas atmospheres, observe the warning “Do not open when energized”.
7. End users is not permitted to change any components insides, but to settle the problem in conjunction with manufacturer to avoid damage to the product.
8. When installation, use and maintenance of this product, observe following standards:
 GB3836.13-1997 “Electrical apparatus for explosive gas atmospheres Part 13: Repair and overhaul for apparatus used in explosive gas atmospheres”
 GB3836.15-2000 “Electrical apparatus for explosive gas atmospheres Part 15: Electrical installations in hazardous area (other than mines)”
 GB3836.16-2006 “Electrical apparatus for explosive gas atmospheres Part 16: Inspection and maintenance of electrical installation (other than mines)”
 GB50257-1996 “Code for construction and acceptance of electric device for explosion atmospheres and fire hazard electrical equipment installation engineering”

- I3** China Intrinsic Safety
 Certificate: GYJ11.1536X
 Standards: GB3836.1-2000, GB3836.4-2010
 Markings: Ex ia IIC T4/T5/T6

Special Conditions for Safe Use (X):

- Symbol "X" is used to denote specific conditions of use:
 - The enclosure may contain light metal, attention should be taken to avoid ignition hazard due to impact or friction when used in Zone 0.
 - When fitted with the "Transient Terminal Option", this apparatus is not capable of withstanding the 500 V r.m.s. insulation test required by Clause 6.3.12 of GB3836.4-2010
- Relation between T code and ambient temperature range is:

Output	T code	Ambient temperature
HART	T6	$-60^{\circ}\text{C} \leq T_a \leq +50^{\circ}\text{C}$
	T5	$-60^{\circ}\text{C} \leq T_a \leq +70^{\circ}\text{C}$
Fieldbus	T4	$-60^{\circ}\text{C} \leq T_a \leq +60^{\circ}\text{C}$

- Parameters:

Power/loop terminals (+ and -)

Output	Maximum input voltage:	Maximum input current:	Maximum input power:	Maximum internal parameters	
	U_i (V)	I_i (mA)	P_i (W)	C_i (nF)	L_i (μH)
HART	30	300	1	5	0
Fieldbus	30	300	1.3	2.1	0

Sensor terminal (1 to 5)

Output	Maximum input voltage:	Maximum input current:	Maximum input power:	Maximum internal parameters	
	U_o (V)	I_o (mA)	P_o (W)	C_i (nF)	L_i (μH)
HART	13.6	56	0.19	78	0
Fieldbus	13.9	23	0.079	7.7	0

Load connected to sensor terminals (1 to 5)

Output	Group	Maximum external parameters	
		C_o (μF)	L_o (μH)
HART	IIC	0.74	11.7
	IIB	5.12	44
	IIA	18.52	94
Fieldbus	IIC	0.73	30.2
	IIB	4.8	110.9
	IIA	17.69	231.2

Temperature transmitters comply to the requirements for FISCO field devices specified in GB3836.19-2010. FISCO parameters are as follows:

Maximum input voltage:	Maximum input current:	Maximum input power:	Maximum internal parameters	
			U_i (V)	I_i (mA)
17.5	380	5.32	2.1	0

- The product should be used with Ex-certified associated apparatus to establish explosion protection system that can be used in explosive gas atmospheres. Wiring and terminals should comply with the instruction manual of the product and associated apparatus.
- The cables between this product and associated apparatus should be shielded cables (the cables must have insulated shield). The shielded has to be grounded reliably in non-hazardous area.
- End users are not permitted to change any components insides, but to settle the problem in conjunction with manufacturer to avoid damage to the product.
- When installation, use and maintenance of this product, observe following standards:
 GB3836.13-1997 "Electrical apparatus for explosive gas atmospheres Part 13: Repair and overhaul for apparatus used in explosive gas atmospheres"
 GB3836.15-2000 "Electrical apparatus for explosive gas atmospheres Part 15: Electrical installations in hazardous area (other than mines)"
 GB3836.6-2006 "Electrical apparatus for explosive gas atmospheres Part 16: Inspection and maintenance of electrical installation (other than mines)"
 GB50257-1996 "Code for construction and acceptance of electric device for explosion atmospheres and fire hazard electrical equipment installation engineering"

EAC - Belarus, Kazakhstan, Russia

- EM** Technical Regulation Customs Union (EAC) Flameproof
 Certificate: RU C-US.GB05.B.00289
 Markings: 1Ex d IIC T6...T1 Gb X

Special Condition for Safe Use (X):

- See certificate for special conditions.

- IM** Technical Regulation Customs Union (EAC) Intrinsic Safety
 Certificate: RU C-US.GB05.B.00289
 Markings: [HART]: 0Ex ia IIC T5, T6 Ga X;
 [Fieldbus/PROFIBUS[®]]: 0Ex ia IIC T4 Ga X

Special Condition for Safe Use (X):

- See certificate for special conditions.

Japan

E4 TIIS Flameproof

Certificate: TC16120, TC16121

Markings: Ex d IIB T6 ($-20\text{ °C} \leq T_a \leq +55\text{ °C}$)

Certificate: TC16127, TC16128, TC16129, TC16130

Markings: Ex d IIB T4 ($-20\text{ °C} \leq T_a \leq +55\text{ °C}$)

Combinations

K1 Combination of E1, I1, N1, and ND

K2 Combination of E2 and I2

K5 Combination of E5 and I5

K7 Combination of E7, I7, N7

KA Combination of K1 and K6

KB Combination of K5, I6, and K6

KM Combination of EM and IM

Tables

Table 5. Process Temperatures

	T6	T5	T4	T3	T2	T1	T130
Max ambient	+ 40 °C	+ 60 °C	+ 60 °C	+ 60 °C	+ 60 °C	+ 60 °C	+ 70 °C
Sensor extension	Transmitter with LCD display						
	0-in.	55 °C	70 °C	95 °C	95 °C	95 °C	95 °C
	3-in.	55 °C	70 °C	100 °C	100 °C	100 °C	100 °C
	6-in.	60 °C	70 °C	100 °C	100 °C	100 °C	100 °C
	9-in.	65 °C	75 °C	110 °C	110 °C	110 °C	110 °C
	Transmitter without LCD display						
	0-in.	55 °C	70 °C	100 °C	170 °C	280 °C	440 °C
	3-in.	55 °C	70 °C	110 °C	190 °C	300 °C	450 °C
	6-in.	60 °C	70 °C	120 °C	200 °C	300 °C	450 °C
	9-in.	65 °C	75 °C	130 °C	200 °C	300 °C	450 °C

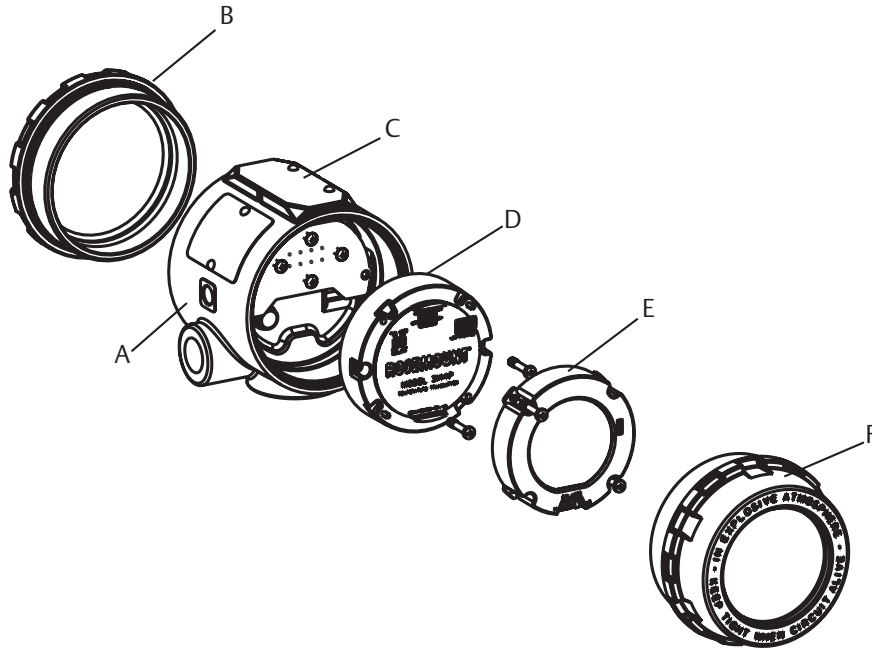
Table 6. Entity Parameters

	HART	Fieldbus/PROFIBUS	FISCO
Voltage U_i (V)	30	30	17.5
Current I_i (mA)	300	300	380
Power P_i (W)	1	1.3	5.32
Capacitance C_i (nF)	5	2.1	2.1
Inductance L_i (mH)	0	0	0

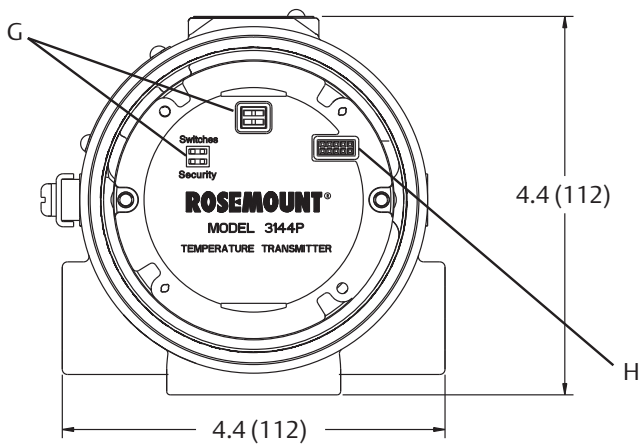
Dimensional drawings

Figure 1. Rosemount 3144P Temperature Transmitter

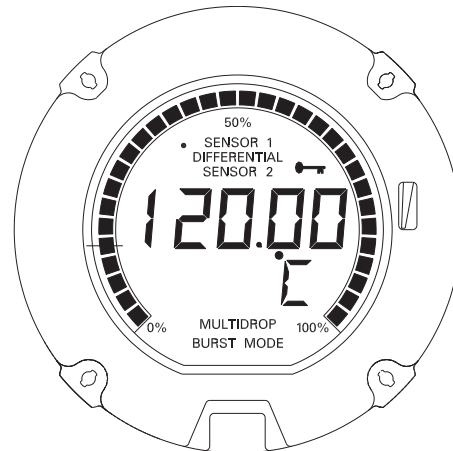
Transmitter exploded view



Switch location



LCD display faceplate



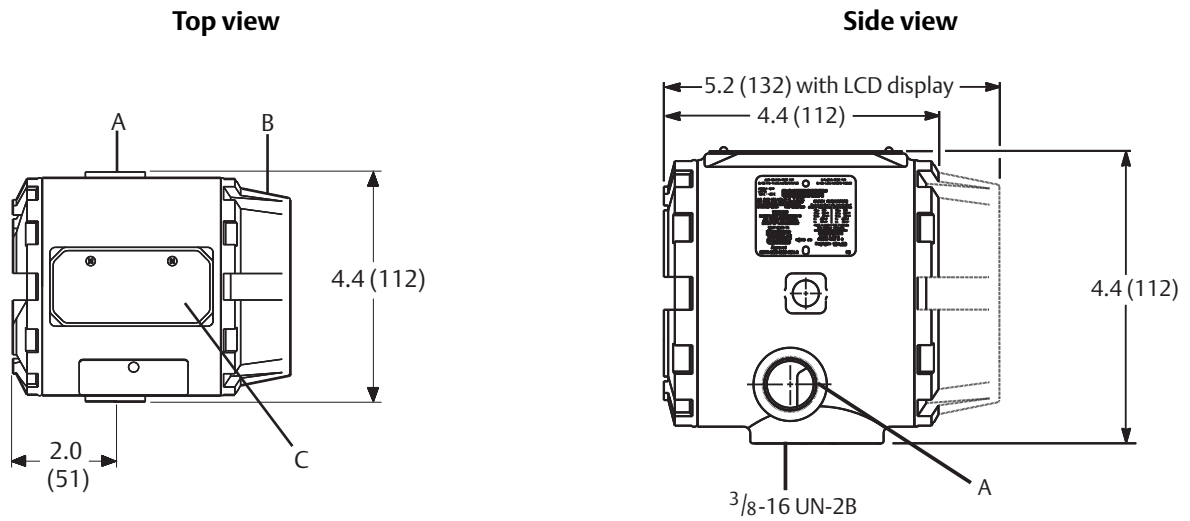
- A. Housing with permanent terminal block
- B. Cover with wiring diagram label
- C. Nameplate
- D. Electronics module

- E. LCD display
- F. Display cover
- G. Switches⁽¹⁾
- H. LCD connector

Dimensions are in inches (millimeters).

(1) Alarm and Write Protect (HART), Simulate and Write Protect (FOUNDATION fieldbus)

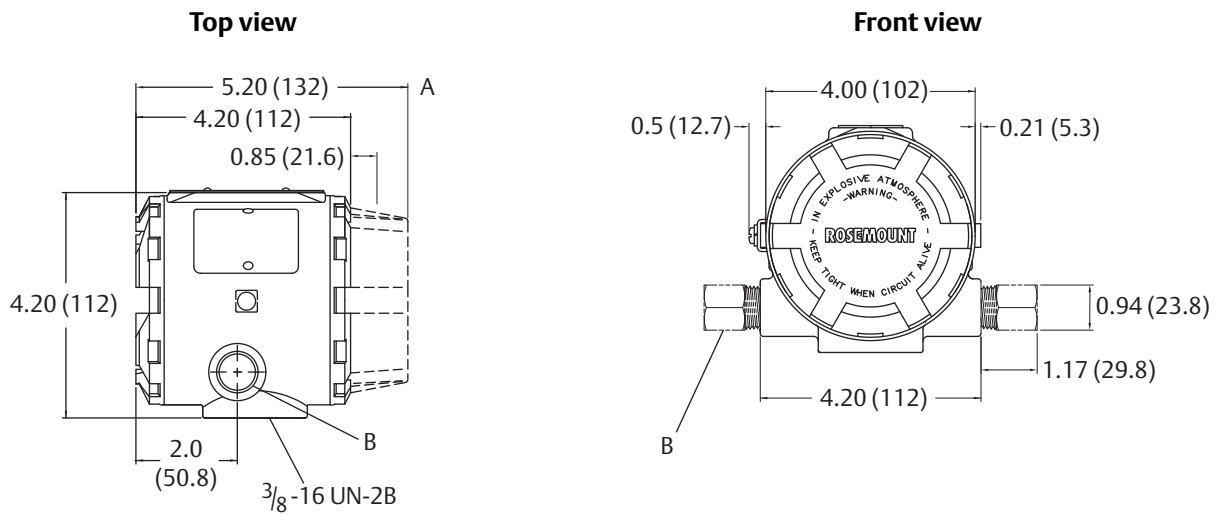
Figure 2. Transmitter Dimensional Drawing



- A. Conduit entry
- B. Display cover
- C. Nameplate

Dimensions are in inches (millimeters).

Figure 3. Transmitter Dimensional Drawing for Conduits with M20 × 1.5, PG 13.5, and JIS G¹/₂ Entries

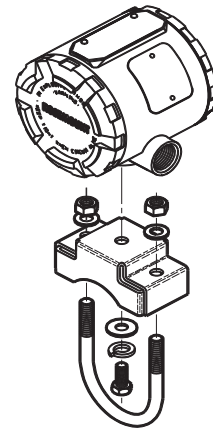
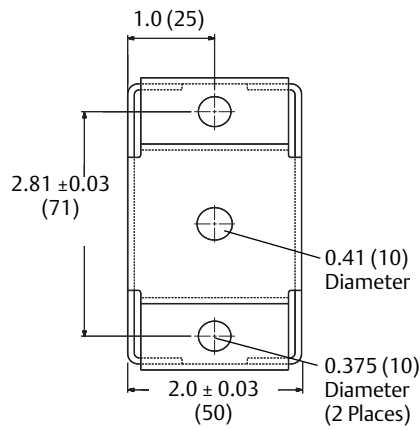
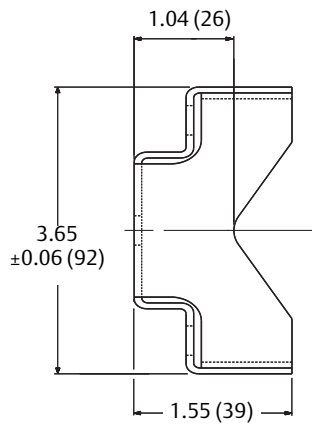


- A. Clearance required to remove cover
- B. Adapters for M20 × 1.5, PG 13.5, and JIS G¹/₂ entries

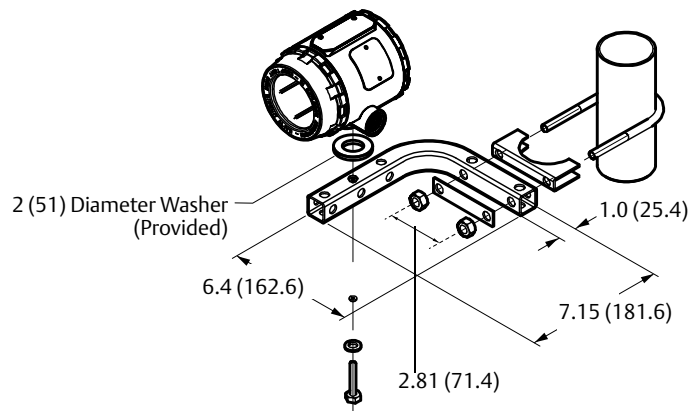
Dimensions are in inches (millimeters).

Figure 4. Optional Transmitter Mounting Brackets

Option code B4 bracket



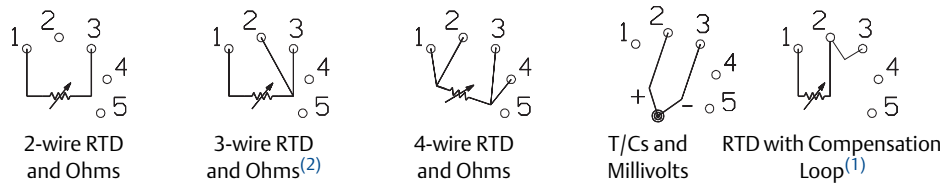
Option code B5 bracket



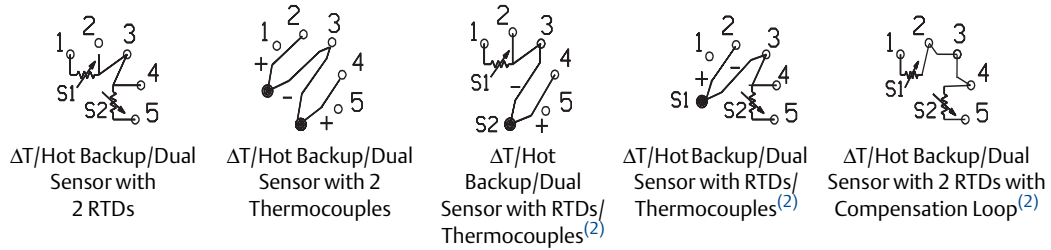
Dimensions are in inches (millimeters).

Figure 5. HART/4–20 mA

3144P single-sensor connections



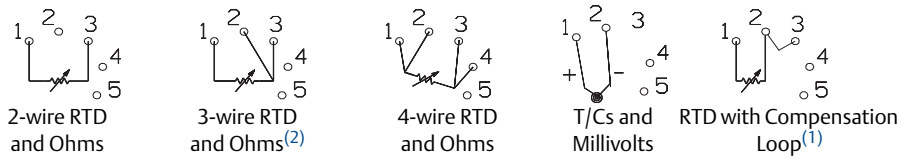
3144P dual-sensor connections



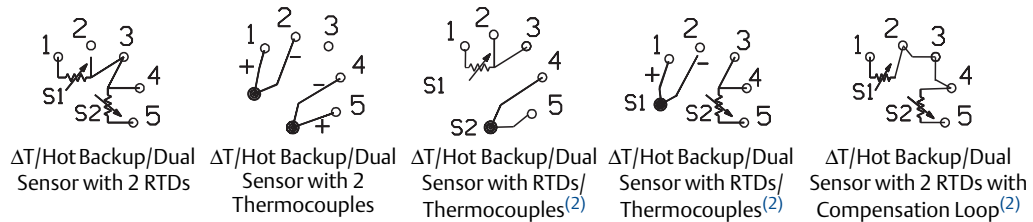
(1) Transmitter must be configured for a 3-wire RTD in order to recognize an RTD with a compensation loop.
 (2) Emerson Process Management provides 4-wire sensors for all single-element RTDs. Use these RTDs in 2-wire or 3-wire configurations by leaving the unneeded leads disconnected and insulated with electrical tape.

Figure 6. FOUNDATION fieldbus

3144P single-sensor connections



3144P dual-sensor connections



(1) Transmitter must be configured for a 3-wire RTD in order to recognize an RTD with a compensation loop.
 (2) Emerson Process Management provides 4-wire sensors for all single-element RTDs. Use these RTDs in 2-wire or 3-wire configurations by leaving the unneeded leads disconnected and insulated with electrical tape.

Standard configuration

Both standard and custom configuration settings may be changed. Unless specified, the transmitter will be shipped as follows:

Standard configuration	
4 mA value/Lower Range (HART/4–20 mA) Measurement Point LO (FOUNDATION fieldbus)	0 °C
20 mA value/Upper Range (HART/4–20 mA) Measurement Point HI (FOUNDATION fieldbus)	100 °C
Damping	5 seconds
Output	Linear with temperature
Failure Mode (HART/4–20 mA)	High
Line Voltage Filter	60 Hz
Software Tag	See “Software tag” on page 9
Optional Integral Display	Units and mA/Sensor 1 units
Single-sensor option	
Sensor Type	4-wire, Pt 100 $\alpha = 0.00385$ RTD
Primary Variable (HART/4–20 mA) AI 1400 (FOUNDATION fieldbus)	Sensor 1
Secondary Variable AI 1600 (FOUNDATION fieldbus)	Terminal Temperature
Tertiary Variable	Not Used
Quaternary Variable	Not Used
Dual-sensor option	
Sensor Type	Two 3-wire, Pt 100 $\alpha = 0.00385$ RTD
Primary Variable (HART/4–20 mA) AI 1400 (FOUNDATION fieldbus)	Sensor 1
Secondary Variable AI 1500 (FOUNDATION fieldbus)	Sensor 2
Tertiary Variable AI 1600 (FOUNDATION fieldbus)	Terminal Temperature
Quaternary Variable	Not Used

Custom configuration

The Rosemount 3144P Transmitter can be ordered with custom configuration. The table below lists the requirements necessary to specify a custom configuration.

Option code	Requirements/specification
C1: Factory Data ⁽¹⁾	Date: day/month/year Descriptor: 16 alphanumeric character Message: 32 alphanumeric character Custom Alarm Levels can be specified for configuration at the factory.
C2: Transmitter-Sensor Matching	The 3144P transmitter is designed to accept Callendar-van Dusen constants from a calibrated RTD schedule and generate a custom curve to match any specific sensor curve. Specify a Series 68, 65, or 78 RTD sensor on the order with a special characterization curve (V or X8Q4 option). These constants will be programmed into the 3144P when this option is selected.
C4: Five Point Calibration	Will include five-point calibration at 0, 25, 50, 75, and 100% analog and digital output points. Use with option code Q4 to obtain a Calibration Certificate.
C7: Special Sensor	Used for non-standard sensor, adding a special sensor or expanding input. Customer must supply the non-standard sensor information. Additional special curve will be added to sensor curve input choices.

Option code	Requirements/specification
A1: NAMUR-Compliant, high alarm	Analog output levels compliant with NAMUR. Alarm is set to fail high.
CN: NAMUR-Compliant, low alarm	Analog output levels compliant with NAMUR. Alarm is set to fail low.
C8: Low Alarm	Analog output levels compliant with Rosemount standard. Alarm is set to fail low.
F5: 50 Hz Line Voltage Filter	Calibrated to 50 Hz line voltage filter.

(1) CDS required.

To custom configure the 3144P with the dual-sensor option transmitter for one of the applications described below, indicate the appropriate option code in the model number. If a sensor type is not specified, the transmitter will be configured for two 3-wire Pt 100 ($\alpha = 0.00385$) RTDs if any of the following option codes are selected.

Option Code U1: Hot Backup	
Primary Usage	Primary usage sets the transmitter to automatically use sensor 2 as the primary input if sensor 1 fails. Switching from sensor 1 to sensor 2 is accomplished without any effect on the analog signal. A digital alert will be sent in the event of a failed sensor.
Primary Variable	1st good
Secondary Variable	Sensor 1
Tertiary Variable	Sensor 2
Quaternary Variable	Terminal Temperature

Option Code U2: Average Temperature with Hot Backup and Sensor Drift Alert – Warning Mode	
Primary Usage	Critical applications, such as safety interlocks and control loops. Outputs the average of two measurements and sends a digital alert if temperature difference exceeds the set maximum differential (Sensor Drift Alert – warning mode). If a sensor fails, an alert will be sent digitally and the primary variable will be reported as the remaining good sensor value.
Primary Variable	Sensor Average
Secondary Variable	Sensor 1
Tertiary Variable	Sensor 2
Quaternary Variable	Terminal Temperature

Option Code U3: Average Temperature with Hot Backup and Sensor Drift Alert – Alarm Mode	
Primary Usage	Critical applications, such as safety interlocks and control loops. Outputs the average of two measurements and sets the analog output into alarm if temperature difference exceeds the set maximum differential (Sensor Drift Alert – alarm mode). If a sensor fails, an alert will be sent digitally and the primary variable will be reported as the remaining good sensor value.
Primary Variable	Sensor Average
Secondary Variable	Sensor 1
Tertiary Variable	Sensor 2
Quaternary Variable	Terminal Temperature

Option Code U4: Two Independent Sensors	
Primary Usage	Used in non-critical applications where the digital output is used to measure two separate process temperatures.
Primary Variable	Sensor 1
Secondary Variable	Sensor 2
Tertiary Variable	Terminal Temperature
Quaternary Variable	Not Used

Option Code U5: Differential Temperature	
Primary Usage	The differential temperature of two process temperatures is configured as the primary variable. If the temperature difference exceeds the maximum differential, the analog output will go into alarm. Primary Variable will be reported as a bad sensor value.
Primary Variable	Differential Temperature
Secondary Variable	Sensor 1
Tertiary Variable	Sensor 2
Quaternary Variable	Terminal Temperature

Option Code U6: Average Temperature	
Primary Usage	When average measurement of two different process temperatures is required. If a sensor fails, the analog output will go into alarm and the primary variable will report the measurement of the remaining good sensor.
Primary Variable	Sensor Average
Secondary Variable	Sensor 1
Tertiary Variable	Sensor 2
Quaternary Variable	Terminal Temperature

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Rosemount® 2088 Absolute and Gage Pressure Transmitter



- Performance of 0.065% with High Accuracy option
- Lightweight, compact design for cost-effective installation
- Protocols available include 4-20 mA HART® and 1-5 Vdc HART Low Power
- Absolute and gage pressure ranges up to 4,000 psi (276 bar)
- Rangeability of 50:1

Rosemount 2088 Pressure Transmitter Product Offering

Proven reliability for gage and absolute applications



- Available protocols include 4-20 mA HART and 1-5 Vdc HART Low Power
- Fully configurable LCD display to display process variable, percent of range, and diagnostic messages
- Lightweight, compact design enables easy installation
- Choice of stainless steel or Alloy C-276 wetted materials

Unlock the value of devices with the Smart Wireless THUM™ Adapter



- Gain access to field intelligence and improve quality, safety, availability, operations, and maintenance costs
- Remotely manage devices and monitor health
- Enable new wireless measurement points
- Utilize existing loop power

Proven, reliable, and innovative DP Level technologies



- Connect to virtually any process with a comprehensive offering of process connections, fill fluids, direct mount or capillary connections and materials
- Quantify and optimize total system performance with QZ option

Instrument manifolds – quality, convenient, and easy



- Designed and engineered for optimal performance with Rosemount transmitters
- Save installation time and money with factory assembly
- Offers a variety of styles, materials, and configurations

Contents

Ordering Information	3	Product Certifications	11
Specifications	8	Dimensional Drawings	16

Ordering Information

Rosemount 2088 In-Line Pressure Transmitter



Configuration	Transmitter output code
4-20 mA HART 2088 with Selectable HART	S
1-5 Vdc Low Power 2088 with Selectable HART	N

Additional information

Specifications : [page 8](#)

Product Certifications : [page 11](#)

Dimensional Drawings : [page 16](#)

Specification and selection of product materials, options, or components must be made by the purchaser of the equipment. See [page 10](#) for more information on Material Selection.

Table 1. Rosemount 2088 Pressure Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery.
The Expanded offering is manufactured after receipt of order and is subject to additional delivery lead time.

Model	Product description		
2088	Pressure Transmitter		
Measurement type			
A	Absolute		
G	Gage		
Pressure ranges			
	2088G	2088A	
1	-14.7 to 30 psi /(-1,01 to 2,1 bar)	0 to 30 psi (0 to 2,1 bar)	★
2	-14.7 to 150 psi (-1,01 to 10,3 bar)	0 to 150 psi (0 to 10,3 bar)	★
3	-14.7 to 800 psi (-1,01 to 55,2 bar)	0 to 800 psi (0 to 55,2 bar)	★
4	-14.7 to 4,000 psi (-1,01 to 275,8 bar)	0 to 4,000 psi (0 to 275,8 bar)	★
Transmitter output			
S ⁽¹⁾	4–20 mA dc/Digital HART Protocol		
N ⁽¹⁾	1-5 Vdc Low Power/Digital HART protocol		
Materials of construction			
	Process connection	Isolating diaphragm	Fill fluid
22 ⁽²⁾	316L SST	316L SST	Silicone
33 ⁽²⁾	Alloy C-276	Alloy C-276	Silicone
2B ⁽²⁾	316L SST	316L SST	Inert

Table 1. Rosemount 2088 Pressure Transmitter Ordering Information

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Process connection		
A	½–14 NPT Female	★
B ⁽³⁾	DIN 16288 G ½ Male	★
D ⁽³⁾⁽⁴⁾	M20 3 1.5 Male	★
C ⁽³⁾⁽⁴⁾	RC ½ Female	
Conduit entry		
1	½–14 NPT	★
2 ⁽³⁾	M20 3 1.5	★
4 ⁽³⁾⁽⁵⁾	G ½	
Options (Include with selected model number)		
Extended product warranty		
WR3	3-year limited warranty	★
WR5	5-year limited warranty	★
Diaphragm seal assemblies		
S1 ⁽⁶⁾⁽⁷⁾	Assemble to one Rosemount 1199 Diaphragm Seal	★
Display and interface		
M4	LCD Display with Local Operator Interface	★
M5	LCD Display, configured for Engineering Units	★
Configuration buttons		
D4	Analog Zero and Span	★
DZ	Digital Zero Trim	★
Mounting brackets		
B4	SST mounting bracket with SST Bolts	★
Product certifications		
C6	CSA Explosion-Proof, Dust-ignition-proof, Intrinsic Safe, and NonIncendive	★
E2	INMETRO Flameproof	★
E3	China Flameproof	★
Product certifications		
E4 ⁽³⁾⁽⁸⁾	TIIS Flameproof	★
E5	FM Explosion-Proof (XP) and Dust Ignition-proof (DIP)	★
E7	IECEX Flameproof	★
ED	ATEX Flameproof	★

Table 1. Rosemount 2088 Pressure Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery.

The Expanded offering is manufactured after receipt of order and is subject to additional delivery lead time.

EM	Technical Regulations Customs Union (EAC) Flameproof	★
I1 ⁽³⁾	ATEX Intrinsic Safety	★
I2	INMETRO Intrinsic Safety	★
I3	China Intrinsic Safety	★
I5	FM Intrinsically safe (IS) and Nonincendive	★
I7	IECEX Intrinsic Safety	★
IM	Technical Regulation Customs Union (EAC) Intrinsic Safety	★
K1	ATEX Flameproof, Intrinsic Safety, Type n, Dust	★
K2	INMETRO Flameproof, Intrinsic Safety	★
K5	FM Explosion-Proof, Dust Ignition-proof, Intrinsically Safe, Division 2	★
K6 ⁽³⁾	ATEX and CSA Explosion-Proof, Dust Ignition-proof, Intrinsically Safe, Division 2	★
K7	IECEX Flameproof, Intrinsic Safety, Type n, Dust	★
KB	FM and CSA Explosion-Proof, Dust Ignition-proof, Intrinsically Safe, Division 2	★
KM	Technical Regulation Customs Union (EAC) Flameproof and Intrinsic Safety	★
KH ⁽³⁾	FM Approvals and ATEX Explosion-Proof and Intrinsically Safe	★
N1 ⁽³⁾	ATEX Type n	★
N3	China Type n	★
N7	IECEX Type n	★
ND ⁽³⁾	ATEX Dust	★
NK	IECEX Dust	★
Shipboard approvals		
SBS	American Bureau of Shipping (ABS) Type Approval	★
SBV	Bureau Veritas (BV) Type Approval	★
SDN	Det Norske Veritas (DNV) Type Approval	★
SLL	Lloyd's Register (LR) Type Approval	★
Pressure testing		
P1	Hydrostatic testing	
Terminal blocks		
T1	Transient protection	★
Special cleaning		
P2	Cleaning for special service	
Calibration certificate		
Q4	Calibration certificate	★

Table 1. Rosemount 2088 Pressure Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery.

The Expanded offering is manufactured after receipt of order and is subject to additional delivery lead time.

Quality calibration certificate traceability certification		
Q8	Material Traceability Certification per EN 10204 3.1	★
Q15	Certificate of Compliance to NACE® MR0175/ISO 15156 for wetted materials	★
Q25	Certificate of Compliance to NACE MR0103 for wetted materials	★
Digital signal		
C4 ⁽³⁾	NAMUR alarm and saturation levels, high alarm	★
CN ⁽³⁾	NAMUR alarm and saturation levels, low alarm	★
C5 ⁽⁹⁾⁽¹⁰⁾	Custom alarm and saturation levels, high alarm, (requires C9 and Configuration Data Sheet)	★
C7 ⁽⁹⁾⁽¹⁰⁾	Custom alarm and saturation levels, low alarm (requires C9 and Configuration Data Sheet)	★
C8 ⁽¹⁰⁾	Low alarm (Standard Rosemount Alarm and Saturation Levels)	★
Configuration		
C9	Software configuration	★
Manifold assemblies		
S5 ⁽⁶⁾⁽⁷⁾	Assemble to Rosemount 306 integral manifold	★
Calibration accuracy		
P8 ⁽¹¹⁾	0.065% accuracy to 10:1 turndown	★
Water approval		
DW ⁽¹²⁾	NSF drinking water approval	★
Surface finish		
Q16	Surface finish certification for sanitary remote seals	★
Toolkit total system performance reports		
QZ	Remote Seal System Performance Calculation Report	★
HART Revision configuration		
HR 5 ⁽¹⁰⁾⁽¹³⁾	Configured for HART Revision 5	★
HR7 ⁽¹⁰⁾⁽¹⁴⁾	Configured for HART Revision 7	★
Typical model number: 2088 G 2 S 22 A 1 B4 M5		

- HART Revision 5 is the default HART output. The 2088 with selectable HART can be factory or field configured to HART Revision 7. To order HART Revision 7 factory configured, add option code HR7.
- Materials of Construction comply with recommendations per NACE MR0175/ISO 15156 for sour oil field production environments. Environmental limits apply to certain materials. Consult latest standard for details. Selected materials also conform to NACE MR0103 for sour refining environments.
- Not available with low-power Transmitter Output code N.
- Not available with Alloy C-276, Material of Construction code 33.
- Consists of a 1/2-14 NPT housing with a G1/2 adapter.
- Use 1/2- 14 NPT Female Process Connection code A.
- "Assemble-to" items are specified separately and require a completed model number.

8. Only available with Conduit Thread code 4.
9. Only available with 4-20 mA HART Output (Output Code A).
10. Select Configuration Buttons (option code D4 or DZ) or Local Operator Interface (option code M4) if local configuration buttons are required.
11. Requires Transmitter Output code S with either Materials of Construction code 22 or 23.
12. Requires Materials of Construction code 22 with Process Connection code A.
13. Configures the HART output to HART Revision 5. The device can be field configured to HART Revision 7 if needed.
14. Configures the HART output to HART Revision 7. The device can be field configured to HART Revision 5 if needed.

Specifications

Performance specifications

For zero-based spans, reference conditions, silicone oil fill, 316L SST isolating diaphragm.

Reference accuracy

±0.075% of calibrated span. Includes combined effects of linearity, hysteresis, and repeatability

±0.065% of calibrated span (high accuracy option - P8)

For spans less than 10:1, accuracy = $\pm \left[0.009 \left(\frac{URL}{Span} \right) \right]$ % of Span

Ambient temperature effect

Expressed as a total effect per 50 °F (28 °C)

Total effect includes zero and span effects.

± (0.15% URL + 0.15% of span)

Stability

Ranges 2-4: ±0.10% of URL for 3 years

Range 1: ±0.10% of URL for 1 year

Warranty⁽¹⁾

All Rosemount 2088 models:

- 1-year limited warranty is standard⁽²⁾
- Extended 3-year and 5-year limited warranties available if ordered.⁽³⁾ (Select option WR3 or WR5 in model string respectively)

Vibration effect

Less than ±0.1% of URL when tested per the requirements of IEC60770-1 field or pipeline with high vibration level (10 - 60 Hz 0.21 mm displacement peak amplitude / 60 - 2000 Hz 3g).

Power supply effect

Less than ±0.005% of calibrated span per volt change in voltage at the transmitter terminals.

Mounting position effect

Zero shifts to ±2.5 inH₂O (6,22 mbar), which can be zeroed
Span: no effect

Transient protection

Tested in accordance with IEEE C62.41.2-2002,

Location Category B

6 kV crest (0.5 µs - 100 kHz)

3 kA crest (8 x 20 microseconds)

6 kV crest (1.2 x 50 microseconds)

General specifications

Tested to IEC 801-3

Functional specifications

Table 2. 2088 Range Values

Range	Minimum span	Upper (URL)	Lower (LRL)	Lower ⁽¹⁾ (LRL) (gage)
1	0.60 psi (41,37 mbar)	30.00 psi (2,07 bar)	0 psia (0 bar)	-14.70 psig (-1,01 bar)
2	3.00 psi (206,85 mbar)	150.00 psi (10,34 bar)	0 psia (0 bar)	-14.70 psig (-1,01 bar)
3	16.00 psi (1,11 bar)	800.00 psi (55,16 bar)	0 psia (0 bar)	-14.70 psig (-1,01 bar)
4	80.00 psi (5,52 bar)	4000.00 psi (275,79 bar)	0 psia (0 bar)	-14.70 psig (-1,01 bar)

1. Assumes atmospheric pressure of 14.70 psia (1,01 bar-a).

Output

Code S: 4–20 mA

Code N: 1-5 Vdc, low power

(Outputs are directly proportional to the input pressure)

Selectable HART

Digital communications based on HART Revision 5 (default) or Revision 7 (option code HR7) protocol can be selected. The HART revision can be switched in the field using any HART based configuration tool or the optional local operator interface (LOI).

Service

Liquid, gas, and vapor applications

1. Warranty details can be found in Emerson™ Process Management Terms & Conditions of Sale, Document 63445, Rev G (10/6).

2. Goods are warranted for twelve (12) months from the date of initial installation or eighteen (18) months from the date of shipment by seller, whichever period expires first.

3. 3-year and 5-year warranty period begins on date of shipment by seller.

Power supply

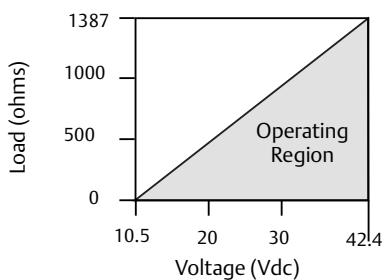
External power supply required. Transmitter operates on 10.5–42.4 Vdc with no load (5.8-28 V for Low Power). Reverse polarity protection is standard.

Load Limitations

Reverse polarity protection is standard. Maximum loop resistance is determined by the power supply voltage as described by the following equations:

Figure 1. Maximum Loop Resistance

Max. Loop Resistance = 43.5 (Power Supply Voltage – 10.5)



The Field Communicator requires a minimum loop resistance of 250Ω for communication.

Indication

Optional two line LCD/LOI Display.

Zero and span adjustment requirements

Zero and span values can be set anywhere within the range limits stated in Table 2. Span must be greater than or equal to the minimum span stated in Table 2.

Local operator interface

The LOI utilizes a two-button menu with internal and external configuration buttons. Internal buttons are always configured for Local Operator Interface. External buttons can be configured for either LOI, (option code M4), Analog Zero and Span (option code D4) or Digital Zero Trim (option code DZ) for LOI configuration menu.

Current draw

Output Code N: ≤ 3 mA.

Overpressure limits

Range 1: 120 psig max

All other ranges: two times the URL

Burst pressure

11,000 psi for all ranges

Zero elevation and suppression

Zero can be suppressed between atmosphere for gage transmitters or 0 psia for absolute transmitters and upper range limit, provided the calibrated span is equal to or greater than the minimum span, and the upper range value does not exceed the upper range limit.

Dynamic performance

Total Response Time: 145 milliseconds

Update rate: 20 times per second minimum

Temperature limits

Ambient:

-40 to 185 °F (-40 to 85 °C)

With LCD display⁽¹⁾: -40 to 176 °F (-40 to 80 °C)

Storage⁽²⁾:

-50 to 230 °F (-46 to 110 °C)

With LCD display: -40 to 185 °F (-40 to 85 °C)

Process

Silicone fill sensor: -40 to 250 °F (-40 to 121 °C)⁽³⁾

Inert fill sensor: -22 to 250 °F (-30 to 121 °C)⁽³⁾

Process temperatures above 185 °F (85 °C) require derating the ambient limits by a 1.5:1 ratio. For example, for process temperature of 195 °F (91 °C), new ambient temperature limit is equal to 170 °F (77 °C). This can be determined as follows: (195 °F - 185 °F) × 1.5 = 15 °F, 185 °F - 15 °F = 170 °F

Humidity limits

0–100% relative humidity

Volumetric displacement

Less than 0.0005 in³ (0,008 cm³)

Damping

Analog output response time to a step change is user-selectable from 0 to 60 seconds for one time constant. Software damping is in addition to sensor module response time.

1. For the output code N, LCD display may not be readable and LCD display updates will be slower at temperatures below -22 °F (-30 °C).
2. If storage temperature is above 85 °C, perform a sensor trim prior to installation.
3. 220 °F (104 °C) limit in vacuum service; 130 °F (54 °C) for pressures below 0.5 psia.

Turn-on time

2.0 seconds, no warm-up required

Transmitter security

Activating the transmitter security function prevents changes to the transmitter configuration, including local zero and span adjustments. Security is activated by an internal switch.

Failure mode alarm

If self-diagnostics detect a sensor or microprocessor failure, the analog signal will be driven either high or low to alert the user. High or low failure mode is user-selectable with a jumper on the transmitter. The values to which the transmitter drives its output in failure mode depend on whether it is factory-configured to standard or NAMUR-compliant operation. The values for each are as follows:

Table 3. Standard Operation

Output code	Linear output	Fail high	Fail low
S	$3.9 \leq I \leq 20.8$	$I \geq 21.75 \text{ mA}$	$I \leq 3.75 \text{ mA}$
N	$0.97 \leq V \leq 5.2$	$V \geq 5.4 \text{ V}$	$V \leq 0.95 \text{ V}$

Table 4. NAMUR-Compliant Operation

Output code	Linear output	Fail high	Fail low
S	$3.8 \leq I \leq 20.5$	$I \geq 22.5 \text{ mA}$	$I \leq 3.6 \text{ mA}$

Physical specifications**Material selection**

Emerson Process Management provides a variety of Rosemount product with various product options and configurations including materials of construction that can be expected to perform well in a wide range of applications. The Rosemount product information presented is intended as a guide for the purchaser to make an appropriate selection for the application. It is the purchaser's sole responsibility to make a careful analysis of all process parameters (such as all chemical components, temperature, pressure, flow rate, abrasives, contaminants, etc.), when specifying product, materials, options and components for the particular application. Emerson is not in a position to evaluate or guarantee the compatibility of the process fluid or other process parameters with the product, options, configuration or materials of construction selected.

Electrical connections

$1/2$ -14 NPT, M20 3 1.5 (CM20), or
G $1/2$ female (PF $1/2$ female) conduit entry

Process connections

$1/2$ -14 NPT female, DIN 16288 G $1/2$ male, RC $1/2$ female
(PT $1/2$ female), M20 3 1.5 (CM20) male

Process-wetted parts**Isolating diaphragm**

316L SST (UNS S31603), Alloy C-276 (UNS N10276)

Process connector

316L stainless steel CF-3M (Cast version of 316L SST, material per ASTM_A743) or Alloy C-276

Non-wetted parts**Electronics housing**

Low-copper aluminum, NEMA 4X, IP65, IP67,
CSA enclosure Type 4X

Paint for aluminum housing

Polyurethane

Cover O-rings

Buna-N

Fill fluid

Silicone or inert fill

Weight

Output Code S and N: Approximately 2.44 lb (1, 11 kg)

Product Certifications

Rev 1.1

European Directive Information

A copy of the EC Declaration of Conformity can be found at the end of the Quick Start Guide. The most recent revision of the EC Declaration of Conformity can be found at www.rosemount.com.

Ordinary Location Certification

As standard, the transmitter has been examined and tested to determine that the design meets the basic electrical, mechanical, and fire protection requirements by a nationally recognized test laboratory (NRTL) as accredited by the Federal Occupational Safety and Health Administration (OSHA).

North America

- E5** USA Explosionproof (XP) and Dust-Ignitionproof (DIP)
Certificate: 1V2A8.AE
Standards: FM Class 3600 - 2011, FM, Class 3615 - 2006, FM class 3616 - 2011, FM Class 3810 - 2005, ANSI/NEMA 250 - 1991
Markings: XP CL I, DIV 1, GP B, C, D; DIP CL II, DIV 1, GP E, F, G; CL III; T5(-40°C ≤ Ta ≤ +85°C); Factory Sealed; Type 4X

- I5** USA Intrinsic Safety (IS) and Nonincendive (NI)
Certificate: 0V9A7.AX
Standards: FM Class 3600 - 1998, FM Class 3610 - 2010, FM Class 3611 - 2004, FM Class 3810 - 1989
Markings: IS CL I, DIV 1, GP A, B, C, D; CL II, DIV 1, GP E, F, G; Class III; DIV 1 when connected per Rosemount drawing 02088-1018; NI CL 1, DIV 2, GP A, B, C, D; T4(-40°C ≤ Ta ≤ +70°C); Type 4x

Special Condition for Safe Use (X):

1. The Model 2088 transmitter with the transient terminal block (Option code T1) will not pass the 500Vrms dielectric strength test and this must be taken into account during installation.

- C6** CSA Explosionproof, Dust-Ignitionproof, Intrinsic Safety and Nonincendive
Certificate: 1015441
Standards: CAN/CSA C22.2 No. 0-M91 (R2001), CSA Std C22.2 No. 25-1966, CSA Std C22.2 No. 30-M1986, CAN/CSA-C22.2 No. 94-M91, CSA Std C22.2 No. 142-M1987, CAN/CSA-C22.2 No. 157-92, CSA Std C22.2 No. 213-M1987, ANSI-ISA-12.27.01-2003

Markings: Explosionproof for Class I, Division 1, Groups B, C and D; Dust-Ignitionproof Class II, Division 1, Groups E, F, G; Class III Division 1; Intrinsically Safe Class I, Division 1 Groups A, B, C, D when connected in accordance with Rosemount drawing 02088-1024, Temperature Code T3C; Class I Division 2 Groups A, B, C and D; Type 4X; Factory Sealed; Single Seal

Europe

- ED** ATEX Flameproof
Certificate: KEMA97ATEX2378X
Standards: EN60079-0:2006, EN60079-1:2007, EN60079-26:2007
Markings: Ⓔ II 1/2 G Ex d IIC T6/T4, T6(-40 °C ≤ Ta ≤ +40 °C), T4(-40 °C ≤ Ta ≤ +80 °C)

Special Conditions for Safe Use (X):

1. This device contains a thin wall diaphragm. Installation, maintenance and use shall take into account the environmental conditions to which the diaphragm will be subjected. The manufacturer's instructions for installation and maintenance shall be followed in detail to assure safety during its expected lifetime.
2. For information on the dimensions of the flameproof joints the manufacturer shall be contacted.

- I1** ATEX Intrinsic Safety
Certificate: BAS00ATEX1166X
Standards: EN60079-0:2012, EN60079-11:2012
Markings: Ⓔ II 1 G Ex ia IIC T5/T4 Ga, T5(-55 °C ≤ Ta ≤ +40 °C), T4(-55 °C ≤ Ta ≤ +70 °C)

Table 5. Input Parameters

Parameter	HART
Voltage U _i	30 V
Current I _i	200 mA
Power P _i	0.9 W
Capacitance C _i	0.012 μF

Special Condition For Safe Use (X):

1. The apparatus is not capable of withstanding the 500V insulation test required by EN60079-11. This must be taken into account when installing the apparatus.

- N1** ATEX Type n
Certificate: BAS00ATEX3167X
Standards: EN60079-0:2012, EN60079-15:2010
Markings: Ⓔ II 3 G Ex nA IIC T5 Gc (-40 °C ≤ Ta ≤ +70 °C)

Special Condition For Safe Use (X):

1. The apparatus is not capable of withstanding the 500 V insulation test required by EN60079-15. This must be taken into account when installing the apparatus.

ND ATEX Dust

Certificate: BAS01ATEX1427X
 Standards: EN60079-0:2012, EN60079-31:2009
 Markings: $\text{Ex} \text{ II 1 D Ex t IIIC T50 }^\circ\text{C T}_{500} \text{ 60 }^\circ\text{C Da}$

Special Conditions For Safe Use (X):

1. The user must ensure that the maximum rated voltage and current (36 volts, 24 milliamps, d.c.) are not exceeded. All connection to other apparatus or associated apparatus shall have control over this voltage and current to a category 'ib' circuit.
2. Cable entries must be used which maintain the ingress protection of the enclosure to at least IP66.
3. Unused cable entries must be filled with suitable blanking plugs which maintain the ingress protection of the enclosure to at least IP66.
4. Cable entries and blanking plugs must be suitable for the ambient range of the apparatus and capable of withstanding a 7J impact test.
5. The 2088/2090 sensor module must be securely screwed in place to maintain the ingress protection of the enclosure.

International

E7 IECEx Flameproof

Certificate: IECEx KEM 06.0021X
 Standards: IEC60079-0:2004, IEC60079-1:2003, IEC60079-26:2004,
 Markings: $\text{Ex d IIC T4...T6, T6}(-20^\circ\text{C} \leq T_a \leq +40^\circ\text{C}), T4(-20^\circ\text{C} \leq T_a \leq +80^\circ\text{C})$

Special Condition For Safe Use (x):

1. The material of the diaphragm shall not be subjected to environmental conditions that might adversely affect the partition wall.

I7 IECEx Intrinsic Safety

Certificate: IECEx BAS 12.0071X
 Standards: IEC60079-0:2011, IEC60079-11:2011
 Markings: $\text{Ex ia IIC T5/T4 Ga, T5}(-55^\circ\text{C} \leq T_a \leq +40^\circ\text{C}), T4(-55^\circ\text{C} \leq T_a \leq +70^\circ\text{C})$

Table 6. Entity Parameters

Parameter	HART
Voltage U_i	30 V
Current I_i	200 mA
Power P_i	0.9 W
Capacitance C_i	0.012 μF

Special Conditions for Safe Use (X):

1. When fitted with a transient suppression terminal block, the Model 2088 is incapable of passing the 500 V isolation test. This must be taken into account during installation.
2. The enclosure may be made of aluminum alloy and given a protective polyurethane paint finish; however, care should be taken to protect it from impact or abrasion if located in a Zone 0 environment.

N7 IECEx Type n

Certificate: IECEx BAS 12.0072X
 Standards: IEC60079-0:2011, IEC60079-15:2010
 Markings: $\text{Ex nA IIC T5 Gc}(-40^\circ\text{C} \leq T_a \leq +70^\circ\text{C})$

Special Condition for Safe Use (X):

1. When fitted with a transient suppression terminal block, the Model 2088 is incapable of passing the 500 V isolation test. This must be taking into account during installation.

NK IECEx Dust

Certificate: IECEx BAS12.0073X
 Standards: IEC60079-0:2011, IEC60079-31: 2008
 Markings: $\text{Ex t IIIC T50 }^\circ\text{C T}_{500} \text{ 60 }^\circ\text{C Da}$

Table 7. Input Parameters

Parameter	HART
Voltage U_i	36 V
Current I_i	24 mA

Special Conditions For Safe Use (x):

1. Cable entries must be used which maintain the ingress protection of the enclosure to at least IP66.
2. Unused cable entries must be filled with suitable blanking plugs which maintain the ingress protection of the enclosure to at least IP66.
3. Cable entries and blanking plugs must be suitable for the ambient range of the apparatus and capable of withstanding a 7J impact.

Brazil

I2 INMETRO Intrinsic Safety

Certificate: UL-BR 13.0246X
 Standards: ABNT NBR IEC60079-0:2008 + Errata 1:2011, ABNT NBR IEC60079-11:2009
 Markings: $\text{Ex ia IIC T5/T4 Ga, T5}(-55^\circ\text{C} \leq T_a \leq +40^\circ\text{C}); T4(-55^\circ\text{C} \leq T_a \leq +70^\circ\text{C})$

Table 8. Input Parameters

Parameter	HART
Voltage U_i	30 V
Current I_i	200 mA
Power P_i	0.9 W
Capacitance C_i	0.012 μF

Special Conditions For Safe Use (x):

1. When fitted with a transient suppression terminal block, the model 2088 is incapable of passing the 500 V isolation test. This must be taken into account during installation.
2. The enclosure may be made of aluminum alloy and given a protective polyurethane paint finish; however, care should be taken to protect it from impact or abrasion if located in a zone 0 environment.

China

E3 China Flameproof
 Certificate: GYJ111062
 Standards: GB3836.1-2000, GB3836.2-2010
 Markings: Ex d IIC T4/T6, T6(-20 °C ≤ T_a ≤ +40 °C),
 T4(-20 °C ≤ T_a ≤ +80 °C)

Special Conditions For Safe Use (X):

1. The ambient temperature is as follows:

T _a	Temperature class
-20 °C ≤ T _a ≤ 80 °C	T4
-20 °C ≤ T _a ≤ 40 °C	T6

2. The earth connection facility in the enclosure should be connected reliably.
3. During installation in hazardous location, cable glands, conduits, and blanking plugs, certified by state-appointed inspection bodies with Ex d IIC type of protection, should be used.
4. Obey the warning “Do not open when energized.”
5. Installation and maintenance should be done in a non-hazardous environment.
6. End user is not permitted to change any internal component.
7. During installation, use and maintenance of this product, observe the following standards:
 GB3836.13-1997 “Electrical apparatus for explosive gas atmospheres Part 13: Repair and overhaul for apparatus used in explosive gas atmospheres”
 GB3836.15-2000 “Electrical apparatus for explosive gas atmospheres Part 15: Electrical installations in hazardous area (other than mines)”
 GB3836.16-2006 “Electrical apparatus for explosive gas atmospheres Part 16: Inspection and maintenance of electrical installation (other than mines)”
 GB50257-1996 “Code for construction and acceptance of electric device for explosion atmospheres and fire hazard electrical equipment installation engineering”

I3 China Intrinsic Safety
 Certificate: GYJ111063X
 Standards: GB3836.1-2000, GB3836.4-2000
 Markings: Ex ia IIC T4

Special Conditions For Safe Use (X):

1. This apparatus is not capable of withstanding the 500 V r.m.s. insulation test required by Clause 6.4.12 of GB3836.4-2000.
2. The ambient temperature is:

T _a	Temperature class
-55 °C ≤ T _a ≤ 40 °C	T5
-55 °C ≤ T _a ≤ 70 °C	T4

3. Intrinsically safe parameters:

Parameter	HART
Voltage U _i	30 V
Current I _i	200 mA
Power P _i	0.9 W
Capacitance C _i	0.012 μF
Inductance L _i	0 mH

4. The product should be used with Ex-certified linear associated apparatus to establish explosion protection system that can be used in explosive gas atmospheres. Wiring and terminals should comply with the instruction manual of the product and associated apparatus.
5. The cables between this product and associated apparatus should be shielded cables (the cables must have insulated shields). The shield has to be grounded reliably in a non-hazardous area.
6. End users are not permitted to change any internal components, but to settle the problem in conjunction with the manufacturer to avoid damage to the product.
7. During installation, use and maintenance of this product, observe the following standards:
 GB3836.13-1997 “Electrical apparatus for explosive gas atmospheres Part 13: Repair and overhaul for apparatus used in explosive gas atmospheres”
 GB3836.15-2000 “Electrical apparatus for explosive gas atmospheres Part 15: Electrical installations in hazardous area (other than mines)”
 GB3836.16-2006 “Electrical apparatus for explosive gas atmospheres Part 16: Inspection and maintenance of electrical installation (other than mines)”
 GB50257-1996 “Code for construction and acceptance of electric device for explosion atmospheres and fire hazard electrical equipment installation engineering”

N3 China Type n
 Certificate: GYJ15.1108X
 Standards: GB3836.1-2000, GB3836. 8-2003
 Markings: Ex nA nL IIC T5 Gc (-40 °C ≤ T_a ≤ +70 °C)

Special Conditions For Safe Use (X):

1. The apparatus is not capable of withstanding the 500V r.m.s. insulation test required by GB3836.8-2003.
2. The ambient temperature range is -40 °C ≤ T_a ≤ +70 °C.
3. Maximum input voltage: 50 V.

4. Cable glands, conduit or blanking plugs, certified by NEPSI with Ex e or Ex n protection types should be used on external connections and redundant cable entries.
5. Maintenance should be done in non-hazardous location.
6. End users are not permitted to change any internal components, but to settle the problem in conjunction with manufacturer to avoid damage to the product.
7. During installation, use and maintenance of this product, observe the following standards:
 GB3836.13-2013 “Electrical apparatus for explosive gas atmospheres Part 13: Repair and overhaul for apparatus used in explosive gas atmospheres”
 GB3836.15-2000 “Electrical apparatus for explosive gas atmospheres Part 15: Electrical installations in hazardous area (other than mines)”
 GB3836.16-2006 “Electrical apparatus for explosive gas atmospheres Part 16: Inspection and maintenance of electrical installation (other than mines)”
 GB50257-1996 “Code for construction and acceptance of electric device for explosion atmospheres and fire hazard electrical equipment installation engineering”

Japan

E4 Japan Flameproof
 Certificate: TC15871, TC15872, TC15873, TC15874, TC20869, TC20870
 Markings: Ex d IIC T6

Technical Regulations Customs Union (EAC)

EM, IM, KM Contact an Emerson Process Management representative for additional information

Combinations

- K1** Combination of ED, I1, ND, and N1
- K2** Combination of E2 and I2
- K5** Combination of E5 and I5
- K6** Combination of C6, ED, and I1
- K7** Combination of E7, I7, NK, and N7
- KB** Combination of K5 and C6
- KH** Combination of ED, I1, K5

Conduit Plugs and Adapters

IECEx Flameproof and Increased Safety
 Certificate: IECEx FMG 13.0032X
 Standards: IEC60079-0:2011, IEC60079-1:2007-04, IEC60079-7:2006-07

Markings: Ex de IIC Gb

ATEX Flameproof and Increased Safety
 Certificate: FM13ATEX0076X
 Standards: EN60079-0:2012, EN60079-1:2007, IEC60079-7:2007

Markings: II 2 G Ex de IIC Gb

Table 9. Conduit Plug Thread Sizes

Thread	Identification mark
M20 x 1.5	M20
1/2 - 14 NPT	1/2 NPT
G1/2A	G1/2

Table 10. Thread Adapter Thread Sizes

Male thread	Identification mark
M20 x 1.5 – 6H	M20
1/2- 14 NPT	1/2 - 14 NPT
3/4 - 14 NPT	3/4 - 14 NPT
Female thread	Identification mark
M20 x 1.5 – 6H	M20
1/2 - 14 NPT	1/2 - 14 NPT
PG 13.5	PG 13.5
G1/2	G1/2

Special Conditions For Safe Use (X):

1. When the thread adapter or blanking plug is used with an enclosure in type of protection increased safety “e” the entry thread shall be suitably sealed in order to maintain the ingress protection rating (IP) of the enclosure.
2. The blanking plug shall not be used with an adapter.
3. Blanking Plug and Threaded Adapter shall be either NPT or Metric thread forms. G1/2 and PG 13.5 thread forms are only acceptable for existing (legacy) equipment installations.

Additional Certifications

SBS American Bureau of Shipping (ABS) Type Approval

Certificate: 09-HS446883D-3-PDA

Intended Use: Measure gauge or absolute pressure of liquid, gas or vapor applications on ABS classed vessels, marine, and offshore installations.

ABS Rules: 2014 Steel Vessels Rules 1-1-4/7.7, 1-1-Appendix 3, 4-8-3/1.7, 4-8-3/13.1, 4-8-3/13.3.1 & 13.3.2, 4-8-4/27.5.1

SBV Bureau Veritas (BV) Type Approval

Certificate: 23156/A2 BV

Requirements: Bureau Veritas Rules for the Classification of Steel Ships

Application: Class notations: AUT-UMS, AUT-CCS, AUT-PORT and AUT-IMS; Pressure transmitter type 2088 cannot be installed on diesel engines.

SDN Det Norske Veritas (DNV) Type Approval

Certificate: A-14185

Intended Use: Det Norske Veritas' Rules for Classification of Ships, High Speed & Light Craft; Det Norske Veritas' Offshore Standards

Application:

Location classes	
Temperature	D
Humidity	B
Vibration	A
EMC	B
Enclosure	D

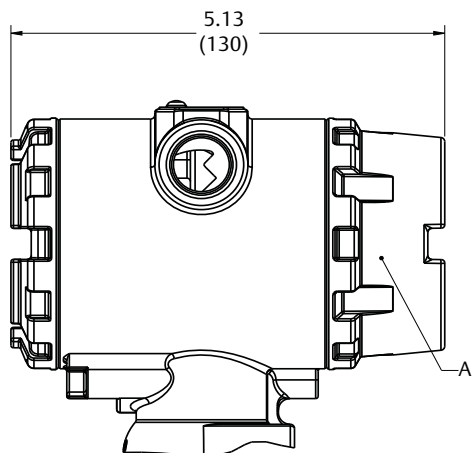
SLL Lloyds Register (LR) Type Approval

Certificate: 11/60002

Application: Environmental categories ENV1, ENV2, ENV3 and ENV5

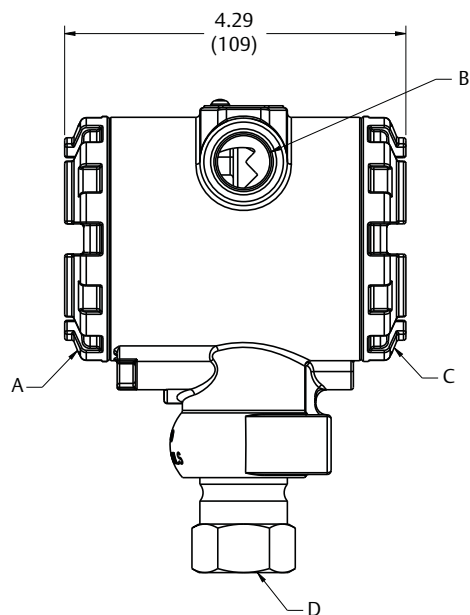
Dimensional Drawings

Figure 2. Rosemount 2088 with Optional Digital Display



- A. Digital display cover
- B. 2 x 1/2-14 NPT conduit connection

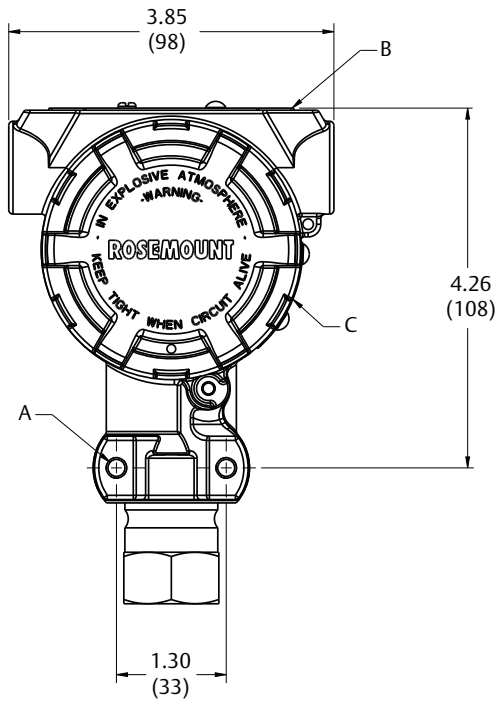
Figure 3. Rosemount 2088 Process Connection



- A. Field terminals
- B. Conduit connection
- C. Transmitter electronics
- D. 1/2-14 NPT female connection⁽¹⁾

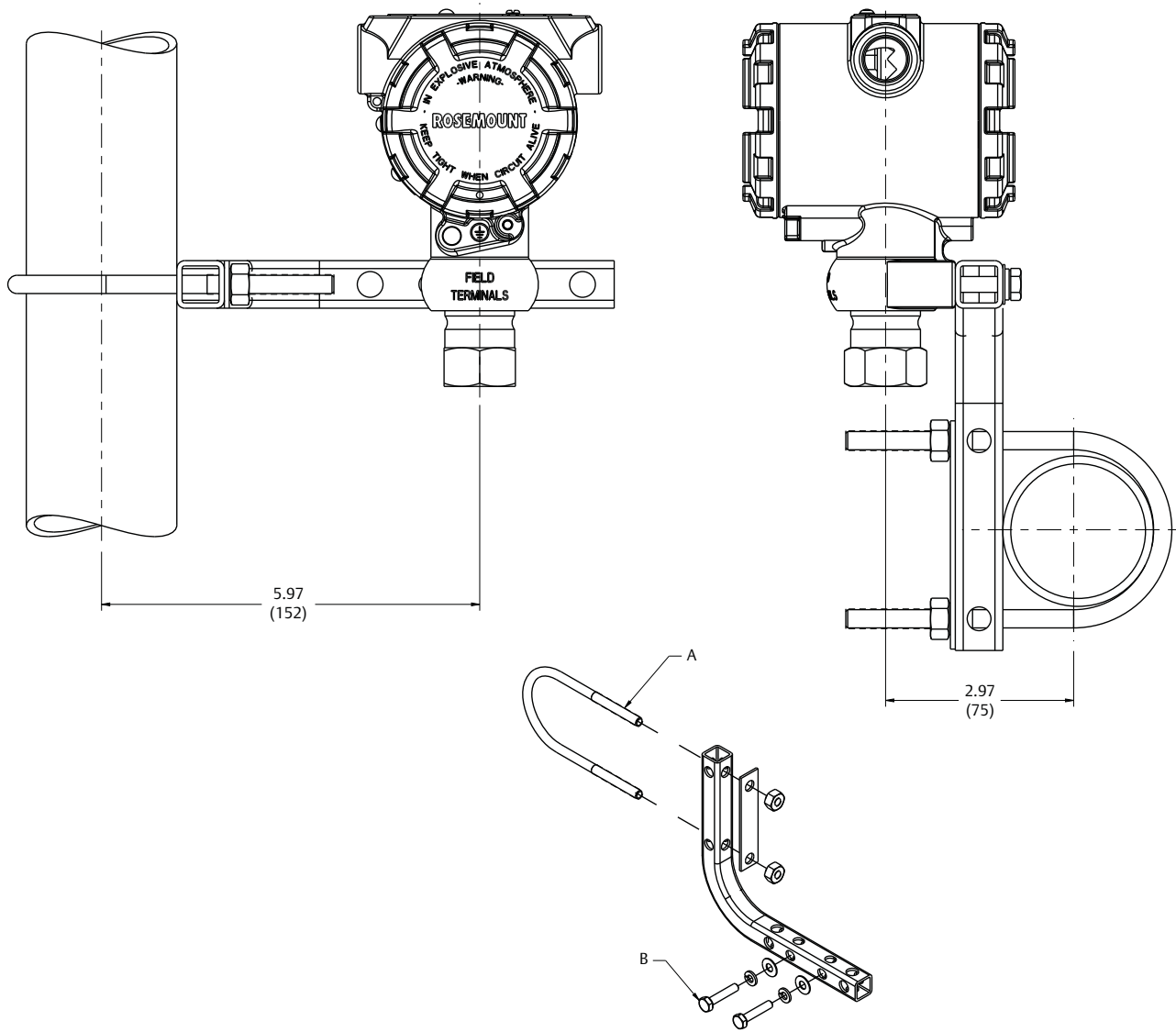
1. RC 1/2 female (PT 1/2 female), and M20 female also available as options

Figure 4. Rosemount 2088 Nameplate and Labels



- A. Bracket mounting holes ($1/4$ -20 UNC)
- B. Nameplate
- C. Certification label (located on side)

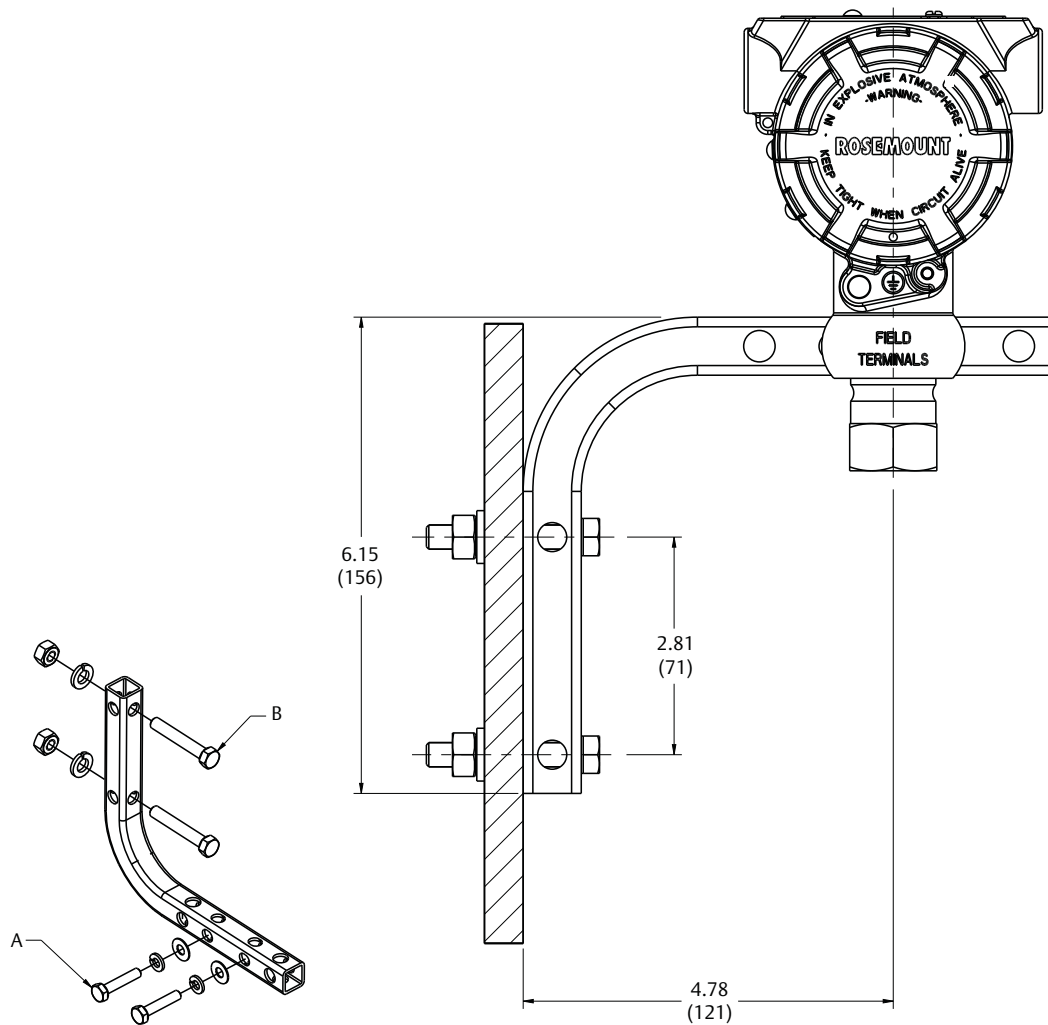
Figure 5. Rosemount 2088 with Optional Pipe Mounting Bracket



- A. 2-in. U-bolt for pipe mounting (clamp shown)
- B. 1/4 x 1 1/4 bolts for transmitter mounting

Dimensions are in inches (millimeters).

Figure 6. Rosemount 2088 with Optional Panel Mounting Bracket



- A. $\frac{1}{4} \times 1\frac{1}{4}$ bolts for transmitter mounting
- B. $\frac{5}{16} \times 1\frac{1}{2}$ bolts for panel mounting (not supplied)

Dimensions are in inches (millimeters).

Options

Standard configuration

Unless otherwise specified, transmitter is shipped as follows:

Engineering units	psi (all ranges)
4 mA (1 Vdc)	0 (engineering units)
20 mA (5 Vdc)	Upper range limit
Output	Linear
Flange type	Specified model code option
Flange material	Specified model code option
O-ring material	Specified model code option
Drain/vent	Specified model code option
LCD display	Installed or none
Alarm	High
Software tag	(Blank)

Custom configuration

If Option Code C9 is ordered, the customer may specify the following data in addition to the standard configuration parameters.

- Output Information
- Transmitter Information
- LCD display Configuration
- Hardware Selectable Information
- Signal Selection

Refer to the “Rosemount 2088 Configuration Data Sheet” document number 00806-0100-4690.

Tagging (3 options available)

- Standard SST hardware tag is permanently affixed on transmitter. Tag character height is 0.125 in. (3,18 mm), 84 characters maximum.
- Tag may be wired to the transmitter nameplate upon request, 85 characters maximum.
- For HART protocols, the tag may be stored in transmitter memory (eight characters maximum). Software tag is left blank unless specified.
- HART Revision 5: 8 characters
- HART Revision 7: 32 characters

Optional Rosemount 306 Integral Manifold

Factory assembled to 2088 transmitters. Refer to Product Data Sheet (document number 00813-0100-4733 for Rosemount 306) for additional information.

Other seals

Refer to Product Data Sheet (document number 00813-0100-4016 or 00813-0201-4016) for additional information.

Output information

Output range points must be the same unit of measure. Available units of measure include:

Pressure units ⁽¹⁾		
torr	psf ⁽¹⁾	cmH ₂ O @ 4 °C ⁽¹⁾
atm	inH ₂ O	mH ₂ O @ 4 °C ⁽¹⁾
Pa	inH ₂ O @ 4 °C ⁽¹⁾	inHg
kPa	inH ₂ O @ 60 °F ⁽¹⁾	mmHg
MPa ⁽¹⁾	ftH ₂ O	cmHG @ 0 °C ⁽¹⁾
hPa ⁽¹⁾	ftH ₂ O @ 4 °C ⁽¹⁾	mHG @ 0 °C ⁽¹⁾
mbar	ftH ₂ O @ 60 °F ⁽¹⁾	g/cm ²
bar	mmH ₂ O	kg/m ² ⁽¹⁾
psi	mmH ₂ O @ 4 °C ⁽¹⁾	kg/cm ²

1. Field configurable only, not available for factory calibration or custom configuration (option code C9 “Software configuration”).

Display and interface options

- M4** Digital Display with Local Operator Interface (LOI)
 - Available for 4-20 mA HART, 4-20 mA HART Low Power
- M5** Digital Meter
 - 2-Line, 5-digit LCD display for 4-20 mA HART
 - 2-Line, 5-digit LCD display for 1-5 Vdc HART Low Power
 - Direct reading of digital data for higher accuracy
 - Displays user-defined flow, level, volume, or pressure units
 - Displays diagnostic messages for local troubleshooting
 - 90-degree rotation capability for easy viewing

Configuration buttons

Rosemount 2088 now offers optional internal and external configuration buttons.

- Selecting option D4 will add external Analog Zero and Span configuration buttons
- Selecting option DZ will add an external Digital Zero Trim configuration button
- Selecting option M4 (LOI) adds both internal and external local configuration buttons.

Certain button options can also be combined as shown below:

Table 11. Button Configuration

Option codes	Internal	External
DZ	N/A	Digital Zero Trim
D4	N/A	Analog Zero & Trim
M4	LOI	LOI
M4 + DZ	LOI	Digital Zero Trim
M4 + D4	LOI	Analog Zero & Trim

Rosemount 2088 bracket option

- B4** Bracket for 2-in. pipe or panel mounting
- Bracket for mounting of transmitter on 2-in. pipe or panel
 - Stainless steel construction with stainless steel bolts

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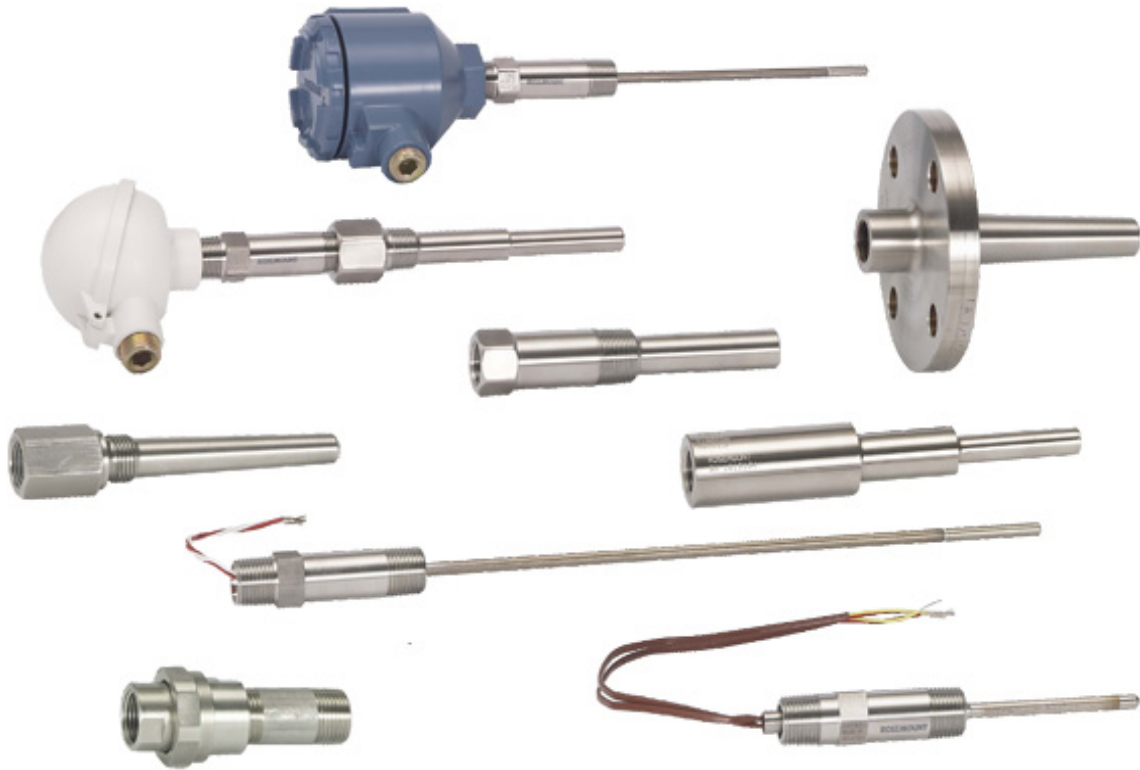
Middle East and Africa Regional Office

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Volume 1 Temperature Sensors and Accessories (English)



- RTD and Thermocouple offering in single and dual sensor models
- Barstock Thermowell offering in wide range of materials and process connections
- Calibration capabilities for increased measurement accuracy
- Sanitary RTD for hygienic applications

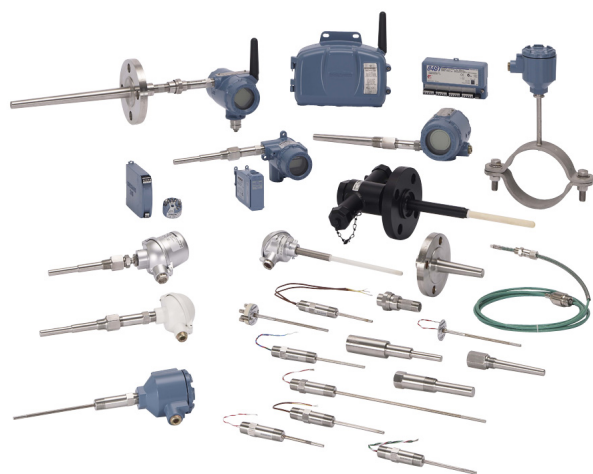
Rosemount Volume 1 Temperature Sensor and Thermowells

Optimize plant efficiency and increase measurement reliability with industry-proven design and specifications

- Available in a variety of sensing technologies – RTD and Thermocouples
- All sensor styles and lengths are available in 1/4-in. diameter
- State of the art manufacturing procedures provide robust element packaging, increasing reliability
- Industry-leading calibration capabilities allow for Callendar-van Dusen values to give increased accuracy when paired with Rosemount transmitters
- Optional Class A accuracy for critical temperature measurement points
- Sanitary offering provides sensor assemblies approved for hygienic applications

Streamline operations and maintenance with sensor and thermowell design

- Spring loaded threaded adapter, general-purpose welded adapter, capsule, and bayonet styles offer remote or integral transmitter mounting configuration



Explore the benefits of a Complete Point Solution™ from Rosemount Temperature Measurement

- An “Assemble Sensor to Specific Transmitter” option enables Emerson to provide a complete point temperature solution, delivering an installation-ready transmitter and sensor assembly
- Emerson has a complete portfolio of Single Point and High Density Temperature Measurement solutions, allowing you to effectively measure and control your processes with the reliability you trust from Rosemount products

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Experience global consistency and local support from numerous worldwide Rosemount Temperature manufacturing sites

- World-class manufacturing provides globally consistent product from every factory and the capacity to fulfill the needs of any project, large or small.
- Experienced Instrumentation Consultants help select the right product for any temperature application and advise on best installation practices.
- An extensive global network of Emerson service and support personnel can be on-site when and where they are needed.



Rosemount 68 Sensor and Thermowell



The Rosemount 78 Sensor and Thermowell have designs that provide flexible and reliable temperature measurements in process environments.

Features include:

- Industry-standard Pt-100 RTD
- Variety of enclosure and connection head options
- Global hazardous-location approvals
- Calibration services to give you insight to sensor performance
- Calibration certification documentation to accompany sensor
- Assemble to Transmitter option

Specification and selection of product materials, options, or components must be made by the purchaser of the equipment. See [page 69](#) for more information on Material Selection.

Table 1. Series 68 RTD Sensor Assemblies WITHOUT Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time. The Expanded offering is subject to additional delivery lead time.

Model	Product description	
0068	Platinum Temperature Sensor without Thermowell	
Connection head		
R	Aluminum Connection Head, Six Terminals, Flat Cover, Unpainted	★
T	Aluminum Connection Head, Six Terminals, Extended Cover, Unpainted	★
P	Aluminum Connection Head, Six Terminals, Flat Cover, Painted	★
L	Aluminum Connection Head, Six Terminals, Extended Cover, Painted	★
N	Sensor Only with 6-in. PTFE-insulated, 24-gauge lead wires	★
D	Rosemount Aluminum Connection Head with 1/2-in. Entries	★
C	Polypropylene Connection Head	
G	Rosemount SST Connection Head with 1/2-in. Entries	
Sensor type (single element -50 to 400 °C [-58 to 752 °F])		
01 ⁽¹⁾⁽²⁾	Capsule Style	★
11 ⁽³⁾	General-purpose Style	★
21	Spring-loaded Style	★
31 ⁽⁴⁾	Bayonet Spring-Loaded Style (available in [X] lengths of 1 to 21-in., increments of 1-in.)	
Extension type		Extension type material
A ⁽⁵⁾	Nipple Coupling	300 series SST
C ⁽⁵⁾	Nipple Union	300 series SST
N	None (use with Extension Length Option Code 00)	None

Table 1. Series 68 RTD Sensor Assemblies WITHOUT Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.
 The Expanded offering is subject to additional delivery lead time.

Extension length (E)		
00	0.0 in.	★
30	3.0 in.	★
60	6.0 in.	★
Thermowell material		
N	No Thermowell Required	★
Sensor immersion length (L)		
010 ⁽⁶⁾	1.0-in.	★
015	1.5-in.	★
020	2.0-in.	★
025	2.5-in.	★
030	3.0-in.	★
035	3.5-in.	★
040	4.0-in.	★
045	4.5-in.	★
050	5.0-in.	★
055	5.5-in.	★
060	6.0-in.	★
065	6.5-in.	★
070	7.0-in.	★
075	7.5-in.	★
080	8.0-in.	★
085	8.5-in.	★
090	9.0-in.	★
095	9.5-in.	★
100	10.0-in.	★
105	10.5-in.	★
110	11.0-in.	★
115	11.5-in.	★
120	12.0-in.	★
125	12.5-in.	★
130	13.0-in.	★
135	13.5-in.	★
140	14.0-in.	★
145	14.5-in.	★

Table 1. Series 68 RTD Sensor Assemblies WITHOUT Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.
The Expanded offering is subject to additional delivery lead time.

Sensor immersion length (L)		
150	15.0-in.	★
155	15.5-in.	★
160	16.0-in.	★
165	16.5-in.	★
170	17.0-in.	★
175	17.5-in.	★
180	18.0-in.	★
185	18.5-in.	★
190	19.0-in.	★
195	19.5-in.	★
200	20.0-in.	★
205	20.5-in.	★
210	21.5-in.	★
215	21.5-in.	★
220	22.0-in.	★
225	22.5-in.	★
230	23.0-in.	★
240	24.0-in.	★
250	25.0-in.	★
260	26.0-in.	★
270	27.0-in.	★
280	28.0-in.	★
290	29.0-in.	★
300	30.0-in.	★
310	31.0-in.	★
320	32.0-in.	★
330	33.0-in.	★
340	34.0-in.	★
350	35.0-in.	★
360	36.0-in.	★
370	37.0-in.	★
380	38.0-in.	★
390	39.0-in.	★
400	40.0-in.	★
410	41.0-in.	★

Table 1. Series 68 RTD Sensor Assemblies WITHOUT Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.
The Expanded offering is subject to additional delivery lead time.

Sensor immersion length (L)		
420	42.0-in.	★
430	43.0-in.	★
440	44.0-in.	★
450	45.0-in.	★
460	46.0-in.	★
470	47.0-in.	★
480	48.0-in.	★

Options (include with selected model number)

Approval options		
E1	ATEX Flameproof Approval (see Figure 32)	★
E2	Ex d- CEPEL Flameproof Approval- Brazil	★
E5	FM Explosion-proof Approval (see Figure 30)	★
E6	CSA Explosion-proof Approval (see Figure 31)	★
E7	IECEx Flameproof Approval	★
KF	ATEX + CSA Explosion-proof Combination Approval	★
EM	Technical Regulations Customs Union (EAC) Flameproof	★
Callendar-Van Dusen constants		
V1-V7	Callendar Van Dusen Constant (V4 not available with series 68 sensors)	★
Calibration schedule		
X8	Customer-Specified Temperature Range Calibration	★
X9	Customer-Specified Single Temperature Point Calibration	★
Calibration certification		
Q4	Calibration Certification, Customer-Specified Temperature	★
Mounting adapters		
M5-M7	Mounting adapter: Sensor Compression Fitting: M5 = 1/8 - 27 NPT, M6 = 1/4 - 18 NPT, M7 = 1/2 - 14 NPT	★
A Leadkit		
A1-A8	Twisted Lead Wire Extension: A1 = 1.5 ft, A2 = 3.0 ft, A3 = 6.0 ft, A4 = 12 ft, A5 = 24 ft, A6 = 50 ft, A7 = 75 ft, A8 = 100 ft	★
B Leadkit		
B1-B8	Shielded Cable Lead Wire Extension: B1 = 1.5 ft, B2 = 3.0 ft, B3 = 6.0 ft, B4 = 12 ft, B5 = 24 ft, B6 = 50 ft, B7 = 75 ft, B8 = 100 ft	★
C Leadkit		
C1-C8 ⁽⁷⁾	Armored Cable Lead Wire Extension: C1 = 1.5 ft, C2 = 3.0 ft, C3 = 6.0 ft, C4 = 12 ft, C5 = 24 ft, C6 = 50 ft, C7 = 75 ft, C8 = 100 ft	★

Table 1. Series 68 RTD Sensor Assemblies WITHOUT Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.

The Expanded offering is subject to additional delivery lead time.

D Leadkit		
D1-D8 ⁽⁸⁾	Armored Cable Lead Wire Extensions With Electrical Plug: D1 = 1.5 ft, D2 = 3.0 ft, D3 = 6.0 ft, D4 = 12 ft, D5 = 24 ft, D6 = 50 ft, D7 = 75 ft, D8 = 100 ft	★
L1-L8 ⁽⁸⁾	Armored Cable Mating Plugs With Lead Wire Extension: L1 = 1.5 ft, L2 = 3.0 ft, L3 = 6.0 ft, L4 = 12 ft, L5 = 24 ft, L6 = 50 ft, L7 = 75 ft, L8 = 100 ft	★
J Leadkit		
J1 ⁽⁷⁾	Moisture-proof Seal Assembly For Armored Cables	★
Assemble to options		
XA ⁽⁹⁾	Assemble Connection Head or Transmitter to a Sensor Assembly	★

- (1) Capsule style available in 1-in. increments only, starting at 1-in.
- (2) This option can only be used with Sensor Lead Wire Termination code N and is not available with assembly code XA or with Approval Options.
- (3) General-purpose sensors are only available in (L) lengths of 2.5-in. or greater.
- (4) Not available with Sensor Lead Wire Termination codes R, P, or C or with Approval Options.
- (5) Codes A and C must be used with an Extension Length.
- (6) 1-in. length without extension is only available in Capsule Style.
- (7) These options are only available with Sensor Lead Wire Termination codes T, L, or N.
- (8) These options are only available with Sensor Lead Wire Termination code N.
- (9) If ordering option code XA with a transmitter, specify the same option on the transmitter model code.

Table 2. Ordering Example

Typical Model Number	Model	Lead wire termination	Sensor type	Extension type	Extension length	Thermowell material	Sensor length	Additional options
	0068	N	11	N	00	N	045	E5

Specification and selection of product materials, options, or components must be made by the purchaser of the equipment. See [page 69](#) for more information on Material Selection.

Table 3. Series 68 RTD Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time. The Expanded offering is subject to additional delivery lead time.

Model	Product description	
0068	Platinum Temperature Sensors with Thermowell	
Connection head		
R	Aluminum Connection Head, Six Terminals, Flat Cover, Unpainted	★
T	Aluminum Connection Head, Six Terminals, Extended Cover, Unpainted	★
P	Aluminum Connection Head, Six Terminals, Flat Cover, Painted	★
L	Aluminum Connection Head, Six Terminals, Extended Cover, Painted	★
N	Sensor Only with 6-in. PTFE-insulated, 24-gauge Lead Wires	★
D	Rosemount Aluminum Connection Head with 1/2-in. Entries	★
C	Polypropylene Connection Head	
G	Rosemount SST Connection Head with 1/2-in. Entries	
Sensor type (single element -50 to 400 °C [-58 to 752 °F])		
11	General-purpose Style	★
21	Spring-loaded Style	★
31 ⁽¹⁾	Bayonet Spring-loaded Style (available in (X) lengths of 1 to 21-in., increments of 1-in.)	
Extension type		
A ⁽²⁾	Nipple Coupling	★
C ⁽²⁾	Nipple Union	★
N	None (use with Extension Length Option Code 00)	★
Extension length (E)		
00	0.0 in.	★
30	3.0 in.	★
60	6.0 in.	★
Thermowell material		
A	316 SST	★
B	304 SST	★
C	Carbon Steel	★
D	316L SST	★
E	304L SST	★
F	Alloy 20	
G	Alloy 400	
H	Alloy 600	
J	Alloy C-276	
L	Alloy B	

Table 3. Series 68 RTD Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.

The Expanded offering is subject to additional delivery lead time.

Thermowell material			
M	304 SST with PTFE coating		
P	Chrome Molybdenum Grade F22		
R	Nickel 200		
T	Titanium		
U ⁽³⁾	316 SST with Tantalum Sheath		
V	310 SST		
W	321 SST		
Z	Chrome Molybdenum Grade F11		
Immersion length (U)	Thermowell length (L) ⁽⁴⁾	Lagging length (T) ⁽⁵⁾	
015 ⁽⁶⁾	1.5-in.	4.0-in.	1.0-in. ★
020 ⁽⁶⁾	2.0-in.	4.0-in.	0.5-in. ★
025 ⁽⁶⁾	2.5-in.	4.0-in.	0.0-in. ★
030	3.0-in.	6.0-in.	1.5-in. ★
035	3.5-in.	6.0-in.	1.0-in. ★
040	4.0-in.	6.0-in.	0.5-in. ★
045	4.5-in.	6.0-in.	0.0-in. ★
050	5.0-in.	9.0-in.	2.5-in. ★
055	5.5-in.	9.0-in.	2.0-in. ★
060	6.0-in.	9.0-in.	1.5-in. ★
065	6.5-in.	9.0-in.	1.0-in. ★
070	7.0-in.	9.0-in.	0.5-in. ★
075	7.5-in.	9.0-in.	0.0-in. ★
080	8.0-in.	12.0-in.	2.5-in. ★
085	8.5-in.	12.0-in.	2.0-in. ★
090	9.0-in.	12.0-in.	1.5-in. ★
095	9.5-in.	12.0-in.	1.0-in. ★
100	10.0-in.	12.0-in.	0.5-in. ★
105	10.5-in.	12.0-in.	0.0-in. ★
110	11.0-in.	15.0-in.	2.5-in. ★
115	11.5-in.	15.0-in.	2.0-in. ★
120	12.0-in.	15.0-in.	1.5-in. ★
125	12.5-in.	15.0-in.	1.0-in. ★
130	13.0-in.	15.0-in.	0.5-in. ★
135	13.5-in.	15.0-in.	0.0-in. ★
140	14.0-in.	18.0-in.	2.5-in. ★
145	14.5-in.	18.0-in.	2.0-in. ★

Table 3. Series 68 RTD Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.
The Expanded offering is subject to additional delivery lead time.

Immersion length (U)		Thermowell length (L) ⁽⁴⁾	Lagging length (T) ⁽⁵⁾	
150	15.0-in.	18.0-in.	1.5-in.	★
155	15.5-in.	18.0-in.	1.0-in.	★
160	16.0-in.	18.0-in.	0.5-in.	★
165	16.5-in.	18.0-in.	0.0-in.	★
170	17.0-in.	21.0-in.	2.5-in.	★
175	17.5-in.	21.0-in.	2.0-in.	★
180	18.0-in.	21.0-in.	1.5-in.	★
185	18.5-in.	21.0-in.	1.0-in.	★
190	19.0-in.	21.0-in.	0.5-in.	★
195	19.5-in.	21.0-in.	0.0-in.	★
200	20.0-in.	24.0-in.	2.5-in.	★
205	20.5-in.	24.0-in.	2.0-in.	★
210	21.0-in.	24.0-in.	1.5-in.	★
215	21.5-in.	24.0-in.	1.0-in.	★
220	22.0-in.	24.0-in.	0.5-in.	★
225	22.5-in.	24.0-in.	0.0-in.	★
230	23.0-in.	27.0-in.	2.5-in.	★
240	24.0-in.	27.0-in.	1.5-in.	★
250	25.0-in.	27.0-in.	0.5-in.	★
260	26.0-in.	30.0-in.	2.5-in.	★
270	27.0-in.	30.0-in.	1.5-in.	★
280	28.0-in.	30.0-in.	0.5-in.	★
290	29.0-in.	33.0-in.	2.5-in.	★
300	30.0-in.	33.0-in.	1.5-in.	★
310	31.0-in.	33.0-in.	0.5-in.	★
320	32.0-in.	36.0-in.	2.5-in.	★
330	33.0-in.	36.0-in.	1.5-in.	★
340	34.0-in.	36.0-in.	0.5-in.	★
350	35.0-in.	39.0-in.	2.5-in.	★
360	36.0-in.	39.0-in.	1.5-in.	★
370	37.0-in.	39.0-in.	0.5-in.	★
380	38.0-in.	42.0-in.	2.5-in.	★
390	39.0-in.	42.0-in.	1.5-in.	★
400	40.0-in.	42.0-in.	0.5-in.	★
410	41.0-in.	45.0-in.	2.5-in.	★
420	42.0-in.	45.0-in.	1.5-in.	★
430	43.0-in.	45.0-in.	0.5-in.	★

Table 3. Series 68 RTD Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.

The Expanded offering is subject to additional delivery lead time.

Immersion length (U)		Thermowell length (L) ⁽⁴⁾	Lagging length (T) ⁽⁵⁾	
440	44.0-in.	48.0-in.	2.5-in.	★
450	45.0-in.	48.0-in.	1.5-in.	★
460	46.0-in.	48.0-in.	0.5-in.	★
470	47.0-in.	51.0-in.	2.5-in.	★
480	48.0-in.	51.0-in.	1.5-in.	★
Thermowell style		Mounting	Stem	
T20	Threaded	1/2-14 ANPT	Stepped	★
T22	Threaded	3/4-14 ANPT	Stepped	★
T24	Threaded	1-11.5 ANPT	Stepped	★
T26	Threaded	3/4-14 ANPT	Tapered	★
T28	Threaded	1-11.5 ANPT	Tapered	★
T30	Threaded	1 1/2-11 ANPT	Tapered	★
T32	Threaded	1/2-14 ANPT	Straight	★
T34	Threaded	3/4-14 ANPT	Straight	★
T36	Threaded	1-11.5 ANPT	Straight	★
T38	Threaded	3/4-14 ANPT	Straight	★
T44	Threaded	1/2-14 ANPT	Tapered	★
W38	Welded	3/4-in. pipe	Stepped	★
W40	Welded	1-in. pipe	Stepped	★
W42	Welded	3/4-in. pipe	Tapered	★
W44	Welded	1-in. pipe	Tapered	★
W46	Welded	1 1/4-in. pipe	Tapered	★
W48	Welded	3/4-in. pipe	Straight	★
W50	Welded	1-in. pipe	Straight	★
F10	Flanged	2-in., Class 150	Straight	★
F12	Flanged	3-in., Class 150	Straight	★
F52 ⁽⁷⁾	Flanged	1-in., Class 150	Stepped	★
F54	Flanged	1 1/2-in., Class 150	Stepped	★
F56	Flanged	2-in., Class 150	Stepped	★
F58 ⁽⁸⁾	Flanged	1-in., Class 150	Tapered	★
F60	Flanged	1 1/2-in., Class 150	Tapered	★
F62	Flanged	2-in. Class 150	Tapered	★
F64 ⁽⁷⁾	Flanged	1-in., Class 150	Straight	★
F66	Flanged	1 1/2-in., Class 150	Straight	★
F70 ⁽⁷⁾	Flanged	1-in., Class 300	Stepped	★
F72	Flanged	1 1/2-in., Class 300	Stepped	★
F74	Flanged	2-in., Class 300	Stepped	★

Table 3. Series 68 RTD Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.
The Expanded offering is subject to additional delivery lead time.

Thermowell style		Mounting	Stem	
F76 ⁽⁸⁾	Flanged	1-in., Class 300	Tapered	★
F78	Flanged	1½-in., Class 300	Tapered	★
F80	Flanged	2-in., Class 300	Tapered	★
F82 ⁽⁷⁾	Flanged	1-in., Class 300	Straight	★
F84	Flanged	1½-in., Class 300	Straight	★
F86	Flanged	2-in., Class 300	Straight	★
F88 ⁽⁷⁾	Flanged	1-in., Class 600	Stepped	★
F90 ⁽⁹⁾	Flanged	1½-in., Class 600	Stepped	★
F92 ⁽⁹⁾	Flanged	2-in., Class 600	Stepped	★
F94 ⁽⁸⁾⁽⁹⁾	Flanged	1-in., Class 600	Tapered	★
F96 ⁽⁹⁾	Flanged	1½-in., Class 600	Tapered	★
F98 ⁽⁹⁾	Flanged	2-in., Class 600	Tapered	★
F02 ⁽⁷⁾⁽⁹⁾	Flanged	1-in., Class 600	Straight	★
F04 ⁽⁹⁾	Flanged	1½-in., Class 600	Straight	★
F06 ⁽⁹⁾	Flanged	2-in., Class 600	Straight	★
F16 ⁽⁹⁾	Flanged	1½-in., Class 900	Tapered	★
F34 ⁽⁹⁾	Flanged	1½-in., Class 1500	Tapered	★
F24 ⁽⁹⁾	Flanged	2-in., Class 1500	Tapered	★
F08 ⁽¹⁰⁾	Flanged	1½-in., Class 2500	Tapered	★
Q02 ⁽¹¹⁾	Sanitary, Tri-Clamp™	1-in., Tri-Clamp	Stepped	★
Q04 ⁽¹¹⁾	Sanitary, Tri-Clamp	1½-in., Tri-Clamp	Stepped	★
Q06 ⁽¹¹⁾	Sanitary, Tri-Clamp	2-in., Tri-Clamp	Stepped	★
Q08 ⁽¹¹⁾	Sanitary, Tri-Clamp	3-in., Tri-Clamp	Stepped	★
Q20 ⁽¹¹⁾	Sanitary, Tri-Clamp	¾-in., Tri-Clamp	Straight	★
Q22 ⁽¹¹⁾	Sanitary, Tri-Clamp	1-in., Tri-Clamp	Straight	★
Q24 ⁽¹¹⁾	Sanitary, Tri-Clamp	1½-in., Tri-Clamp	Straight	★
Q26 ⁽¹¹⁾	Sanitary, Tri-Clamp	2-in., Tri-Clamp	Straight	★
Q28 ⁽¹¹⁾	Sanitary, Tri-Clamp	3-in., Tri-Clamp	Straight	★

Options (include with selected model number)

Product certifications		
E1	ATEX Flameproof approval (see Figure 32)	★
E2	Ex d- CEPEL Flameproof Approval- Brazil	★
E5	FM Explosion-proof approval (see Figure 30)	★
E6	CSA Explosion-proof approval (see Figure 31)	★
E7	IECEx Flameproof approval	★

Table 3. Series 68 RTD Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.
The Expanded offering is subject to additional delivery lead time.

Product certifications		
KF	ATEX + CSA Explosion-proof Combination Approval	★
EM	Technical Regulations Customs Union (EAC) Flameproof	★
Callendar-Van Dusen Constants		
V1-V7	Callendar-van Dusen Constants (V4 not available with series 68 sensors)	★
Calibration schedule		
X8	Customer-Specified Temperature Calibration	★
X9	Customer-Specified Single Temperature Point Calibration	★
Q4	Calibration Certification, Customer-Specified Temperature	★
A Leadkit		
A1-A8	Twisted Lead Wire Extension: A1 = 1.5 ft, A2 = 3.0 ft, A3 = 6.0 ft, A4 = 12 ft, A5 = 24 ft, A6 = 50 ft, A7 = 75 ft, A8 = 100 ft	★
B Leadkit		
B1-B8	Shielded Cable Lead Wire Extension: B1 = 1.5 ft, B2 = 3.0 ft, B3 = 6.0 ft, B4 = 12 ft, B5 = 24 ft, B6 = 50 ft, B7 = 75 ft, B8 = 100 ft	★
C Leadkit		
C1-C8 ⁽¹²⁾	Armored Cable Lead Wire Extension: C1 = 1.5 ft, C2 = 3.0 ft, C3 = 6.0 ft, C4 = 12 ft, C5 = 24 ft, C6 = 50 ft, C7 = 75 ft, C8 = 100 ft	★
D Leadkit		
D1-D8 ⁽¹³⁾	Armored Cable Lead Wire Extensions with Electrical Plug: D1 = 1.5 ft, D2 = 3.0 ft, D3 = 6.0 ft, D4 = 12 ft, D5 = 24 ft, D6 = 50 ft, D7 = 75 ft, D8 = 100 ft	★
L Leadkit		
L1-L8 ⁽¹³⁾	Armored Cable Mating Plugs with Lead Wire Extension: L1 = 1.5 ft, L2 = 3.0 ft, L3 = 6.0 ft, L4 = 12 ft, L5 = 24 ft, L6 = 50 ft, L7 = 75 ft, L8 = 100 ft	★
J Leadkit		
J1 ⁽¹²⁾	Moisture-Proof Seal Assembly for Armored Cables	★
Special external pressure test		
R01	Special External Pressure Test	★
Material certification		
Q8	Material Certification	★
Surface finish certification		
Q16	Surface Finish Certification	★
Dye penetration test		
R03	Dye Penetration Test	★
NACE Approval		
R05	NACE Approval	★

Table 3. Series 68 RTD Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.
The Expanded offering is subject to additional delivery lead time.

SST plug and chain		
R06	Stainless Steel Plug and Chain	★
Full penetration weld		
R07 ⁽¹⁴⁾	Full Penetration Weld	★
Flange face options		
R09 ⁽¹⁴⁾⁽¹⁵⁾	Concentric serrations of thermowell flange face	★
Flat faced flange		
R10 ⁽¹⁴⁾⁽¹⁵⁾	Flat Faced Flange	★
Vent hole		
R11	Vent Hole	★
Thermowell X-ray		
R12	Thermowell Xray	★
Special surface finish		
R14	Special Surface Finish (12 Ra) (Maximum “U” length = 22.5-in.)	★
Ring joint flange		
R16 ⁽¹⁴⁾⁽¹⁵⁾	Ring Joint Flange (not available with 0-in. [T] length)	★
Electropolish		
R20 ⁽¹⁶⁾	Electropolish	★
Wake frequency		
R21	Wake Frequency-Thermowell Strength Calculation	★
Internal pressure test		
R22	Internal Pressure Test	★
Brass plug and chain		
R23	Brass plug and chain	★
Canadian registration no.		
R24	CRN Marking for British Columbia	
R25	CRN Marking for Alberta	
R26	CRN Marking for Saskatchewan	
R27	CRN Marking for Manitoba	
R28	CRN Marking for Ontario	
R29	CRN Marking for Quebec	
R30	CRN Marking for New Brunswick	
R31	CRN Marking for Nova Scotia	
R32	CRN Marking for Prince Edward Island	

Table 3. Series 68 RTD Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.

The Expanded offering is subject to additional delivery lead time.

Canadian registration no.		
R33	CRN Marking for Yukon Territory	
R34	CRN Marking for Northwest Territory	
R35	CRN Marking for Nunavut	
R36	CRN Marking for Newfoundland and Labrador	
Twell from hex stock		
R37	Thermowell from Hex Stock	
Assemble to options		
XA ⁽¹⁷⁾	Assemble Connection Head or Transmitter to a Sensor Assembly	★

(1) Not available with Sensor Lead Wire Termination codes R, P, or C or with Approval Options.

(2) Codes A and C must be used with an Extension Length.

(3) Available only with straight stem flanged thermowells.

(4) Thermowells with an overall length ("U" + "T" + 1.75-in.) of 36-in. or less are machined from solid barstock. Thermowells with an overall length larger than 42-in. will be constructed using a welded 3-piece design and are available only with a stepped stem style. For lengths between 36-in. and 42-in consult factory for construction method.

(5) For additional (T) lengths, see [Table 18](#) (Thermowell lagging length (T) section).

(6) Available only with straight or tapered stem thermowells.

(7) F52, F64, F70, F88, and F02 are not compatible with 1-in. Sch. XXs pipe.

(8) F58, F76, and F94 may not be compatible with 1-in. Sch. pipe and are not compatible with 1-in. Sch. 80, 160 or XXs pipe.

(9) These options cannot be used with 0-in. (T) length.

(10) F08 cannot be used with 0- or 1.2-in. (T) length.

(11) Limited to 24-in. immersion length and 316 or 304 SST materials only.

(12) These options are only available with Sensor Lead Wire Termination codes T, L or N.

(13) These options are only available with Sensor Lead Wire Termination code N.

(14) Available on flanged thermowells only.

(15) Only one flange face option allowed.

(16) Not available on flanged thermowells and L lengths longer than 24-in.

(17) If ordering option code XA with a transmitter, specify the same option on the transmitter model code.

Table 4. Ordering Example

Typical Model Number	Model	Lead wire termination	Sensor type	Extension type	Extension length	Material code	Immersion length	Mounting style	Additional options
	0068	N	21	A	30	A	075	T22	E5

Rosemount 78 Sensor and Thermowell



The Rosemount 78 Sensor and Thermowell have designs that provide flexible and reliable temperature measurements in process environments.

Features include:

- Industry-standard Pt-100 RTD
- Single Element High Temperature RTD or Dual Element RTD
- Variety of enclosure and connection head options
- Global hazardous-location approvals (Option Codes E5, E6, E7)
- Calibration services to give you insight to sensor performance (Option Codes V1-V8, X8, X9)
- Calibration certification documentation to accompany sensor (Option Code Q4)
- Assemble to Transmitter option (Option Code XA)

Table 5. Series 78 RTD Sensor Assemblies WITHOUT Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time. The Expanded offering is subject to additional delivery lead time.

Model	Product description		
0078	Platinum Temperature Sensor without Thermowell		
Connection head			
R	Aluminum Connection Head, Six Terminals, Flat Cover, Unpainted		★
T	Aluminum Connection Head, Six Terminals, Extended Cover, Unpainted		★
P	Aluminum Connection Head, Six Terminals, Flat Cover, Painted		★
L	Aluminum Connection Head, Six Terminals, Extended Cover, Painted		★
N	Sensor only with 6-in. PTFE-insulated, 22-gauge lead wires		★
D	Rosemount Aluminum Connection head		★
C	Polypropylene Connection Head		
G	Rosemount SST Connection Head with 1/2 in. Entries		
Sensor type			Temperature range
Single element temperature sensors			-200 to 500 °C (-328 to 932 °F)
01 ⁽¹⁾⁽²⁾	Capsule Style		★
11 ⁽³⁾	General-purpose Style		★
21	Spring-loaded Style		★
31 ⁽⁴⁾	Bayonet Spring-loaded Style (available in [X] lengths of 1 to 21-in, increments of 1-in.)		
Single element high temperature sensors			0 to 600 °C (32 to 1112 °F)
03 ⁽²⁾	Capsule Style (available in [X] lengths of 3 to 24-in, increments of 1-in.)		★
13 ⁽³⁾	General-purpose Style (available in [X] lengths of 3 to 24-in, increments of 1/2-in.)		★
23	Spring-loaded style (available in [X] lengths of 3 to 24-in, increments of 1/2-in.)		★
33 ⁽⁴⁾	Bayonet spring-loaded style (available in [X] lengths of 3 to 21-in, increments of 1-in.)		

Table 5. Series 78 RTD Sensor Assemblies WITHOUT Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.

The Expanded offering is subject to additional delivery lead time.

Sensor type		Temperature range	
Dual-element temperature sensors		-200 to 500 °C (-328 to 932 °F)	
05 ⁽²⁾	Capsule Style		★
15 ⁽³⁾	General-purpose Style		★
25	Spring-loaded Style		★
35 ⁽⁴⁾	Bayonet Spring-loaded Style (available in [X] lengths of 1 to 21-in, increments of 1-in.)		
Extension type		Extension type material	
A ⁽⁵⁾	Nipple Coupling	300 series SST	★
C ⁽⁵⁾	Nipple Union	300 series SST	★
N	None (use with Extension Length Option code 00)	None	★
Extension length (E)			
00	0.0 in.		★
30	3.0 in.		★
60	6.0 in.		★
Thermowell material			
N	No Thermowell Required		★
Sensor immersion length (L)			
010 ⁽⁶⁾	1.0-in.		★
015	1.5-in.		★
020	2.0-in.		★
025	2.5-in.		★
030	3.0-in.		★
035	3.5-in.		★
040	4.0-in.		★
045	4.5-in.		★
050	5.0-in.		★
055	5.5-in.		★
060	6.0-in.		★
065	6.5-in.		★
070	7.0-in.		★
075	7.5-in.		★
080	8.0-in.		★
085	8.5-in.		★
090	9.0-in.		★
095	9.5-in.		★
100	10.0-in.		★

Table 5. Series 78 RTD Sensor Assemblies WITHOUT Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.
 The Expanded offering is subject to additional delivery lead time.

Sensor immersion length (L)		
105	10.5-in.	★
110	11.0-in.	★
115	11.5-in.	★
120	12.0-in.	★
125	12.5-in.	★
130	13.0-in.	★
135	13.5-in.	★
140	14.0-in.	★
145	14.5-in.	★
150	15.0-in.	★
155	15.5-in.	★
160	16.0-in.	★
165	16.5-in.	★
170	17.0-in.	★
175	17.5-in.	★
180	18.0-in.	★
185	18.5-in.	★
190	19.0-in.	★
195	19.5-in.	★
200	20.0-in.	★
205	20.5-in.	★
210	21.0-in.	★
215	21.5-in.	★
220	22.0-in.	★
225	22.5-in.	★
230	23.0-in.	★
235	23.5-in.	★
240	24.0-in.	★
245	24.5-in.	★
250	25.0-in.	★
260	26.0-in.	★
270	27.0-in.	★
280	28.0-in.	★
290	29.0-in.	★
300	30.0-in.	★
310	31.0-in.	★
320	32.0-in.	★

Table 5. Series 78 RTD Sensor Assemblies WITHOUT Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.
The Expanded offering is subject to additional delivery lead time.

Sensor immersion length (L)		
330	33.0-in.	★
340	34.0-in.	★
350	35.0-in.	★
360	36.0-in.	★
370	37.0-in.	★
380	38.0-in.	★
390	39.0-in.	★
400	40.0-in.	★
410	41.0-in.	★
420	42.0-in.	★
430	43.0-in.	★
440	44.0-in.	★
450	45.0-in.	★
460	46.0-in.	★
470	47.0-in.	★
480 ⁽⁷⁾	48.0-in.	★

Options (include with selected model number)

Sensor		
A ⁽⁸⁾	IEC 751 Class A Sensor (-200 to 500 °C)	
Approval options		
E1	ATEX Flameproof approval (see Figure 32)	★
E2	Ex d- CEPEL Flameproof Approval- Brazil	★
E5	FM Explosion-proof approval (see Figure 30)	★
E6	CSA Explosion-proof approval (see Figure 31)	★
E7	IECEX Flameproof approval	★
KF	ATEX + CSA Explosion-proof Combination Approval	★
EM	Technical Regulations Customs Union (EAC) Flameproof	★
Callendar-Van Dusen constants		
V1-V7	Callendar-Van Dusen Constants	★
Calibration schedule		
X8	Customer-Specified Temperature Range Calibration	★
X9	Customer-Specified Single Temperature Point Calibration	★
Calibration certification		
Q4	Calibration Certification, Customer-Specified Temperature	★

Table 5. Series 78 RTD Sensor Assemblies WITHOUT Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time. The Expanded offering is subject to additional delivery lead time.

Mounting adapters		
M5-M7	Mounting Adapter; Sensor Compression Fitting: M5= 1/8-27 NPT, M6 = 1/4-18 NPT, M7 = 1/2-14 NPT	★
A Leadkit		
A1-A8	Twisted lead wire extension: A1 = 1.5 ft, A2 = 3.0 ft, A3 = 6.0 ft, A4 = 12 ft, A5 = 24 ft, A6 = 50 ft, A7 = 75 ft, A8 = 100 ft	★
B Leadkit		
B1-B8	Shielded cable lead wire extension: B1 = 1.5 ft, B2 = 3.0 ft, B3 = 6.0 ft, B4 = 12 ft, B5 = 24 ft, B6 = 50 ft, B7 = 75 ft, B8 = 100 ft	★
C Leadkit		
C1-C8 ⁽⁹⁾	Armored cable lead wire extension: C1 = 1.5 ft, C2 = 3.0 ft, C3 = 6.0 ft, C4 = 12 ft, C5 = 24 ft, C6 = 50 ft, C7 = 75 ft, C8 = 100 ft	★
D Leadkit		
D1-D ⁽¹⁰⁾	Armored cable lead wire extensions with electrical plug: D1 = 1.5 ft, D2 = 3.0 ft, D3 = 6.0 ft, D4 = 12 ft, D5 = 24 ft, D6 = 50 ft, D7 = 75 ft, D8 = 100 ft	★
L Leadkit		
L1-L8 ⁽¹⁰⁾	Armored cable mating plugs with lead wire extension: L1 = 1.5 ft, L2 = 3.0 ft, L3 = 6.0 ft, L4 = 12 ft, L5 = 24 ft, L6 = 50 ft, L7 = 75 ft, L8 = 100 ft	★
J Leadkit		
J1 ⁽⁹⁾	Moisture-proof seal assembly for armored cables	★
Assemble to options		
XA ⁽¹¹⁾	Assemble connection head or transmitter to a sensor assembly (PTFE paste where appropriate, fully wired.)	★

- (1) Capsule style available in 1-in. increments only, starting at 1-in.
- (2) This option can only be used with Sensor Lead Wire Termination code N and is not available with assembly option XA or with Approval Options.
- (3) General-purpose sensors are available in (L) lengths of 2.5-in. or greater.
- (4) Not available with Sensor Lead Wire Termination codes R, P, or C or Approval Options.
- (5) Codes A and C must be used with an extension length.
- (6) 1-in. length without extension is only available in Capsule Style.
- (7) Additional lengths are available up to 68-in., increments of 1-in.
- (8) The IEC 751 Class A option is not available with high-temperature sensors.
- (9) These options are only available with Sensor Leadwire Termination Codes T, L, or N.
- (10) These options are only available with Sensor Leadwire Termination code N.
- (11) If ordering option code XA with a transmitter, specify the same option on the transmitter model code.

Table 6. Ordering Example

Typical Model Number	Model	Connection head	Sensor type	Extension type	Extension length	Thermowell material	Immersion length	Additional options
	0078	N	21	N	00	N	045	E5

Table 7. Series 78 RTD Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.
The Expanded offering is subject to additional delivery lead time.

Model	Product description	
0078	Platinum Temperature Sensor with Thermowell	
Connection head		
R	Aluminum Connection Head, Six Terminals, Flat Cover, Unpainted	★
T	Aluminum Connection Head, Six Terminals, Extended Cover, Unpainted	★
P	Aluminum Connection Head, Six Terminals, Flat Cover, Painted	★
L	Aluminum Connection Head, Six Terminals, Extended Cover, Painted	★
N	Sensor Only with 6-in. PTFE-insulated, 24-gauge Lead Wires	★
D	Rosemount Aluminum Connection Head with 1/2-in. Entries	★
C	Polypropylene Connection Head	
G	Rosemount SST Connection Head with 1/2-in. Entries	
Sensor type		Temperature range
Single Element Temperature Sensors		-200 to 500 °C (-328 to 932 °F)
11	General-purpose Style	★
21	Spring-loaded Style	★
31 ⁽¹⁾	Bayonet Spring-loaded Style (available in [X] lengths of 1 to 21-in., increments of 1-in.)	
Single element high temperature sensors		0 to 600 °C (32 to 1112 °F)
13	General-purpose Style (available in [X] lengths of 3 to 24-in., increments of 1/2-in.)	★
23	Spring-loaded Style (available in [X] lengths of 3 to 24-in., increments of 1/2-in.)	★
33 ⁽¹⁾	Bayonet Spring-loaded Style (available in [X] lengths of 3 to 21-in., increments of 1-in.)	
Dual-element temperature sensors		-200 to 500 °C (-328 to 932 °F)
15	General-purpose Style	★
25	Spring-loaded Style	★
35 ⁽¹⁾	Bayonet Spring-loaded Style (available in [X] lengths of 1 to 21-in., increments of 1-in.)	
Extension type		Extension type material
A ⁽²⁾	Nipple Coupling	300 series SST
C ⁽²⁾	Nipple Union	300 series SST
N	None (use with extension length option code 00)	None
Extension length (E)		
00	0.0 in.	★
30	3.0 in.	★
60	6.0 in.	★
Thermowell material		
A	316 SST	★
B	304 SST	★

Table 7. Series 78 RTD Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.
The Expanded offering is subject to additional delivery lead time.

Thermowell material				
C	Carbon Steel			★
D	316L SST			★
E	304L SST			★
F	Alloy 20			
G	Alloy 400			
H	Alloy 600			
J	Alloy C-276			
L	Alloy B			
M	304 SST with PTFE coating			
P	Chrome Molybdenum Grade F22			
R	Nickel 200			
T	Titanium			
U ⁽³⁾	316 SST with Tantalum Sheath			
V	310 SST			
W	321 SST			
Z	Chrome Molybdenum Grade F11			
Immersion length (U) ⁽⁴⁾		Thermowell length (L)	Lagging length (T) ⁽⁵⁾	
015 ⁽⁶⁾	1.5-in.	4.0-in.	1.0-in.	★
020 ⁽⁶⁾	2.0-in.	4.0-in.	0.5-in.	★
025 ⁽⁶⁾	2.5-in.	4.0-in.	0.0-in.	★
030	3.0-in.	6.0-in.	1.5-in.	★
035	3.5-in.	6.0-in.	1.0-in.	★
040	4.0-in.	6.0-in.	0.5-in.	★
045	4.5-in.	6.0-in.	0.0-in.	★
050	5.0-in.	9.0-in.	2.5-in.	★
055	5.5-in.	9.0-in.	2.0-in.	★
060	6.0-in.	9.0-in.	1.5-in.	★
065	6.5-in.	9.0-in.	1.0-in.	★
070	7.0-in.	9.0-in.	0.5-in.	★
075	7.5-in.	9.0-in.	0.0-in.	★
080	8.0-in.	12.0-in.	2.5-in.	★
085	8.5-in.	12.0-in.	2.0-in.	★
090	9.0-in.	12.0-in.	1.5-in.	★
095	9.5-in.	12.0-in.	1.0-in.	★
100	10.0-in.	12.0-in.	0.5-in.	★
105	10.5-in.	12.0-in.	0.0-in.	★

Table 7. Series 78 RTD Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.
The Expanded offering is subject to additional delivery lead time.

Immersion length (U) ⁽⁴⁾		Thermowell length (L)	Lagging length (T) ⁽⁵⁾	
110	11.0-in.	15.0-in.	2.5-in.	
115	11.5-in.	15.0-in.	2.0-in.	★
120	12.0-in.	15.0-in.	1.5-in.	★
125	12.5-in.	15.0-in.	1.0-in.	★
130	13.0-in.	15.0-in.	0.5-in.	★
135	13.5-in.	15.0-in.	0.0-in.	★
140	14.0-in.	18.0-in.	2.5-in.	★
145	14.5-in.	18.0-in.	2.0-in.	★
150	15.0-in.	18.0-in.	1.5-in.	★
155	15.5-in.	18.0-in.	1.0-in.	★
160	16.0-in.	18.0-in.	0.5-in.	★
165	16.5-in.	18.0-in.	0.0-in.	★
170	17.0-in.	21.0-in.	2.5-in.	★
175	17.5-in.	21.0-in.	2.0-in.	★
180	18.0-in.	21.0-in.	1.5-in.	★
185	18.5-in.	21.0-in.	1.0-in.	★
190	19.0-in.	21.0-in.	0.5-in.	★
195	19.5-in.	21.0-in.	0.0-in.	★
200	20.0-in.	24.0-in.	2.5-in.	★
205	20.5-in.	24.0-in.	2.0-in.	★
210	21.0-in.	24.0-in.	1.5-in.	★
215	21.5-in.	24.0-in.	1.0-in.	★
220	22.0-in.	24.0-in.	0.5-in.	★
225	22.5-in.	24.0-in.	0.0-in.	★
230	23.0-in.	27.0-in.	2.5-in.	★
240	24.0-in.	27.0-in.	1.5-in.	★
250	25.0-in.	27.0-in.	0.5-in.	★
260	26.0-in.	30.0-in.	2.5-in.	★
270	27.0-in.	30.0-in.	1.5-in.	★
280	28.0-in.	30.0-in.	0.5-in.	★
290	29.0-in.	33.0-in.	2.5-in.	★
300	30.0-in.	30.0-in.	1.5-in.	★
310	31.0-in.	30.0-in.	0.5-in.	★
320	32.0-in.	36.0-in.	2.5-in.	★
330	33.0-in.	36.0-in.	1.5-in.	★
340	34.0-in.	36.0-in.	0.5-in.	★

Table 7. Series 78 RTD Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.
The Expanded offering is subject to additional delivery lead time.

Immersion length (U) ⁽⁴⁾		Thermowell length (L)	Lagging length (T) ⁽⁵⁾	
350	35.0-in.	39.0-in.	2.5-in.	★
360	36.0-in.	39.0-in.	1.5-in.	★
370	37.0-in.	39.0-in.	0.5-in.	★
380	38.0-in.	42.0-in.	2.5-in.	★
390	39.0-in.	42.0-in.	1.5-in.	★
400	40.0-in.	42.0-in.	0.5-in.	★
410	41.0-in.	45.0-in.	2.5-in.	★
420	42.0-in.	45.0-in.	1.5-in.	★
430	43.0-in.	45.0-in.	0.5-in.	★
440	44.0-in.	48.0-in.	2.5-in.	★
450	45.0-in.	48.0-in.	1.5-in.	★
460	46.0-in.	48.0-in.	0.5-in.	★
470	47.0-in.	51.0-in.	2.5-in.	★
480	48.0-in.	51.0-in.	1.5-in.	★
Thermowell style		Mounting	Stem	
T20	Threaded	1/2-14 ANPT	Stepped	★
T22	Threaded	3/4-14 ANPT	Stepped	★
T24	Threaded	1-11.5 ANPT	Stepped	★
T26	Threaded	3/4-14 ANPT	Tapered	★
T28	Threaded	1-11.5 ANPT	Tapered	★
T30	Threaded	1 1/2-11 ANPT	Tapered	★
T32	Threaded	1/2-14 ANPT	Straight	★
T34	Threaded	3/4-14 ANPT	Straight	★
T36	Threaded	1-11.5 ANPT	Straight	★
T38	Threaded	3/4-14 ANPT	Straight	★
T44	Threaded	1/2-14 ANPT	Tapered	★
W38	Welded	3/4-in. pipe	Stepped	★
W40	Welded	1-in. pipe	Stepped	★
W42	Welded	3/4-in. pipe	Tapered	★
W44	Welded	1-in. pipe	Tapered	★
W46	Welded	1 1/4-in. pipe	Tapered	★
W48	Welded	3/4-in. pipe	Straight	★
W50	Welded	1-in. pipe	Straight	★
F10	Flanged	2-in., Class 150	Straight	★
F12	Flanged	3-in., Class 150	Straight	★
F52 ⁽⁷⁾	Flanged	1-in., Class 150	Stepped	★
F54	Flanged	1 1/2-in., Class 150	Stepped	★

Table 7. Series 78 RTD Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.

The Expanded offering is subject to additional delivery lead time.

Thermowell style		Mounting	Stem	
F56	Flanged	2-in., Class 150	Stepped	★
F58 ⁽⁸⁾	Flanged	1-in., Class 150	Tapered	★
F60	Flanged	1½-in., Class 150	Tapered	★
F62	Flanged	2-in. Class 150	Tapered	★
F64 ⁽⁷⁾	Flanged	1-in., Class 150	Straight	★
F66	Flanged	1½-in., Class 150	Straight	★
F70 ⁽⁷⁾	Flanged	1-in., Class 300	Stepped	★
F72	Flanged	1½-in., Class 300	Stepped	★
F74	Flanged	2-in., Class 300	Stepped	★
F76 ⁽⁸⁾	Flanged	1-in., Class 300	Tapered	★
F78	Flanged	1½-in., Class 300	Tapered	★
F80	Flanged	2-in., Class 300	Tapered	★
F82 ⁽⁷⁾	Flanged	1-in., Class 300	Straight	★
F84	Flanged	1½-in., Class 300	Straight	★
F86	Flanged	2-in., Class 300	Straight	★
F88 ⁽⁷⁾	Flanged	1-in., Class 600	Stepped	★
F90 ⁽⁹⁾	Flanged	1½-in., Class 600	Stepped	★
F92 ⁽⁹⁾	Flanged	2-in., Class 600	Stepped	★
F94 ⁽⁸⁾⁽⁹⁾	Flanged	1-in., Class 600	Tapered	★
F96 ⁽⁹⁾	Flanged	1½-in., Class 600	Tapered	★
F98 ⁽⁹⁾	Flanged	2-in., Class 600	Tapered	★
F02 ⁽⁷⁾⁽⁹⁾	Flanged	1-in., Class 600	Straight	★
F04 ⁽⁹⁾	Flanged	1½-in., Class 600	Straight	★
F06 ⁽⁹⁾	Flanged	2-in., Class 600	Straight	★
F16 ⁽⁹⁾	Flanged	1½-in., Class 900	Tapered	★
F34 ⁽⁹⁾	Flanged	1½-in., Class 1500	Tapered	★
F24 ⁽⁹⁾	Flanged	2-in., Class 1500	Tapered	★
F08 ⁽¹⁰⁾	Flanged	1½-in., Class 2500	Tapered	★
Q02 ⁽¹¹⁾	Sanitary, Tri-Clamp	1-in., Tri-Clamp	Stepped	★
Q04 ⁽¹¹⁾	Sanitary, Tri-Clamp	1½-in., Tri-Clamp	Stepped	★
Q06 ⁽¹¹⁾	Sanitary, Tri-Clamp	2-in., Tri-Clamp	Stepped	★
Q08 ⁽¹¹⁾	Sanitary, Tri-Clamp	3-in., Tri-Clamp	Stepped	★
Q20 ⁽¹¹⁾	Sanitary, Tri-Clamp	¾-in., Tri-Clamp	Straight	★
Q22 ⁽¹¹⁾	Sanitary, Tri-Clamp	1-in., Tri-Clamp	Straight	★
Q24 ⁽¹¹⁾	Sanitary, Tri-Clamp	1½-in., Tri-Clamp	Straight	★
Q26 ⁽¹¹⁾	Sanitary, Tri-Clamp	2-in., Tri-Clamp	Straight	★
Q28 ⁽¹¹⁾	Sanitary, Tri-Clamp	3-in., Tri-Clamp	Straight	★

Table 7. Series 78 RTD Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time. The Expanded offering is subject to additional delivery lead time.

Options (include with selected model number)

Sensor		
A ⁽¹²⁾	IEC 751 Class A Sensor (-200 to 500 °C)	
Approval options		
E1	ATEX Flameproof approval (see Figure 32)	★
E2	Ex d- CEPEL Flameproof Approval- Brazil	★
E5	FM Explosion-proof Approval (see Figure 30)	★
E6	CSA Explosion-proof Approval (see Figure 31)	★
E7	IECEx Flameproof Approval	★
KF	ATEX + CSA Explosion-proof Combination Approval	★
EM	Technical Regulations Customs Union (EAC) Flameproof	★
Callendar-Van Dusen Constant		
V1-V7	Callendar-Van Dusen Constants	★
Calibration schedule		
X8	Customer-Specified Temperature Range Calibration	★
X9	Customer-Specified Single Temperature Point Calibration	★
Calibration certification		
Q4	Calibration Certification, Customer-Specified Temperature	★
A Leadkit		
A1-A8	Twisted lead wire extension: A1 = 1.5 ft, A2 = 3.0 ft, A3 = 6.0 ft, A4 = 12 ft, A5 = 24 ft, A6 = 50 ft, A7 = 75 ft, A8 = 100 ft	★
B Leadkit		
B1-B8	Shielded cable lead wire extension: B1 = 1.5 ft, B2 = 3.0 ft, B3 = 6.0 ft, B4 = 12 ft, B5 = 24 ft, B6 = 50 ft, B7 = 75 ft, B8 = 100 ft	★
C Leadkit		
C1-C8 ⁽¹³⁾	Armored cable lead wire extension: C1 = 1.5 ft, C2 = 3.0 ft, C3 = 6.0 ft, C4 = 12 ft, C5 = 24 ft, C6 = 50 ft, C7 = 75 ft, C8 = 100 ft	★
D Leadkit		
D1-D8 ⁽¹⁴⁾	Armored cable lead wire extensions with electrical plug: D1 = 1.5 ft, D2 = 3.0 ft, D3 = 6.0 ft, D4 = 12 ft, D5 = 24 ft, D6 = 50 ft, D7 = 75 ft, D8 = 100 ft	★
L Leadkit		
L1-L8 ⁽¹⁴⁾	Armored cable mating plugs with lead wire extension: L1 = 1.5 ft, L2 = 3.0 ft, L3 = 6.0 ft, L4 = 12 ft, L5 = 24 ft, L6 = 50 ft, L7 = 75 ft, L8 = 100 ft	★
J Leadkit		
J1 ⁽¹³⁾	Moisture-proof seal assembly for armored cables	★

Table 7. Series 78 RTD Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.

The Expanded offering is subject to additional delivery lead time.

Special external pressure test		
R01	Special External Pressure Test	★
Material certifications		
Q8	Thermowell Material Certificate	★
Surface finish certification		
Q16	Surface Finish Certification	★
Dye penetration test		
R03	Dye Penetration Test	★
NACE approval		
R05	NACE Approval	★
SST plug and chain		
R06	SST Plug and Chain	★
Full penetration weld		
R07 ⁽¹⁵⁾	Full Penetration Weld	★
Thermowell face options		
R09 ⁽¹⁵⁾⁽¹⁶⁾	Concentric Serrations of Thermowell Flange Face	★
Flat faced flange		
R10 ⁽¹⁵⁾⁽¹⁶⁾	Flat Faced Flange	★
Vent hole		
R11	Vent Hole	★
Thermowell Xray		
R12	Thermowell Xray	★
Special surface finish		
R14	Special Surface Finish (12 RA) (Maximum "U" length = 22.5-in.)	★
Ring joint flange		
R16 ⁽¹⁵⁾⁽¹⁶⁾	Ring Joint Flange (not available with 0-in. [T] length)	★
Electropolish		
R20 ⁽¹⁷⁾	Electropolish	★
Wake frequency		
R21	Wake Frequency - Thermowell Strength Calculation	★
Internal pressure test		
R22	Internal Pressure Test	★

Table 7. Series 78 RTD Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time. The Expanded offering is subject to additional delivery lead time.

Brass plug and chain		
R23	Brass plug and chain	★
Canadian registration no.		
R24	CRN Marking for British Columbia	
R25	CRN Marking for Alberta	
R26	CRN Marking for Saskatchewan	
R27	CRN Marking for Manitoba	
R28	CRN Marking for Ontario	
R29	CRN Marking for Quebec	
R30	CRN Marking for New Brunswick	
R31	CRN Marking for Nova Scotia	
R32	CRN Marking for Prince Edward Island	
R33	CRN Marking for Yukon Territory	
R34	CRN Marking for Northwest Territory	
R35	CRN Marking for Nunavut	
R36	CRN Marking for Newfoundland and Labrador	
Twell from hex stock		
R37	Thermowell from Hex Stock	
Assemble to option		
XA ⁽¹⁸⁾	Assemble Connection Head or Transmitter to a Sensor Assembly.	★

(1) Not available with Sensor Lead Wire Termination codes R, P, or C or with Approval Options.

(2) Codes A and C must be used with an extension length. Additional non-standard (E) lengths are available in 1/2-in. increments from 2.5 to 9-in.

(3) Available only with straight stem flanged thermowells.

(4) Thermowells with an overall length (“U” + “T” + 1.75-in.) of 36-in. or less are machined from solid barstock. Thermowells with an overall length larger than 42-in. will be constructed using a welded 3-piece design and are available only with a stepped stem style. For lengths between 36-in. and 42-in. consult factory for construction method.

(5) For additional (T) lengths, see [Table 18](#).

(6) Straight or Tapered stem only.

(7) F52, F64, F70, F82, F88, and F02 are not compatible with 1-in. Sch. XXS pipe.

(8) F58, F76, and F94 may not be compatible with 1-in. Sch. pipe and are not compatible with 1-in. Sch. 80, 160, or XXS pipe.

(9) These options cannot be used with 0-in. (T) length.

(10) F08 cannot be used with 0- or 1/2-in. (T) length.

(11) Limited to 24” immersion length and 316 or 304 SST materials only.

(12) The IEC 751 Class A option is not available with high-temperature sensors.

(13) These options are not available with Sensor Lead Wire Termination codes T, L, or N.

- (14) Only available with sensor Lead Wire Termination code N.
- (15) Available on flanged thermowells only.
- (16) Only one flange face option allowed.
- (17) Not available on flanged Thermowells and (L) lengths longer than 24-in.
- (18) If ordering option code XA with a transmitter, specify the same option on the transmitter model code.

Table 8. Ordering Example

Typical Model Number	Model	Lead wire termination	Sensor type	Extension type	Extension length	Material code	Immersion length	Mounting style	Additional options
	0078	N	21	A	30	A	075	T22	E5

Rosemount 183 Sensor and Thermowell

The Rosemount 183 Sensor and Thermowell have designs that provide flexible and reliable temperature measurements in process environments.

Features include:

- Industry-standard sensor types, including J, K, E, and T thermocouple varieties
- Variety of enclosure and connection head options
- Global hazardous-location approvals (Option Codes E5, E6, E7)
- Assemble to Transmitter option (Option Code XA)



Table 9. Series 183 Thermocouple Sensor Assemblies WITHOUT Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time. The Expanded offering is subject to additional delivery lead time.

Model	Product description		
0183	Thermocouple Sensor without Thermowell		
Connection head			
R	Aluminum Connection Head, Six Terminals, Flat Cover, Unpainted		★
T	Aluminum Connection Head, Six Terminals, Extended Cover, Unpainted		★
P	Aluminum Connection Head, Six Terminals, Flat Cover, Painted		★
L	Aluminum Connection Head, Six Terminals, Extended Cover, Painted		★
N	Sensor only with 6-in. PTFE-insulated, 20-gauge Lead Wires		★
D	Rosemount Aluminum Connection Head with 1/2-in. Entries		★
C	Polypropylene Connection Head		
G	Rosemount SST Connection Head with 1/2-in. Entries		
Sensor type		Junction	
Capsule sensor⁽¹⁾⁽²⁾			
01	Single	Grounded	★
02	Dual	Grounded	★
03	Single	Ungrounded	★
04	Dual, Unisolated	Ungrounded	★
05	Dual, Isolated	Ungrounded	★
General purpose sensors⁽³⁾			
11	Single	Grounded	★
12	Dual	Grounded	★
13	Single	Ungrounded	★
14	Dual, Unisolated	Ungrounded	★
15	Dual, Isolated	Ungrounded	★

Table 9. Series 183 Thermocouple Sensor Assemblies WITHOUT Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.

The Expanded offering is subject to additional delivery lead time.

Sensor type		Junction	
Spring-loaded sensors			
21	Single	Grounded	★
22	Dual	Grounded	★
23	Single	Ungrounded	★
24	Dual, Unisolated	Ungrounded	★
25	Dual, Isolated	Ungrounded	★
Bayonet spring-loaded sensors⁽⁴⁾			
31	Single	Grounded	
32	Dual	Grounded	
33	Single	Ungrounded	
34	Dual, Unisolated	Ungrounded	
35	Dual, Isolated	Ungrounded	
Thermocouple type		Temperature range	
J2	J	0 to 760 °C (32 to 1400 °F)	★
K2	K	0 to 1150 °C (32 to 2102 °F)	★
E2	E	0 to 871 °C (32 to 1600 °F)	★
T2	T	-180 to 371 °C (-292 to 700 °F)	★
Extension type		Extension type material	
A ⁽⁵⁾	Nipple Coupling	300 series SST	★
C ⁽⁵⁾	Nipple Union	300 series SST	★
N	None (use with extension length option code 00)	None	★
Extension length (E)			
00	0.0 in.		★
30	3.0 in.		★
60	6.0 in.		★
Thermowell material			
N	No Thermowell Required		★
Code	Sensor immersion length (L)		
020	2.0-in.		★
025	2.5-in.		★
030	3.0-in.		★
035	3.5-in.		★
040	4.0-in.		★
045	4.5-in.		★
050	5.0-in.		★

Table 9. Series 183 Thermocouple Sensor Assemblies WITHOUT Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.
The Expanded offering is subject to additional delivery lead time.

Code	Sensor immersion length (L)	
055	5.5-in.	★
060	6.0-in.	★
065	6.5-in.	★
070	7.0-in.	★
075	7.5-in.	★
080	8.0-in.	★
085	8.5-in.	★
090	9.0-in.	★
095	9.5-in.	★
100	10.0-in.	★
105	10.5-in.	★
110	11.0-in.	★
115	11.5-in.	★
120	12.0-in.	★
125	12.5-in.	★
130	13.0-in.	★
135	13.5-in.	★
140	14.0-in.	★
145	14.5-in.	★
150	15.0-in.	★
155	15.5-in.	★
160	16.0-in.	★
165	16.5-in.	★
170	17.0-in.	★
175	17.5-in.	★
180	18.0-in.	★
185	18.5-in.	★
190	19.0-in.	★
195	19.5-in.	★
200	20.0-in.	★
205	20.5-in.	★
210	21.0-in.	★
215	21.5-in.	★
220	22.0-in.	★
225	22.5-in.	★
230	23.0-in.	★
240	24.0-in.	★

Table 9. Series 183 Thermocouple Sensor Assemblies WITHOUT Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.

The Expanded offering is subject to additional delivery lead time.

Code	Sensor immersion length (L)	
250	25.0-in.	★
260	26.0-in.	★
270	27.0-in.	★
280	28.0-in.	★
290	29.0-in.	★
300	30.0-in.	★
310	31.0-in.	★
320	32.0-in.	★
330	33.0-in.	★
340	34.0-in.	★
350	35.0-in.	★
360	36.0-in.	★
370	37.0-in.	★
380	38.0-in.	★
390	39.0-in.	★
400	40.0-in.	★
410	41.0-in.	★
420	42.0-in.	★
430	43.0-in.	★
440	44.0-in.	★
450	45.0-in.	★
460	46.0-in.	★
470	47.0-in.	★
480	48.0-in.	★

Options (include with selected model number)

Product certifications		
E1	ATEX Flameproof approval (See Figure 32)	★
E1	Ex d- CEPEL Flameproof Approval- Brazil	★
E5	FM Explosion-proof approval (See Figure 30)	★
E6	CSA Explosion-proof approval (See Figure 31)	★
E7	IECEX Flameproof approval	★
KF	ATEX + CSA Explosion-proof Combination Approval	★
EM	Technical Regulations Customs Union (EAC) Flameproof	★

Table 9. Series 183 Thermocouple Sensor Assemblies WITHOUT Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time. The Expanded offering is subject to additional delivery lead time.

Mounting adapter		
M5-M7	Mounting adapter; Sensor Compression Fitting: M5= 1/8-27 NPT, M6= 1/4-18 NPT, M7= 1/2-14 NPT	★
Assembly options		
XA ⁽⁶⁾	Assemble connection head or transmitter to a sensor assembly	★

- (1) Capsule style available in 1-in. increments only, starting at 1-in.
- (2) This option can only be used with Sensor Lead wire Termination Code N and is not available with assembly code XA or with Approval Options.
- (3) General-purpose Sensors are only available in (L) lengths of 2.4-in. or greater. General purpose sensors are not available with Type K Thermocouples.
- (4) Bayonet spring-loaded style is available to 21-inches but is not available with Sensor Lead Wire Termination codes R, P, or C or with Approval Options.
- (5) Codes A and C must be used with an extension length.
- (6) If ordering option code XA with a transmitter, specify the same option on the transmitter model code.

Table 10. Ordering Example

Typical Model Number	Model	Lead wire termination	Sensor type	ISA type	Extension type	Extension length	Thermowell code	Immersion length	Additional options
	0183	N	11	J2	N	00	N	045	E5

Table 11. Series 183 Thermocouple Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.
The Expanded offering is subject to additional delivery lead time.

Model	Product description		
0183	Thermocouple Sensor with Thermowell		
Sensor lead wire termination			
R	Aluminum Connection Head, Six Terminals, Flat Cover, Unpainted		★
T	Aluminum Connection Head, Six Terminals, Extended Cover, Unpainted		★
P	Aluminum Connection Head, Six Terminals, Flat Cover, Painted		★
L	Aluminum Connection Head, Six Terminals, Extended Cover, Painted		★
N	Sensor Only with 6-in. PTFE-insulated, 20-gauge Lead Wires		★
D	Rosemount Aluminum Connection Head with 1/2-in. Entries		★
C	Polypropylene Connection Head		
G	Rosemount SST Connection Head with 1/2-in. Entries		
Sensor type		Junction	
General-purpose sensors⁽¹⁾			
11	Single	Grounded	★
12	Dual	Grounded	★
13	Single	Ungrounded	★
14	Dual, Unisolated	Ungrounded	★
15	Dual, Isolated		★
Spring-loaded sensors			
21	Single	Grounded	★
22	Dual	Grounded	★
23	Single	Ungrounded	★
24	Dual, Unisolated	Ungrounded	★
25	Dual, Isolated	Ungrounded	★
Bayonet spring-loaded sensors⁽²⁾			
31	Single	Grounded	
32	Dual	Grounded	
33	Single	Ungrounded	
34	Dual, Unisolated	Ungrounded	
35	Dual, Isolated	Ungrounded	
Thermocouple type		Temperature range	
J2	J	0 to 760 °C (32 to 1400 °F)	★
K2	K	0 to 1150 °C (32 to 2102 °F)	★
E2	E	0 to 871 °C (32 to 1600 °F)	★
T2	T	-180 to 371 °C (-292 to 700 °F)	★

Table 11. Series 183 Thermocouple Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.
The Expanded offering is subject to additional delivery lead time.

Extension type		Extension type material			
A ⁽³⁾	Nipple Coupling	300 series SST		★	
C ⁽³⁾	Nipple Union	300 series SST		★	
N	None (use with extension length option code 00)	None		★	
Extension length (E)					
00	0.0 in.			★	
30	3.0 in.			★	
60	6.0 in.			★	
Thermowell material					
A	316 SST			★	
B	304 SST			★	
C	Carbon Steel			★	
D	316L SST			★	
E	304L SST			★	
F	Alloy 20				
G	Alloy 400				
H	Alloy 600				
J	Alloy C-276				
L	Alloy B				
M	304 SST with PTFE coating				
P	Chrome Molybdenum Grade F22				
R	Nickel 200				
T	Titanium				
U ⁽⁴⁾	316 SST with Tantalum Sheath				
V	310 SST				
W	321 SST				
Z	Chrome Molybdenum Grade F11				
Immersion length (U) ⁽⁵⁾		Thermowell length (L)	Lagging length (T) ⁽⁶⁾		
015 ⁽⁷⁾	1.5-in.	4.0-in.	1.0-in.		★
020 ⁽⁶⁾	2.0-in.	4.0-in.	0.5-in.		★
025 ⁽⁶⁾	2.5-in.	4.0-in.	0.0-in.		★
030	3.0-in.	6.0-in.	1.5-in.		★
035	3.5-in.	6.0-in.	1.0-in.		★
040	4.0-in.	6.0-in.	0.5-in.		★
045	4.5-in.	6.0-in.	0.0-in.		★
050	5.0-in.	9.0-in.	2.5-in.		★
055	5.5-in.	9.0-in.	2.0-in.		★

Table 11. Series 183 Thermocouple Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.
The Expanded offering is subject to additional delivery lead time.

Immersion length (U) ⁽⁵⁾		Thermowell length (L)	Lagging length (T) ⁽⁶⁾	
060	6.0-in.	9.0-in.	1.5-in.	★
065	6.5-in.	9.0-in.	1.0-in.	★
070	7.0-in.	9.0-in.	0.5-in.	★
075	7.5-in.	9.0-in.	0.0-in.	★
080	8.0-in.	12.0-in.	2.5-in.	★
085	8.5-in.	12.0-in.	2.0-in.	★
090	9.0-in.	12.0-in.	1.5-in.	★
095	9.5-in.	12.0-in.	1.0-in.	★
100	10.0-in.	12.0-in.	0.5-in.	★
105	10.5-in.	12.0-in.	0.0-in.	★
110	11.0-in.	15.0-in.	2.5-in.	★
115	11.5-in.	15.0-in.	2.0-in.	★
120	12.0-in.	15.0-in.	1.5-in.	★
125	12.5-in.	15.0-in.	1.0-in.	★
130	13.0-in.	15.0-in.	0.5-in.	★
135	13.5-in.	15.0-in.	0.0-in.	★
140	14.0-in.	18.0-in.	2.5-in.	★
145	14.5-in.	18.0-in.	2.0-in.	★
150	15.0-in.	18.0-in.	1.5-in.	★
155	15.5-in.	18.0-in.	1.0-in.	★
160	16.0-in.	18.0-in.	0.5-in.	★
165	16.5-in.	18.0-in.	0.0-in.	★
170	17.0-in.	21.0-in.	2.5-in.	★
175	17.5-in.	21.0-in.	2.0-in.	★
180	18.0-in.	21.0-in.	1.5-in.	★
185	18.5-in.	21.0-in.	1.0-in.	★
190	19.0-in.	21.0-in.	0.5-in.	★
195	19.5-in.	21.0-in.	0.0-in.	★
200	20.0-in.	24.0-in.	2.5-in.	★
205	20.5-in.	24.0-in.	2.0-in.	★
210	21.0-in.	24.0-in.	1.5-in.	★
215	21.5-in.	24.0-in.	1.0-in.	★
220	22.0-in.	24.0-in.	0.5-in.	★
225	22.5-in.	24.0-in.	0.0-in.	★
230	23.0-in.	27.0-in.	2.5-in.	
240	24.0-in.	27.0-in.	1.5-in.	
250	25.0-in.	27.0-in.	0.5-in.	

Table 11. Series 183 Thermocouple Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.
The Expanded offering is subject to additional delivery lead time.

Immersion length (U) ⁽⁵⁾		Thermowell length (L)	Lagging length (T) ⁽⁶⁾	
260	26.0-in.	30.0-in.	2.5-in.	
270	27.0-in.	30.0-in.	1.5-in.	
280	28.0-in.	30.0-in.	0.5-in.	
290	29.0-in.	33.0-in.	2.5-in.	
300	30.0-in.	33.0-in.	1.5-in.	
310	31.0-in.	33.0-in.	0.5-in.	
320	32.0-in.	36.0-in.	2.5-in.	
330	33.0-in.	36.0-in.	1.5-in.	
340	34.0-in.	36.0-in.	0.5-in.	
350	35.0-in.	39.0-in.	2.5-in.	
360	36.0-in.	39.0-in.	1.5-in.	
370	37.0-in.	39.0-in.	0.5-in.	
380	38.0-in.	42.0-in.	2.5-in.	
390	39.0-in.	42.0-in.	1.5-in.	
400	40.0-in.	42.0-in.	0.5-in.	
410	41.0-in.	45.0-in.	2.5-in.	
420	42.0-in.	45.0-in.	1.5-in.	
430	43.0-in.	45.0-in.	0.5-in.	
440	44.0-in.	48.0-in.	2.5-in.	
450	45.0-in.	48.0-in.	1.5-in.	
460	46.0-in.	48.0-in.	0.5-in.	
470	47.0-in.	51.0-in.	2.5-in.	
480	48.0-in.	51.0-in.	1.5-in.	
Thermowell style		Mounting	Stem	
T20	Threaded	1/2-14 ANPT	Stepped	★
T22	Threaded	3/4-14 ANPT	Stepped	★
T24	Threaded	1-11.5 ANPT	Stepped	★
T26	Threaded	3/4-14 ANPT	Tapered	★
T28	Threaded	1-11.5 ANPT	Tapered	★
T30	Threaded	1 1/2-11 ANPT	Tapered	★
T32	Threaded	1/2-14 ANPT	Straight	★
T34	Threaded	3/4-14 ANPT	Straight	★
T36	Threaded	1-11.5 ANPT	Straight	★
T38	Threaded	3/4-14 ANPT	Straight	★
T44	Threaded	1/2-14 ANPT	Tapered	★
W38	Welded	3/4-in. pipe	Stepped	★

Table 11. Series 183 Thermocouple Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.
The Expanded offering is subject to additional delivery lead time.

Thermowell style		Mounting	Stem	
W40	Welded	1-in. pipe	Stepped	★
W42	Welded	3/4-in. pipe	Tapered	★
W44	Welded	1-in. pipe	Tapered	★
W46	Welded	1 1/4-in. pipe	Tapered	★
W48	Welded	3/4-in. pipe	Straight	★
W50	Welded	1-in. pipe	Straight	★
F10	Flanged	2-in., Class 150	Straight	★
F12	Flanged	3-in., Class 150	Straight	★
F52 ⁽⁸⁾	Flanged	1-in., Class 150	Stepped	★
F54	Flanged	1 1/2-in., Class 150	Stepped	★
F56	Flanged	2-in., Class 150	Stepped	★
F58 ⁽⁹⁾	Flanged	1-in., Class 150	Tapered	★
F60	Flanged	1 1/2-in., Class 150	Tapered	★
F62	Flanged	2-in. Class 150	Tapered	★
F64 ⁽⁸⁾	Flanged	1-in., Class 150	Straight	★
F66	Flanged	1 1/2-in., Class 150	Straight	★
F70 ⁽⁸⁾	Flanged	1-in., Class 300	Stepped	★
F72	Flanged	1 1/2-in., Class 300	Stepped	★
F74	Flanged	2-in., Class 300	Stepped	★
F76 ⁽⁹⁾	Flanged	1-in., Class 300	Tapered	★
F78	Flanged	1 1/2-in., Class 300	Tapered	★
F80	Flanged	2-in., Class 300	Tapered	★
F82 ⁽⁸⁾	Flanged	1-in., Class 300	Straight	★
F84	Flanged	1 1/2-in., Class 300	Straight	★
F86	Flanged	2-in., Class 300	Straight	★
F88 ⁽⁸⁾	Flanged	1-in., Class 600	Stepped	★
F90 ⁽¹⁰⁾	Flanged	1 1/2-in., Class 600	Stepped	★
F92 ⁽¹⁰⁾	Flanged	2-in., Class 600	Stepped	★
F94 ⁽⁹⁾⁽¹⁰⁾	Flanged	1-in., Class 600	Tapered	★
F96 ⁽¹⁰⁾	Flanged	1 1/2-in., Class 600	Tapered	★
F98 ⁽¹⁰⁾	Flanged	2-in., Class 600	Tapered	★
F02 ⁽⁸⁾⁽¹⁰⁾	Flanged	1-in., Class 600	Straight	★
F04 ⁽¹⁰⁾	Flanged	1 1/2-in., Class 600	Straight	★
F06 ⁽¹⁰⁾	Flanged	2-in., Class 600	Straight	★
F16 ⁽¹⁰⁾	Flanged	1 1/2-in., Class 900	Tapered	★
F34 ⁽¹⁰⁾	Flanged	1 1/2-in., Class 1500	Tapered	★
F24 ⁽¹⁰⁾	Flanged	2-in., Class 1500	Tapered	★

Table 11. Series 183 Thermocouple Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.
The Expanded offering is subject to additional delivery lead time.

Thermowell style		Mounting	Stem	
F08 ⁽¹¹⁾	Flanged	1 1/2-in., Class 2500	Tapered	★
Q02 ⁽¹²⁾	Sanitary, Tri-Clamp	1-in., Tri-Clamp	Stepped	★
Q04 ⁽¹²⁾	Sanitary, Tri-Clamp	1 1/2-in., Tri-Clamp	Stepped	★
Q06 ⁽¹²⁾	Sanitary, Tri-Clamp	2-in., Tri-Clamp	Stepped	★
Q08 ⁽¹²⁾	Sanitary, Tri-Clamp	3-in., Tri-Clamp	Stepped	★
Q20 ⁽¹²⁾	Sanitary, Tri-Clamp	3/4-in., Tri-Clamp	Straight	★
Q22 ⁽¹²⁾	Sanitary, Tri-Clamp	1-in., Tri-Clamp	Straight	★
Q24 ⁽¹²⁾	Sanitary, Tri-Clamp	1 1/2-in., Tri-Clamp	Straight	★
Q26 ⁽¹²⁾	Sanitary, Tri-Clamp	2-in., Tri-Clamp	Straight	★
Q28 ⁽¹²⁾	Sanitary, Tri-Clamp	3-in., Tri-Clamp	Straight	★

Options (include with selected model number)

Product certifications		
E1	ATEX Approval (See Figure 32)	★
E2	Ex d- CEPEL Flameproof Approval- Brazil	★
E5	FM Explosion-proof Approval (See Figure 30)	★
E6	CSA Explosion-proof Approval (See Figure 31)	★
E7	IECEx Flameproof Approval	★
KF	ATEX + CSA Explosion-proof Combination Approval	★
EM	Technical Regulations Customs Union (EAC) Flameproof	★
Special External pressure test		
R01	Special External Pressure Test	★
Material certification		
Q8	Material Certification	★
Dye penetration test		
R03	Dye Penetration Test	★
NACE Approval		
R05	NACE Approval	★
SST plug and chain		
R06	SST Plug and Chain	★
Full penetration weld		
R07 ⁽¹⁵⁾	Full Penetration Weld	★
Thermowell concentric serrations		
R09 ⁽¹³⁾⁽¹⁴⁾	Concentric Serrations of Thermowell Flange Face	★

Table 11. Series 183 Thermocouple Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.
The Expanded offering is subject to additional delivery lead time.

Flat faced flange		
R10 ⁽¹³⁾⁽¹⁴⁾	Flat Faced Flange	★
Vent hole		
R11	Vent Hole	★
Thermowell Xray		
R12	Thermowell Xray	★
Special surface finish		
R14	Special Surface Finish (12 Ra) (Maximum "U" length = 48-in.)	★
Ring joint flange		
R16 ⁽¹³⁾⁽¹⁴⁾	Ring joint flange (not available with 0-in. [T] length)	★
Electropolish		
R20 ⁽¹⁵⁾	Electropolish	★
Wake frequency		
R21	Wake Frequency-Thermowell Strength Calculation	★
Internal pressure test		
R22	Internal Pressure Test	★
Brass plug and chain		
R23	Brass plug and chain	★
Canadian registration no.		
R24	CRN Marking for British Columbia	
R25	CRN Marking for Alberta	
R26	CRN Marking for Saskatchewan	
R27	CRN Marking for Manitoba	
R28	CRN Marking for Ontario	
R29	CRN Marking for Quebec	
R30	CRN Marking for New Brunswick	
R31	CRN Marking for Nova Scotia	
R32	CRN Marking for Prince Edward Island	
R33	CRN Marking for Yukon Territory	
R34	CRN Marking for Northwest Territory	
R35	CRN Marking for Nunavut	
R36	CRN Marking for Newfoundland and Labrador	

Table 11. Series 183 Thermocouple Sensor Assemblies WITH Thermowell

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.

The Expanded offering is subject to additional delivery lead time.

Twell from hex stock		
R37	Thermowell from Hex stock	
Assemble to options		
XA ⁽¹⁶⁾	Assemble connection head or transmitter to a sensor assembly	★

- (1) General purpose sensors are not available with Type K Thermocouples.
- (2) Bayonet spring-loaded style is available to 21-inches but is not available with Sensor Lead Wire Termination codes R, P, or C or with Approval Options.
- (3) Codes A and C must be used with an extension length. Additional non-standard (E) lengths are available in 1/2-in. increments from 2.5 to 9-in.
- (4) Available only with straight stem flanged thermowells.
- (5) Thermowells with an overall length ("U" + "T" + 1.75-in.) of 36-in. or less are machined from solid barstock. Thermowells with an overall length larger than 42-in. will be constructed using a welded 3-piece design and are available only with a stepped stem style.
- (6) For additional (T) lengths, see [Table 18](#).
- (7) Straight or tapered stem thermowells only.
- (8) F52, F64, F20, F82, F88, and F02 are not compatible with 1-in. Sch. XXS pipe.
- (9) F58, F76, and F94 may not be compatible with 1-in. Sch. pipe and are not compatible with 1-in. Sch. 80, 160 or XXS pipe.
- (10) These options cannot be used with 0-in. (T) length.
- (11) F08 cannot be used with 0- or 1/2-in. (T) length.
- (12) Limited to 24-in. immersion length and 316 or 304 SST materials only.
- (13) Available on flanged thermowells only.
- (14) Only one flange face option allowed.
- (15) Not available on flanged Thermowell and L lengths larger than 24-in.
- (16) If ordering option code XA with a transmitter, specify the same option on the transmitter model code.

Table 12. Ordering Example

Typical Model Number	Model	Connection head	Sensor type	ISA type	Extension type	Extension length	Material code	Immersion length	Mounting style	Additional options
	0183	N	21	J2	A	30	A	075	T22	E5

Rosemount 68Q Sanitary Sensor



The Rosemount 68Q Sanitary Sensor has designs that provide flexible and reliable temperature measurements in hygienic process environments.

Features include:

- Industry-standard RTD sensor design
- Tri-Clamp endcap designs for easy installation
- 3-A Standards approval
- Variety of enclosure and connection head options
- Calibration services to give you insight to sensor performance (Option Codes V1-V7)
- Electropolishing Surface Finish (Option Code R20)
- Assemble to Transmitter option (Option Code XA)

Table 13. Series 68Q Sanitary Platinum RTD Sensor Assemblies

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time. The Expanded offering is subject to additional delivery lead time.

Model	Product description	
0068Q	Sanitary Platinum RTD Sensor Assembly	
Sensor lead wire termination		
P	Aluminum Connection Head, Six Terminals, Flat Cover, Painted	★
L	Aluminum Connection Head, Six Terminals, Extended Cover, Painted	★
N	Sensor only	★
D	Rosemount Aluminum Connection Head with 1/2-in. Entries	★
C	Polypropylene Connection Head	
G	Rosemount SST Connection Head with 1/2-in. Entries	
Sensor type		Temperature range
		-50 to 200 °C (-58 to 392 °F)
11	Single Stepped Stem	★
15	Dual Stepped Stem	★
21	Single Straight Stem	★
25	Dual Straight Stem	★
30 ⁽¹⁾⁽²⁾	Mini General Purpose 6-in. Lead with 1/2-in. NPT Threaded Adapter	★
31 ⁽¹⁾⁽²⁾⁽³⁾	Mini General Purpose 6-in. Lead with 1/2-in. NPSM Threaded Adapter	★
32 ⁽¹⁾⁽²⁾⁽³⁾	Mini General Purpose 180-in. Cable with Strain Relief	★
33 ⁽¹⁾⁽²⁾⁽³⁾	Mini General Purpose 300-in. Cable with Strain Relief	★
41 ⁽²⁾⁽⁴⁾	Mini Spring Loaded with Thermowell Replacement Sensor	★

Table 13. Series 68Q Sanitary Platinum RTD Sensor Assemblies

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time.
The Expanded offering is subject to additional delivery lead time.

Sensor immersion length			
U010		1.00-in.	★
U011		1.10-in.	★
U012		1.20-in.	★
U013		1.25-in.	★
U014		1.40-in.	★
U015		1.50-in.	★
U016		1.60-in.	★
U017		1.70-in.	★
U018		1.80-in.	★
U019		1.90-in.	★
U020		2.00-in.	★
U025		2.50-in.	★
U030		3.00-in.	★
U035		3.50-in.	★
U040		4.00-in.	★
U045		4.50-in.	★
U050		5.00-in.	★
U055		5.50-in.	★
U060		6.00-in.	★
U065		6.50-in.	★
U070		7.00-in.	★
U075		7.50-in.	★
U080		8.00-in.	★
U085		8.50-in.	★
U090		9.00-in.	★
U095		9.50-in.	★
Endcap type			
L050 ⁽⁵⁾	Tri-Clamp	$\frac{1}{2}$ -in. to $\frac{3}{4}$ -in.	★
L100	Tri-Clamp	1.00-in.	★
L150	Tri-Clamp	1.50-in.	★
L200	Tri-Clamp	2.00-in.	★
L250	Tri-Clamp	2.50-in.	★
L300	Tri-Clamp	3.00-in.	★

Table 13. Series 68Q Sanitary Platinum RTD Sensor Assemblies

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time. The Expanded offering is subject to additional delivery lead time.

Options (include with selected model number)

Callendar-Van Dusen constants		
V1-V7	Callendar-Van Dusen Constants (V3, V4, V6 not available with 68Q)	★
Calibration schedule		
X8	Customer-Specified Temperature Range Calibration	★
X9	Customer-Specified Single Temperature Point Calibration	★
Calibration certification		
Q4	Calibration Certification, Customer-Specified Temperature	★
Special surface finish electro polish		
R20 ⁽⁶⁾	Electropolishing of Wetted Surfaces	★
Special surface finish high mechanical polish		
HP	High Mechanical Polish (15R _a or better)	★
Thermowell material certification		
Q8	Material Certification	★
Surface finish certification		
Q16	Surface Finish Certification	★
Assemble to options		
XA ⁽⁷⁾	Assemble Connection Head or Transmitter to a Sensor Assembly.	★

(1) Only available in Sensor Immersion Lengths between 1-in. and 2-in.

(2) Only available with Tri-Clamp O.D. tube size $\frac{1}{2}$ -in. to $\frac{3}{4}$ -in. (Endcap Type code L050).

(3) Only available with Sensor Lead Wire Termination code N (Sensor Only).

(4) Only available in U lengths of 2-, 2.5-, or 3-in.

(5) Only available in Sensor Type code 30, 31, 32, 33, 41.

(6) If ordering a Mini General Purpose or Mini Spring Loaded Sensor (Sensor Type codes 30, 31, 32, 33, or 41) with Electropolishing, High Mechanical Polish (Option code HP) is also required.

(7) If ordering option code XA with a transmitter, specify the same option on the transmitter model code.

Table 14. Ordering Example

Typical Model Number	Model	Connection head	Sensor type	Immersion length	Endcap type, tube size	Additional options
	0068Q	N	11	U050	L150	V2

Rosemount 58C Cut-to-Fit Sensor

The Rosemount 58C Cut-to-Fit Sensor has designs that provide flexible and reliable temperature measurements in process environments.

Features include:

- Industry-standard RTD sensor design
- Cut-to-fit eliminates need to stock large selection of sensors in specific lengths
- 12-, 24-, 36-, and 48-in. lengths available

Table 15. Series 58C Cut-to-Fit RTD Sensors

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time. The Expanded offering is subject to additional delivery lead time.

Model	Product description	
0058C	Platinum Resistance Temperature Sensor	
Connection head		
D	Rosemount Aluminum Connection Head with 1/2-in. Entries	★
R	Aluminum Connection Head, Six Terminals, Flat Cover, Unpainted	★
T	Aluminum Connection Head, Six Terminals, Extended Cover, Unpainted	★
P	Aluminum Connection Head, Six Terminals, Flat Cover, Painted	★
L	Aluminum Connection Head, Six Terminals, Extended Cover, Painted	★
N	Sensor only with 6-in. PTFE-insulated, 24-gauge Lead Wires	★
C	Polypropylene Connection Head	
G	Rosemount SST Connection with 1/2-in. Entries	
Sensor immersion length		
1200	12-in.	★
2400	24-in.	★
3600	36-in.	★
4800	48-in.	★
Mounting adapter		
NNN	None	★
C01 ⁽¹⁾	One-compression Fitting 1/2-14 ANPT	★
C02 ⁽¹⁾	Two-compression Fittings 1/2-14 ANPT	★
SNN	Spring-loaded Fitting 1/2-14 ANPT	★

(1) The only difference between C01 and C02 is that the C01 includes one fitting, and the C02 option includes two fittings.

Table 16. Ordering Example

Typical Model Number	Model	Connection head	Sensor length	Mounting adapter
	0058C	R	1200	SNN

Table 17. Series 58C Spare Parts List (specify spare part number separately when ordering mounting adapters)

Mounting adapters	Option code	Spare part number
Compression fitting 1/2-14 ANPT	C01 and C02	C07961-0008
Spring loaded fitting 1/2-14 ANPT	SNN	00058-0010-0001

Rosemount 91 Series Thermowells



The Rosemount 91 Series Thermowells have designs that provide flexible and reliable temperature measurements in process environments.

Features include:

- Threaded, Flanged, and Weld-in Styles
- Wake Frequency Calculations (Option Code R21)
- NACE Approval (Option Code R05)
- Internal Pressure Test (Option Code R22)
- External Pressure Test (Option Code R01)

Table 18. Series 91 Thermowells

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time. The Expanded offering is subject to additional delivery lead time.

Model	Description	
0091	Thermowell	
Thermowell material		
A	316 SST	★
B	304 SST	★
C	Carbon Steel	★
D	316L SST	★
E	304L SST	★
F	Alloy 20	
G	Alloy 400	
H	Alloy 600	
J	Alloy C-276	
L	Alloy B	
M	304 SST with PTFE Coating	
P	Chrome Molybdenum GradeF22	
R	Nickel 200	
T	Titanium	
U ⁽¹⁾	316 SST with Tantalum Sheath	
V	310 SST	
W	321 SST	
X	Special Material	
Y	316Ti SST	
Z	Chrome Molybdenum Grade F11	

Table 18. Series 91 Thermowells

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time. The Expanded offering is subject to additional delivery lead time.

Immersion length (U)⁽²⁾		
005 ⁽³⁾⁽⁴⁾	0.5-in.	★
007 ⁽³⁾⁽⁴⁾	0.75-in.	★
010 ⁽³⁾⁽⁴⁾	1.0-in.	★
015 ⁽³⁾	1.5-in.	★
020 ⁽³⁾	2.0-in.	★
025 ⁽³⁾	2.5-in.	★
030	3.0-in.	★
035	3.5-in.	★
040	4.0-in.	★
045	4.5-in.	★
050	5.0-in.	★
055	5.5-in.	★
060	6.0-in.	★
065	6.5-in.	★
070	7.0-in.	★
075	7.5-in.	★
080	8.0-in.	★
085	8.5-in.	★
090	9.0-in.	★
095	9.5-in.	★
100	10.0-in.	★
105	10.5-in.	★
110	11.0-in.	★
115	11.5-in.	★
120	12.0-in.	★
125	12.5-in.	★
130	13.0-in.	★
135	13.5-in.	★
140	14.0-in.	★
145	14.5-in.	★
150	15.0-in.	★
155	15.5-in.	★
160	16.0-in.	★
165	16.5-in.	★
170	17.0-in.	★
175	17.5-in.	★
180	18.0-in.	★

Table 18. Series 91 Thermowells

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time. The Expanded offering is subject to additional delivery lead time.

Immersion length (U) ⁽²⁾		
185	18.5-in.	★
190	19.0-in.	★
195	19.5-in.	★
200	20.0-in.	★
205	20.5-in.	★
210	21.0-in.	★
215	21.5-in.	★
220	22.0-in.	★
225	22.5-in.	★
230	23.0-in.	★
240	24.0-in.	★
250	25.0-in.	★
260	26.0-in.	★
270	27.0-in.	★
280	28.0-in.	★
290	29.0-in.	★
300	30.0-in.	★
310	31.0-in.	★
320	32.0-in.	★
330	33.0-in.	★
340	34.0-in.	★
350	35.0-in.	★
360	36.0-in.	★
370	37.0-in.	★
380	38.0-in.	★
390	39.0-in.	★
400	40.0-in.	★
410	41.0-in.	★
420	42.0-in.	★
430	43.0-in.	★
440	44.0-in.	★
450	45.0-in.	★
460	46.0-in.	★
470	47.0-in.	★
480	48.0-in.	★

Table 18. Series 91 Thermowells

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time. The Expanded offering is subject to additional delivery lead time.

Thermowell mounting style		Stem style	Tip diameter (A)	Root diameter (B)	
T20	Thread, 1/2-14 ANPT	Stepped	0.50-in.	0.63-in.	★
T22	Thread, 3/4-14 ANPT	Stepped	0.50-in.	0.75-in.	★
T24	Thread, 1-11.5 ANPT	Stepped	0.50-in.	0.88-in.	★
T26	Thread, 3/4-14 ANPT	Tapered	0.63-in.	0.88-in.	★
T28	Thread, 1-11.5 ANPT	Tapered	0.63-in.	1.06-in.	★
T30	Thread, 1 1/2-11.5 ANPT	Tapered	0.75-in.	1.50-in.	★
T32	Thread, 1/2-14 ANPT	Straight	0.50-in.	0.50-in.	★
T34	Thread, 3/4-14 ANPT	Straight	0.75-in.	0.75-in.	★
T36	Thread, 1-11.5 ANPT	Straight	0.75-in.	0.75-in.	★
T38	Thread, 3/4-14 ANPT	Straight	0.50-in.	0.50-in.	★
T44	Thread, 1/2-14 ANPT	Tapered	0.50-in.	0.63-in.	★
W38	Weld, 3/4-in. Pipe	Stepped	0.50-in.	0.75-in.	★
W40	Weld, 1-in. Pipe	Stepped	0.50-in.	0.88-in.	★
W42	Weld, 3/4-in. Pipe	Tapered	0.63-in.	0.82-in.	★
W44	Weld, 1-in. Pipe	Tapered	0.75-in.	1.00-in.	★
W46	Weld, 1 1/4-in. Pipe	Tapered	0.75-in.	1.25-in.	★
W48	Weld, 3/4-in. Pipe	Straight	0.75-in.	0.75-in.	★
W50	Weld, 1-in. Pipe	Straight	0.75-in.	0.75-in.	★
F10	Flange, F = 2-in., Class 150	Straight	0.75-in.	0.75-in.	★
F12	Flange, F = 3-in., Class 150	Straight	0.75-in.	0.75-in.	★
F52 ⁽⁵⁾	Flange, F = 1-in., Class 150	Stepped	0.50-in.	0.75-in.	★
F54	Flange, F = 1 1/2-in., Class 150	Stepped	0.50-in.	0.75-in.	★
F56	Flange, F = 2-in., Class 150	Stepped	0.50-in.	0.75-in.	★
F58 ⁽⁶⁾	Flange, F = 1-in., Class 150	Tapered	0.75-in.	1.00-in.	★
F60	Flange, F = 1 1/2-in., Class 150	Tapered	0.75-in.	1.00-in.	★
F62	Flange, F = 2-in., Class 150	Tapered	0.75-in.	1.25-in.	★
F64 ⁽⁵⁾	Flange, F = 1-in., Class 150	Straight	0.75-in.	0.75-in.	★
F66	Flange, F = 1 1/2-in., Class 150	Straight	0.75-in.	0.75-in.	★
F70 ⁽⁵⁾	Flange, F = 1-in., Class 300	Stepped	0.50-in.	0.75-in.	★
F72	Flange, F = 1 1/2-in., Class 300	Stepped	0.50-in.	0.75-in.	★
F74	Flange, F = 2-in., Class 300	Stepped	0.50-in.	0.75-in.	★
F76 ⁽⁶⁾	Flange, F = 1-in., Class 300	Tapered	0.75-in.	1.00-in.	★
F78	Flange, F = 1 1/2-in., Class 300	Tapered	0.75-in.	1.00-in.	★
F80	Flange, F = 2-in., Class 300	Tapered	0.75-in.	1.25-in.	★
F82 ⁽⁵⁾	Flange, F = 1-in., Class 300	Straight	0.75-in.	0.75-in.	★
F84	Flange, F = 1 1/2-in., Class 300	Straight	0.75-in.	0.75-in.	★
F86	Flange, F = 2-in., Class 300	Straight	0.75-in.	0.75-in.	★

Table 18. Series 91 Thermowells

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time. The Expanded offering is subject to additional delivery lead time.

Thermowell mounting style		Stem style	Tip diameter (A)	Root diameter (B)	
F88 ⁽⁶⁾	Flange, F = 1-in., Class 600	Stepped	0.50-in.	0.75-in.	★
F90 ⁽⁷⁾	Flange, F = 1½-in., Class 600	Stepped	0.50-in.	0.75-in.	★
F92 ⁽⁷⁾	Flange, F = 2-in., Class 600	Stepped	0.50-in.	0.75-in.	★
F94 ⁽⁵⁾⁽⁷⁾	Flange, F = 1-in., Class 600	Tapered	0.75-in.	1.00-in.	★
F96 ⁽⁷⁾	Flange, F = 1½-in., Class 600	Tapered	0.75-in.	1.00-in.	★
F98 ⁽⁷⁾	Flange, F = 2-in., Class 600	Tapered	0.75-in.	1.25-in.	★
F02 ⁽⁵⁾⁽⁷⁾	Flange, F = 1-in., Class 600	Straight	0.75-in.	0.75-in.	★
F04 ⁽⁷⁾	Flange, F = 1½-in., Class 600	Straight	0.75-in.	0.75-in.	★
F06 ⁽⁷⁾	Flange, F = 2-in., Class 600	Straight	0.75-in.	0.75-in.	★
F16 ⁽⁷⁾	Flange, F = 1½-in., Class 900	Tapered	0.75-in.	1.00-in.	★
F34 ⁽⁷⁾	Flange, F = 1½-in., Class 1500	Tapered	0.75-in.	1.00-in.	★
F24 ⁽⁷⁾	Flange, F = 2-in., Class 1500	Tapered	0.75-in.	1.25-in.	★
F08 ⁽⁸⁾	Flange, F = 1½-in., Class 2500	Tapered	0.75-in.	1.00-in.	★
Q02 ⁽⁹⁾	Sanitary, 1-in., Tri-Clamp	Stepped	0.50-in.	0.75-in.	★
Q04 ⁽⁹⁾	Sanitary, 1½-in., Tri-Clamp	Stepped	0.50-in.	0.75-in.	★
Q06 ⁽⁹⁾	Sanitary, 2-in., Tri-Clamp	Stepped	0.50-in.	0.75-in.	★
Q08 ⁽⁹⁾	Sanitary, 3-in., Tri-Clamp	Stepped	0.50-in.	0.75-in.	★
Q20 ⁽⁹⁾	Sanitary, ¾-in., Tri-Clamp	Straight	0.44-in.	0.44-in.	★
Q22 ⁽⁹⁾	Sanitary, 1-in., Tri-Clamp	Straight	0.50-in.	0.50-in.	★
Q24 ⁽⁹⁾	Sanitary, 1½-in., Tri-Clamp	Straight	0.50-in.	0.50-in.	★
Q26 ⁽⁹⁾	Sanitary, 2-in., Tri-Clamp	Straight	0.50-in.	0.50-in.	★
Q28 ⁽⁹⁾	Sanitary, 3-in., Tri-Clamp	Straight	0.50-in.	0.50-in.	★
Thermowell lagging length (T)					
T000	0.0-in.				★
T005	0.5-in.				★
T010	1.0-in.				★
T015	1.5-in.				★
T020	2.0-in.				★
T025	2.5-in.				★
T030	3.0-in.				★
T035	3.5-in.				★
T040	4.0-in.				★
T045	4.5-in.				★
T050	5.0-in.				★
T055	5.5-in.				★
T060	6.0-in.				★
T065	6.5-in.				★

Table 18. Series 91 Thermowells

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time. The Expanded offering is subject to additional delivery lead time.

Thermowell lagging length (T)		
T070	7.0-in.	★
T075	7.5-in.	★
T080	8.0-in.	★
T085	8.5-in.	★
T090	9.0-in.	★
T095	9.5-in.	★
Instrument connection thread		
P	1/2-14 NPSM	★
D	1/2-14 ANPT	★

Options (include with selected model number)

External pressure test		
R01 ⁽¹⁰⁾	External Pressure Test	★
Material certification		
Q8	Material Certification	★
Dye penetration test		
R03	Dye Penetration Test	★
Thermowell special cleaning		
R04	Thermowell Special Cleaning	★
NACE approval		
R05	NACE Approval	★
SST plug and chain		
R06	SST Plug and Chain	★
Full penetration weld		
R07 ⁽¹¹⁾	Full Penetration Weld	★
Thermowell concentric serrations		
R09 ⁽¹¹⁾⁽¹²⁾	Concentric Serration of Thermowell Flange Face	★
Flat faced flange		
R10 ⁽¹¹⁾⁽¹²⁾	Flat Face Flange	★
Vent hole		
R11	Vent Hole	★
Special surface finish		
R14	Thermowell Special Surface Finish (12 R _a Max) (Maximum (U) Length = 22.5-in.)	★

Table 18. Series 91 Thermowells

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery lead time. The Expanded offering is subject to additional delivery lead time.

Ring joint flange		
R16 ⁽¹¹⁾⁽¹²⁾	Ring Joint Flange (not available with 0-in. [T] Length)	★
Electropolish		
R20 ⁽¹³⁾	Electropolish	★
Wake frequency		
R21	Wake Frequency Calculation	★
Internal pressure test		
R22	Internal Pressure Test	★
Brass plug and chain		
R23	Brass plug and chain	★
Canadian registration no.		
R24	CRN Marking for British Columbia	
R25	CRN Marking for Alberta	
R26	CRN Marking for Saskatchewan	
R27	CRN Marking for Manitoba	
R28	CRN Marking for Ontario	
R29	CRN Marking for Quebec	
R30	CRN Marking for New Brunswick	
R31	CRN Marking for Nova Scotia	
R32	CRN Marking for Prince Edward Island	
R33	CRN Marking for Yukon Territory	
R34	CRN Marking for Northwest Territory	
R35	CRN Marking for Nunavut	
R36	CRN Marking for Newfoundland and Labrador	
Twell from hex stock		
R37	Thermowell from Hex stock	

(1) Available only in straight stem flanged thermowells.

(2) Thermowells with an overall lengths ("U" + "T" + 1.75-in.) of 36-in. or less are machined from solid bar stock. Thermowells with an overall length larger than 42-in. will be constructed using a welded 3-piece design and are available only with a stepped stem style. For lengths between 36-in. and 42-in. consult factory for construction method.

(3) Available only in straight or Tapered stem only.

(4) Only available with Thermowell Mounting Style Q20.

(5) F52, F64, F70, F82, F88 and F02 are not compatible with 1-in. Sch. XXS pipe.

(6) F58, F76 and F94 may not be compatible with 1-in. Sch. pipe and are not compatible with 1-in. Sch. 80, 160 or XXS pipe.

(7) These options cannot be used with 0-in. (T) length.

- (8) F08 cannot be used with 0- or $\frac{1}{2}$ -in. (T) length.
- (9) Limited to 24-in. immersion length and 316 or 304 SST materials only.
- (10) Maximum (U) length = 42.0-in.
- (11) Available on flanged thermowells only.
- (12) Only one flange face option allowed.
- (13) Not available on flanged thermowells and L lengths longer than 24-in.

Table 19. Sensor Series and Dimensions

Series	Housing diameter	# of lead wires	Lead wire length
68	0.350 (8)	4	6.0 (152.4)
78 single	0.350 (8)	4	6.0 (152.4)
78 dual	0.350 (8)	6	6.0 (152.4)
183 single	0.375 (9.53)	2	6.0 (152.4)
183 dual	0.375 (9.53)	4	12.0 (304.8)

Introduction

Overview

Emerson Process Management offers a wide variety of RTD and thermocouple sensors that are available alone or as complete assemblies including connection heads, thermowells, and extension fittings. In addition to complete assemblies, Emerson Process Management offers heads, coupling/nipple and union/nipple extensions, compression fittings, and thermowells.

Using this Product Data Sheet (PDS)

Use this PDS to order complete temperature sensor assemblies, which include sensors, thermowells, extensions, and connection heads. These options can also be ordered separately. For example, you can order a thermowell, extension, or connection head for use with an existing sensor. In each case it is important to know and understand the sections of this PDS when specifying the items.

Threaded sensors and assemblies

- Includes descriptions, specifications, and ordering information for Series 58C, 68, 68Q, and 78 RTDs, and the Series 183 Thermocouples.
- Includes information for ordering sensors, connection heads, extensions, and thermowells as complete assemblies.

Calibration

- Includes characterization schedules and information for ordering calibrated Series 68, 68Q, and 78 RTD Sensors.
- Includes information regarding the use of Callendar-Van Dusen constants to match specific Series 68, 68Q, and 78 RTDs to Rosemount Smart Temperature Transmitters.

Sensor accessories

- Includes descriptions, specifications, and ordering information for temperature accessories such as thermowells, extensions, connection heads, mounting adapters, lead wire extensions, connectors, and thermowells.

Hazardous area approvals

- Includes descriptions of the FM, CSA, IECEx, and ATEX approvals for sensors and connection heads.

Configuration data sheet

- Provides a form used for thermowell application calculations.

RTD

Series 58C, 68, 68Q, and 78 Platinum RTD Temperature Sensors are primarily used when high accuracy, durability, and long-term stability are required. These sensors conform to international standards: IEC 751:1983, Amendments 1&2.⁽¹⁾

Series 58C Platinum RTD Temperature Sensors

- Combine an economical thin-film design with a sheath that can be shortened to any length with tubing cutter.

Series 68Q Quick Response Sanitary RTD Sensors

- Conform to 3-A Sanitary Standards and feature product contact surfaces designed for CIP cleaning.

Series 68 Platinum RTD Temperature Sensors

- Provide high performance in an economical thin-film design.

Series 78 Platinum RTDs Temperature Sensors

- Use a wire-wound element which allows for a broader measurement range.

Thermocouples

Series 183 Thermocouple Temperature Sensors conform to ASTM E-230, and are available in types J, K, E, and T.

Series 183 Thermocouple Temperature Sensors are available:

- Grounded or ungrounded
- Isolated or unisolated
- With immersion lengths from 2-in. to 48-in.

(1) 100 ohms at 0 °C, $\alpha = 0.00385 \text{ ohms/ohm/}^\circ\text{C}$.

The use of 2-, 3-, and 4- wire RTDs

To help you attain the highest possible temperature measurement accuracy, Rosemount provides 4-wire sensors for all single element RTDs. You can use these RTDs in 2-, 3-, or 4-wire configurations by simply securing the unneeded leads with tape. To properly wire the 4-wire RTD for use in a 2-, 3-, or 4-wire configuration, refer to the following wiring diagrams:

2-wire configuration

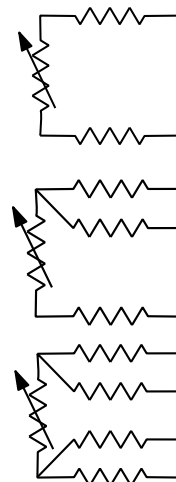
2-wire RTDs provide one connection to each end of the sensor. In a 2-wire configuration, lead wires add resistance to the circuit which cannot be compensated. The 2-wire configuration is rarely used because the added lead wire resistance can cause substantial errors in the temperature reading.

3-wire configuration

3-wire RTDs provide one connection to one end of the sensor, and two connections to the other end. The 3-wire approach does not eliminate all lead wire effects. However, for sensors with lead wires of the same length, lead wire effects are slight, and the approach provides reasonable accuracy.

4-wire configuration

The most effective way to eliminate lead wire effects is with two connections at each end of the sensor. 4-wire RTDs fully compensate for lead wire effects.



Benefits and limitations of RTDs when compared to Thermocouples

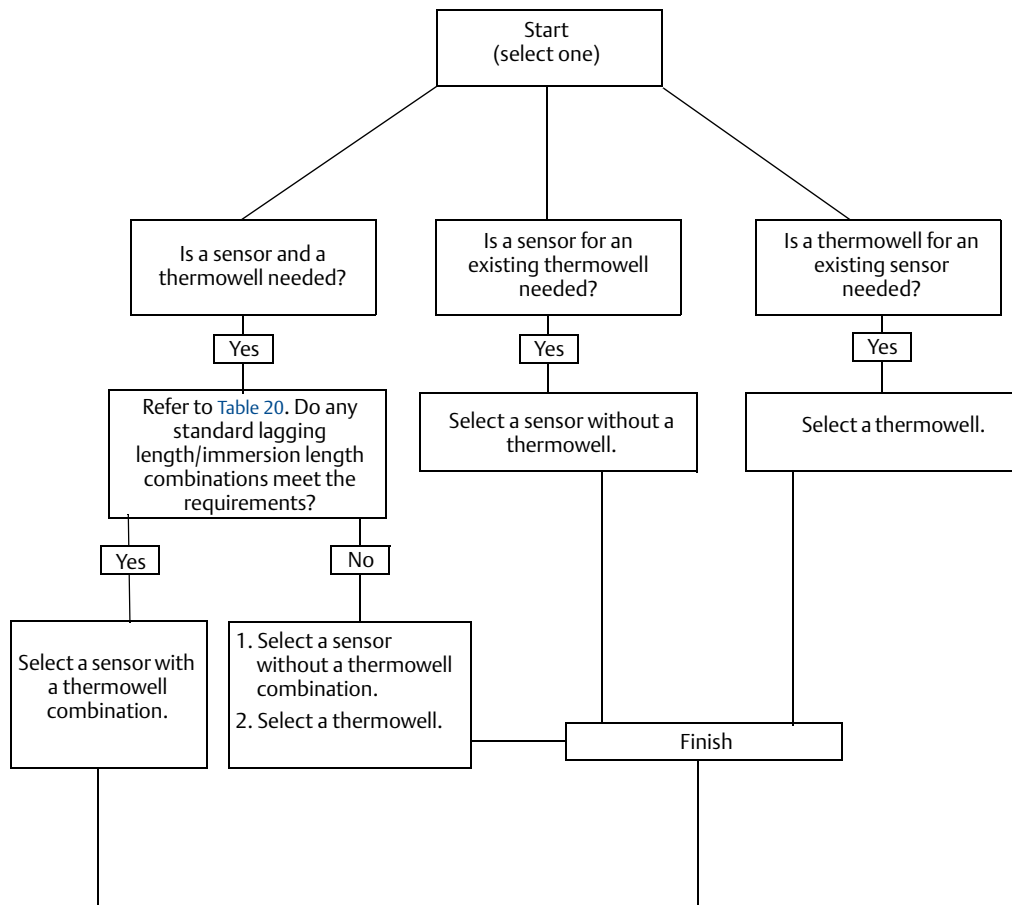
Benefits

- Higher accuracy
- Better linearity and long-term stability
- Cold junction compensation not required
- Special extension lead wire not required
- Less susceptible to noise
- Can be “matched” to a Rosemount transmitter with transmitter sensor matching

Limitations

- Lower maximum temperature limit
- Slower response time in applications without a thermowell
- Reduced resistance to vibration-induced failure

How to Decide What to Order



Model code visible

If Rosemount sensor and model code is visible on the sensor:

1. If the thermowell is ordered separately
(0078P23C30N060) 11th digit = 'N'
 - a. Start with immersion length - digits 12-14; 060 = 6.0 in.
 - b. Add extension length - digits 9 & 10; 30 = 3.0 in. (3 + 6 = 9)
 - c. Order the replacement sensor for the total length without connection heads (5th digit N) and extension (8th digit N)
0078N23N00N090.
2. If the thermowell is ordered integral to sensor
(0078P23C30A060W40) 11th digit = not 'N'
 - a. Immersion length 'U' is defined by the 12-14th digits; 060 = 6.0 in.
 - b. Look up 'L' length from the correct order chart for given 'U' length. This will be 4 inches for short sensors, or a whole number divisible by 3 for sensors longer than 4 inches (4, 6, 9, 12, 15, 18... inches);
'U' 060 = 9 inches 'L'.
 - c. Add extension length as defined by 9th and 10th digits; 30 = 3.0 in. to the 'L' length found in table.
(9" + 3" = 12", Length code 120).
 - d. This will be the replacement sensor length 'X'.
 - e. Order sensor without connection head (5th digit N) or extension (8th digit N) 0078N23N00N120.

Model code not visible

If model code is NOT visible on the sensor, follow one of three steps below.

1. Measure the inside depth of the thermowell.
 - a. Measure down the inside of the thermowell hole to the top-most face of the extension used, or the thermowell if no extension.
 - b. This will be the replacement sensor length if depth = 12.0 in., sensor length will be 12 in.
 - c. Order sensor without connection heads (5th digit N) or extension (8th digit N) 0078N23N00N120.
2. Measure the overall outside length of the thermowell from end to end.
 - a. Measure down the outside of the thermowell from the tip to the end face of the extension if used, or the thermowell if no extension.
 - b. Subtract $\frac{1}{4}$ in. to account for thickness of the thermowell at the tip.
 - c. This will be the replacement sensor length. Overall length = 12.25 in., the replacement will be 12 in.
 - d. Order sensor without connection heads (5th digit N) or extension (8th digit N) 0078N23N00N120.
3. Measure the old sensor length from tip to the flat face of the threaded process connection.
 - a. Determine if the sensor is spring loaded or general purpose (welded) where the sensor sheath meets the threaded adapter.
 - b. For spring loaded sensors, the measurement of the exposed sheath from tip of the start of the threaded portion will be the same as the replacement sensor length.
 - Normal spring compression for a Rosemount sensor is assumed to be $\frac{1}{2}$ in. and the normal thread engagement is also assumed to be $\frac{1}{2}$ in.
 - Round to the nearest whole $\frac{1}{4}$ in. increment as the spring will make up any small differences.
 - Replacement sensor for a spring loaded sensor measuring 6.5 inches will be 6.5 in. length.
 - c. Order sensor without connection heads (5th digit N) or extension (8th digit N) 0078N15N00N065.
 - d. For general purpose sensors with the distance from tip to threaded adapter:
 - Add $\frac{1}{4}$ in. to allow clearance, preventing bottoming sensor during installation.
 - Add $\frac{1}{2}$ in. for the thread engagement of the sensor in the thermowell.
 - The replacement sensor for a general purpose sensor measuring 5.75 in. from the tip to the threaded adapter is 6.5 in. ($5\frac{3}{4} + \frac{1}{4} + \frac{1}{2} = 6\frac{1}{2}$ in).
 - e. Order sensor without connection heads (5th digit N) or extension (8th digit N) 0078N15N00N065.

Model code on thermowell

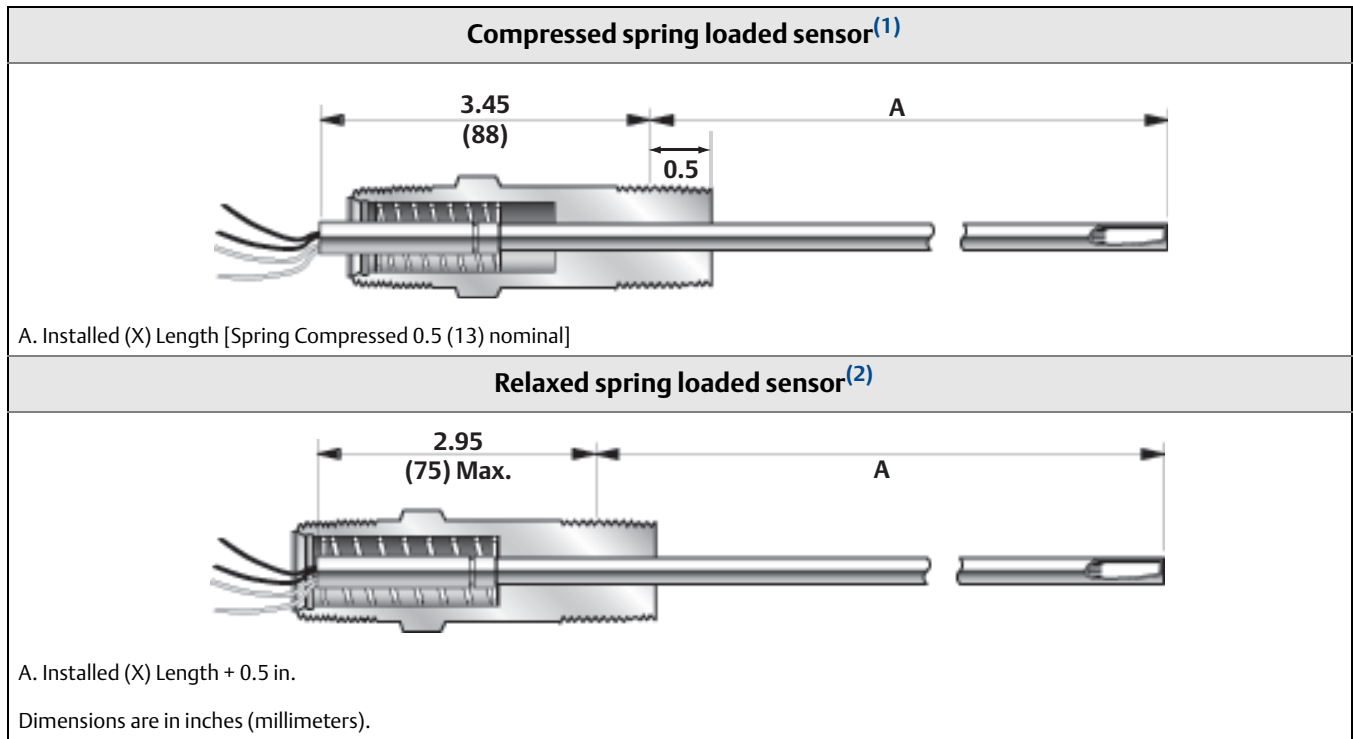
If model code is visible on the thermowell (0091A060W40T015P), follow the instructions below to determine sensor model number.

1. Start with immersion length digits 6-8, 060 = 6.0 in.
 - a. Add additional lagging length digits 13-15, 015 = 1.5 in.
 - b. To those lengths add 1.5 in. (this is the additional standard lagging length on all Rosemount thermowells) 1.75 in. minus (0.25 in. thermowell tip thickness) = 1.50 in.
 - c. $6.0 + 1.5 + 1.5 = 9$ in.
 - d. Order replacement sensor 0078N23N00N090.

Spring-Loaded Sensor Dimensions

When a spring-loaded sensor is used properly, the spring should be compressed approximately 1/2-inch. Therefore, all measurements of spring-loaded sensors are made with the spring compressed. If you measure an existing spring-loaded sensor while it is in a relaxed state, you must subtract 1/2-inch to arrive at the installed length (X) that must be ordered. See Figure 1.

Figure 1. Spring Loaded Sensor Dimensions



- (1) Spring loaded sensor in a compressed state: The actual sensor length is measured when the spring is compressed approximately 1/2-in. shorter than the relaxed sensor.
- (2) Spring loaded sensor in a relaxed state: Normally, when a spring loaded sensor is measured, it is in a relaxed state. You must subtract 1/2-in. from your measurement to order a replacement sensor. Rosemount Inc. assumes that the sensor length you specify is that of a compressed sensor.

Determining the length (L) of a spring-loaded sensor to be used with an existing non-Rosemount Thermowell

(see Figure 1, Figure 3, and Figure 4).

1. Remove the existing sensor from the installed thermowell.
2. Measure the sensor length with the spring in the relaxed state (as shown in Figure 1). Measure from the tip of the sensor to the maximum thread engagement point (0.53-in. into the threads).
3. Subtract 0.5-in. from your measurement. The resulting length is (X).
4. If the sensor is installed with an extension, measure the extension length (E), as shown in Figure 4. If the sensor is not installed with an extension, let (E) = 0.
5. Since $(X) = (E) + (L)$, subtract (E) from (X) to find (L).
6. Use the resulting length (L) in the Section 2 ordering tables to choose the correct length of sensor.

Length code key	
L	Thermowell length minus tip thickness
U	Thermowell Immersion length into process
T	Thermowell Lagging length
E	Extension fitting length
X	Sensor length

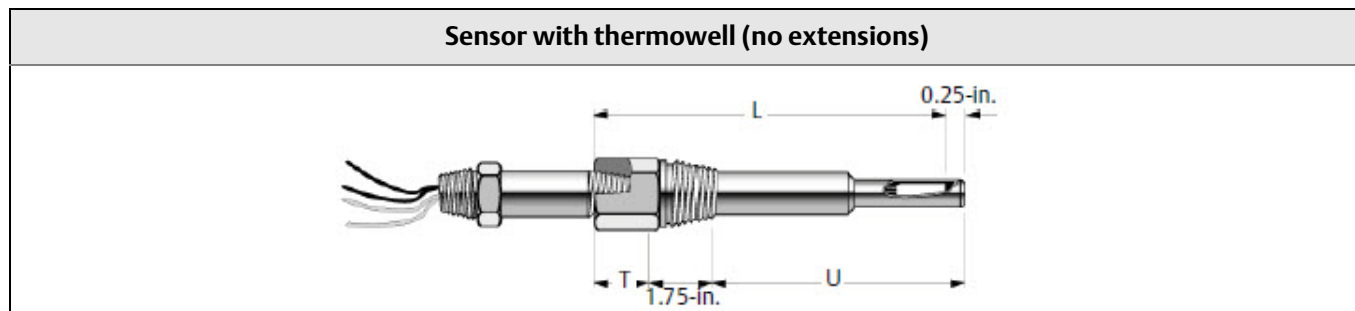
Use the following equations to determine all lengths:

$$L = U + T + 1.5$$

$$X = E + L$$

$$X = E + U + T + 1.5$$

Figure 2. Thermowell Dimensions (use with Sensor Ordering Tables)



1. Determine the (U), (T), and (E) lengths necessary for your installation.
If you do not need an extension, (E) = 0 (zero).
Note: If your existing sensor/thermowell combination is different than Figure 2, refer to the drawings on the following pages.
2. Find your immersion length (U) on Table 20 and compare the corresponding lagging length (T) to the lagging length that you previously determined.
3. If your lengths match the values on the line that corresponds to your required immersion length, order your sensor and thermowell together.
4. If your lengths do not match the values on the line that corresponds to your measured immersion length, order your sensor and thermowell separately. Solve for (L) using the equation $(L) = (U) + (T) + 1.5$ (since (L) is required when ordering the sensor separately from the thermowell).

Length code key	
L	Thermowell length minus tip thickness
U	Immersion length into process
T	Lagging length
E	Extension fitting length
X	Sensor length

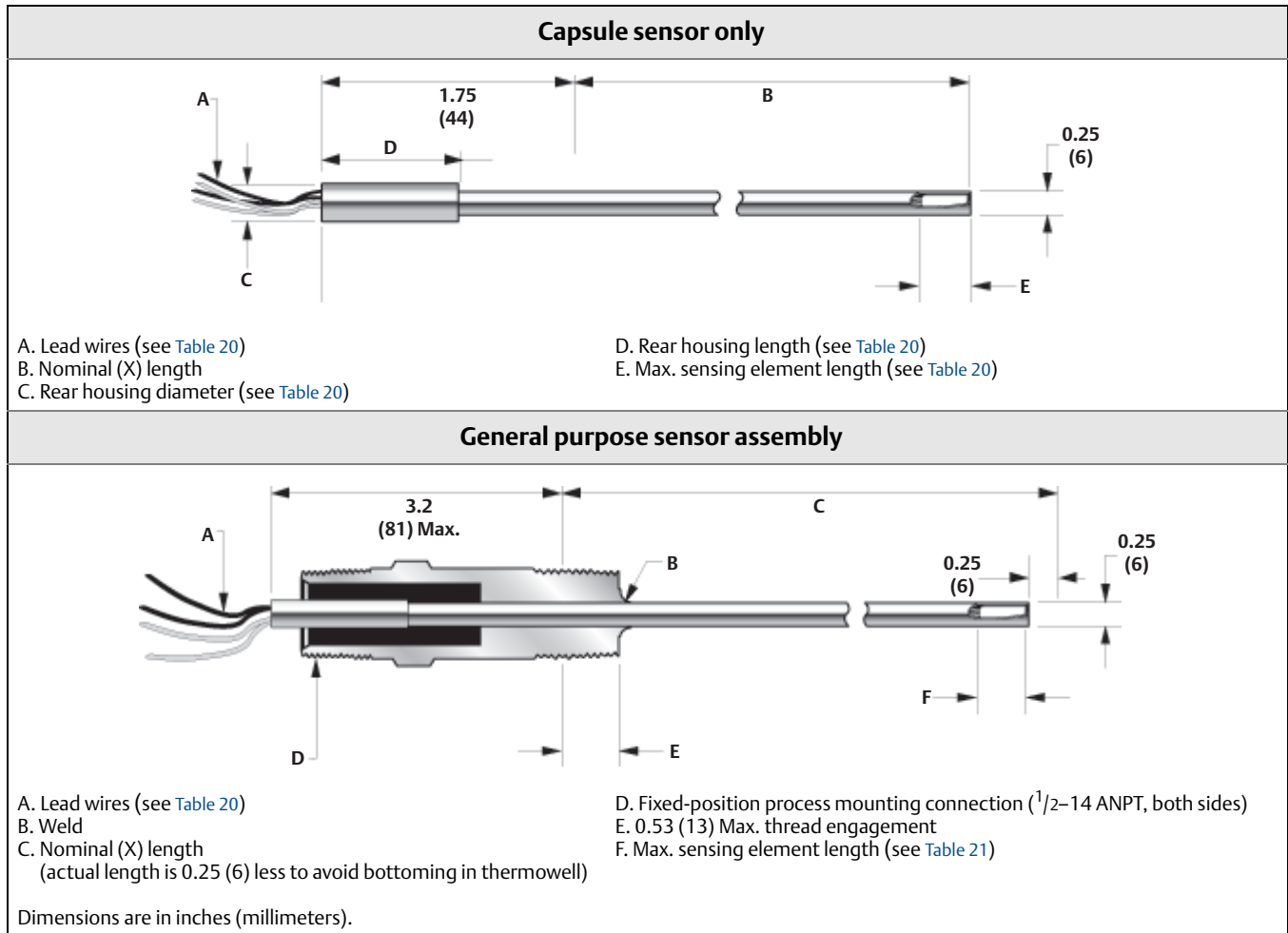
Use the following equations to determine all lengths:

$$L = U + T + 1.5$$

$$X = E + L$$

$$X = E + U + T + 1.5$$

Figure 3. Series 68, 78, and 183 Sensor Assembly Dimensional Drawings



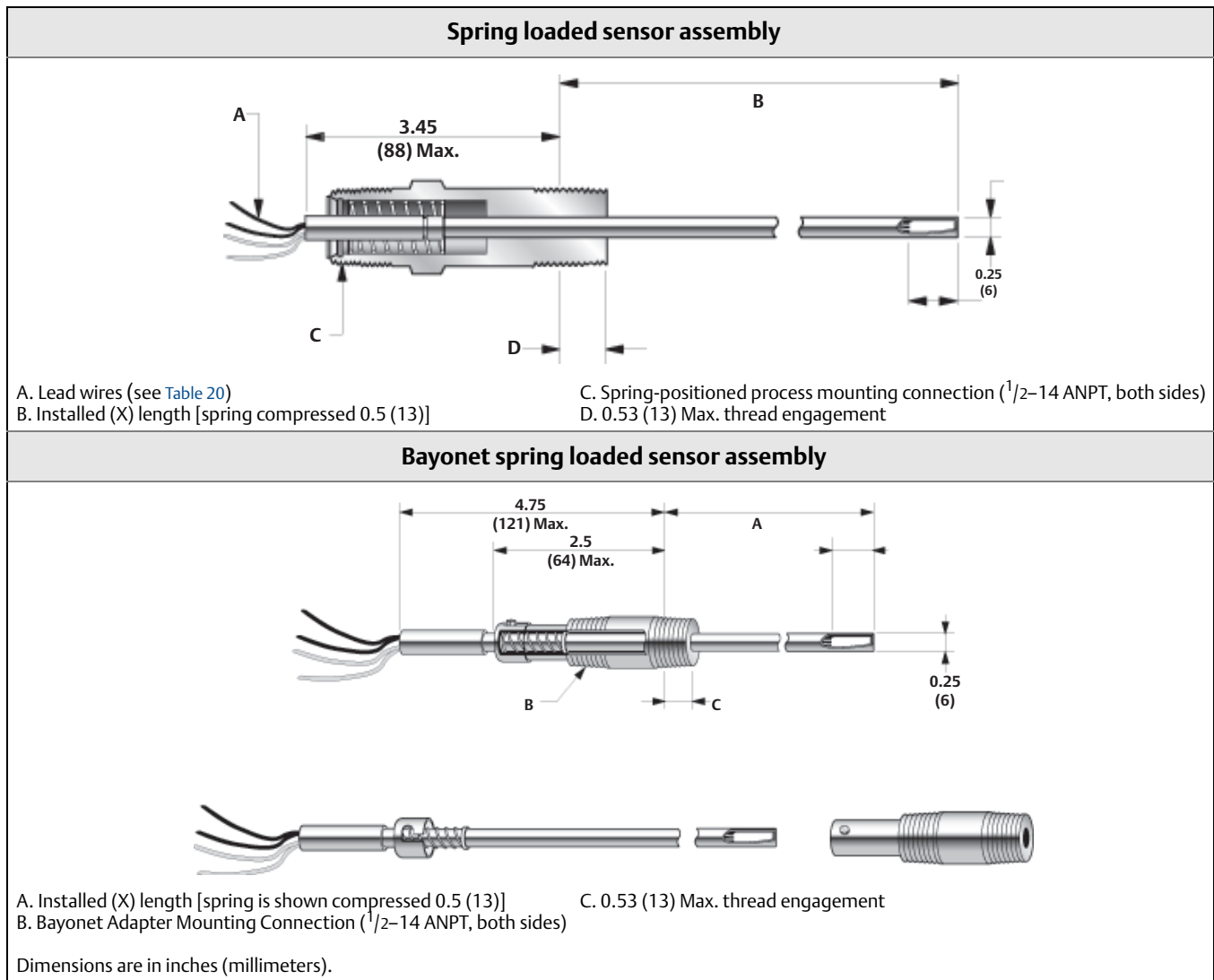
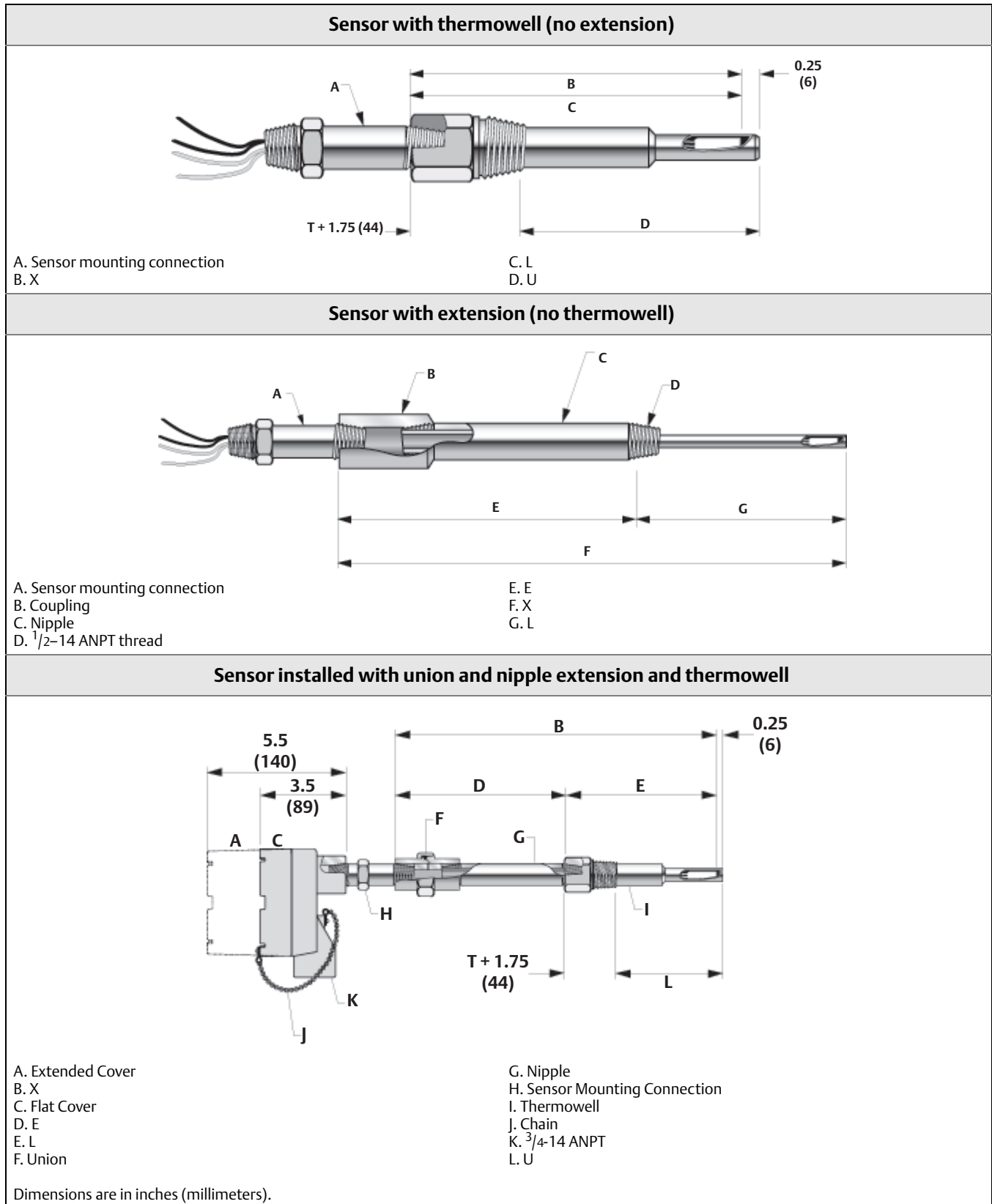


Table 20. Sensor Series and Dimensions

Series	Rear housing diameter	Rear housing length	Max. sensing element length	# of lead wires	Lead wire length
68	0.25 (6)	0.5 (13)	0.9 (23)	4	6.0 (152)
78 Single	0.34 (9)	1.32 (34)	0.6 (15)	4	6.0 (152)
78 Dual	0.34 (9)	1.32 (34)	1.0 (25)	6	6.0 (152)
78 High Temp	0.25 (6)	0.5 (13)	1.85 (47)	4	6.0 (152)
183 Single	0.375 (9.5)	1.25 (32)	0.25 (6)	2	6.5 (165)
183 Dual	0.375 (9.5)	1.25 (32)	0.5 (13)	4	6.5 (165)

Figure 4. Series 68, 78, and 183 Sensor Assembly Length Code Drawings

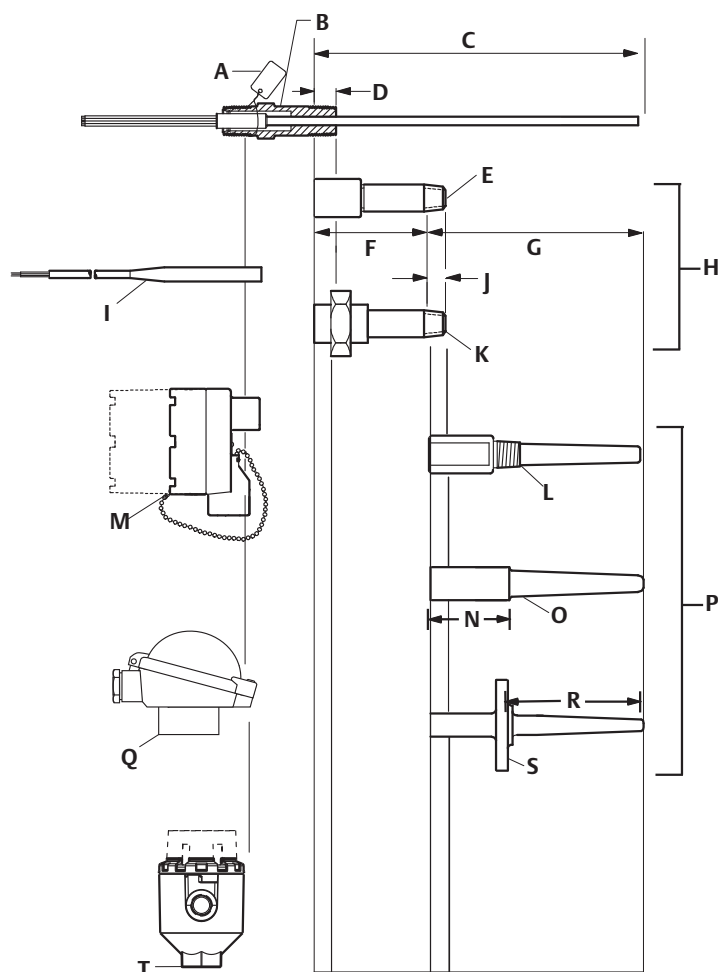


Temperature Sensor Assemblies

Series 68, 68Q, and 78 RTD and Series 183 Thermocouple Sensors may be ordered as complete assemblies. These assemblies provide a complete, yet simple means of specifying the proper industrial hardware for most temperature measurements.

One assembly model number, derived from one ordering table, completely defines the type of sensing element, as well as the material, length, and style of both the extension fittings and thermowells. All sensor assemblies are sized and inspected by Emerson Process Management to ensure complete component compatibility and performance.

Figure 5. Individual Components of a Complete Temperature Assembly



- | | |
|-------------------------------------|--|
| A. Optional identification tag | K. Union-nipple |
| B. Standard adapter sensor assembly | L. Threaded |
| C. Length "X" | M. Aluminum connection heads (with flat or extended cover) |
| D. 0.5 (13) nominal engagement | N. T + 1.75 |
| E. Coupling-nipple | O. Welded |
| F. Length "E" | P. Thermowells |
| G. Length "L" | Q. Polypropylene connection head |
| H. Extensions | R. Length "U" |
| I. Lead wire extensions and seals | S. Flanged |
| J. 0.5 (13) nominal engagement | T. Rosemount aluminum connection head (with standard or LCD display meter cover) |

Dimensions are in inches (millimeters).

Mounting configurations

Capsule

Capsules are designed for direct immersion without mounting fittings. Accessory compression fittings are available for adjustable mounting into a thermowell. See [Mounting adapters for Series 58, 68, 78, and 183](#).

General-purpose sensor assemblies

Designed with a welded, fixed-position, 1/2-14 ANPT process connection fitting for direct immersion or thermowell applications. This sensor design provides a moisture-proof and vapor-tight seal. The maximum static working pressure at 20 °C (68 °F) with no vibration or flow condition is 24.13 MPa (3,500 psig). The use of a thermowell is recommended for process pressure containment. Note that standard lengths are 1/4-inch less than nominal dimension to prevent bottoming of the sensor in a thermowell.

Spring-loaded sensor assemblies

Spring-loaded sensors have a spring-positioned, 1/2-14 ANPT process connection fitting that ensures good surface contact in thermowells for faster time response and vibration resistance. Spring-loaded sensors are not intended to provide a process seal. They must be used in conjunction with a thermowell for this purpose.

Note

When a spring-loaded sensor is used properly, the spring should be compressed approximately 1/2 inch.

Bayonet spring-loaded sensor assemblies

Bayonet assemblies have the same advantages as the spring-loaded sensor. However, the bayonet connector permits the sensor to be easily removed from the process without tools.

Figure 6. Series 68, 68Q, 78, and 58C Lead Wire Configurations

Single element	Dual element ⁽¹⁾
<p>Red Red White White</p>	<p>White White Red Green Green Black</p>

(1) Dual element sensors are only available on Series 68Q and 78 Sensors.

Series 68 Platinum RTD

Rosemount Series 68 Platinum Resistance Temperature Sensors measure from -50 to 400 °C (-58 to 752 °F). Series 68 Class B, Pt100-385 sensors are available in capsule, general purpose, and spring-loaded designs in sensor lengths from 1 to 48 inches.

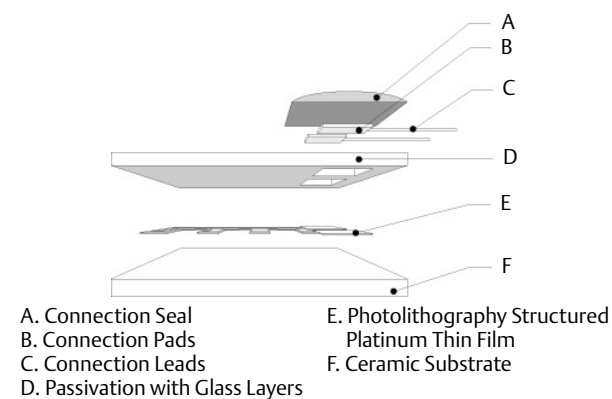
Table 21 shows the interchangeability of the Series 68 RTD. As an option, for maximum system accuracy, Emerson Process Management can provide sensor calibration. See [Sensor characterization \(calibration\) schedules– Option Code V](#). In addition, Emerson Process Management offers optional sensor-to-transmitter matching capability obtainable through the use of Callendar-Van Dusen Constants. See [Option Code “V” Callendar-van Dusen Constants](#).

Table 21. Series 68 Interchangeability

± 0.55 °C (± 0.99 °F) at -50 °C (-58 °F)
± 0.30 °C (± 0.54 °F) at 0 °C (32 °F)
± 0.80 °C (± 1.44 °F) at 100 °C (212 °F)
± 1.30 °C (± 2.34 °F) at 200 °C (392 °F)
± 1.80 °C (± 3.24 °F) at 300 °C (572 °F)
± 2.30 °C (± 4.14 °F) at 400 °C (752 °F)

Construction

Figure 7. Construction of a Platinum Thin Film RTD



Design and construction of the Series 68 Platinum Sensors provides the optimum combination of accuracy and durability available for temperature measurements. The construction of the sensor allows for direct immersion in non-corrosive fluids at reasonable static pressures. For corrosive environments or many industrial applications, these sensors are widely used with standard thermowell assemblies.

Platinum element and lead wire configurations

Single-element temperature sensors have four lead wires and may be used in 2-, 3-, and 4-wire signal conditioning systems.

Specifications

Performance specifications

Temperature range

-50 to 400 °C (-58 to 752 °F)

Effect of temperature cycling

$\pm 0.05\%$ (0.13 °C or 0.23 °F) maximum ice-point resistance shift following 10 cycles over the specified temperature range

Stability

$\pm 0.11\%$ 0.28 °C or 0.51 °F maximum ice-point resistance shift following 1,000 hours at maximum specified temperature (400 °C)

Maximum hysteresis

$\pm 0.1\%$ of operating temperature range

Time constant

12 seconds maximum required to reach 63.2% sensor response in water flowing at 3 ft/s (0.91 m/s)

Nominal R0 100 Ohm

Nominal α 0.00385 $\Omega/\Omega^{\circ}\text{C}$

Physical specifications

Material selection

Emerson provides a variety of Rosemount product with various product options and configurations including materials of construction that can be expected to perform well in a wide range of applications. The Rosemount product information presented is intended as a guide for the purchaser to make an appropriate selection for the application. It is the purchaser's sole responsibility to make a careful analysis of all process parameters (such as all chemical components, temperature, pressure, flow rate, abrasives, contaminants, etc.), when specifying product, materials, options and components for the particular application. Emerson Process Management is not in a position to evaluate or guarantee the compatibility of the process fluid or other process parameters with the product, options, configuration or materials of construction selected.

Sheath material

316 SST and 321 SST

Lead wire

PTFE insulated, silver plated, 24-gauge stranded copper wire

Identification data

The model, serial numbers, and up to six lines of permanent tagging information are etched on each sensor adapter. Stainless steel tags are available upon request.

Environmental specifications

Humidity limits

Lead seal can withstand 100% relative humidity

Vibration limits

±0.05% maximum ice-point resistance shift due to 30 minutes of 14 g peak vibration from 5 to 350 Hz at 20 °C (68 °F) for unsupported stem length of less than 6 inches

Quality assurance

Each sensor is subjected to a resistance accuracy test at 0 °C and an insulation resistance test

Enclosure ratings

When installed properly, Rosemount Series 68 sensors are suitable for indoor and outdoor NEMA 4X and CSA Enclosure Type 4X installations. See [Hazardous area approvals](#) for complete installation information

Insulation resistance

1000 x 10⁶ ohms minimum insulation resistance when measured at 500 Vdc at room temperature

Series 78 Platinum RTD

Series 78 Sensors are intended for applications that require high accuracy, dual-elements, and/or are subjected to high temperatures. Series 78 Platinum Resistance Temperature Sensors measure from -200 to 600 °C (-328 to 1112 °F). These sensors are available in capsule, general-purpose, and spring-loaded in sensor (X) lengths from 1 to 68 inches. They are also available bayonet spring-loaded style in sensor (X) lengths from 1 to 45 inches.

Table shows the interchangeability of the Series 78 Pt100-385 Sensors. The performance of the standard Series 78 Sensor conforms to the standard set by IEC 751 Class B. Additionally, IEC-751 Class A accuracy is available as an option. For maximum system accuracy, Emerson Process Management can provide sensor calibration. See [Sensor characterization \(calibration\) schedules– Option Code V](#). Emerson Process Management also offers optional sensor-to-transmitter matching capability obtainable through the use of Callendar-Van Dusen Constants. See [Option Code “V” Callendar-van Dusen Constants and Graph of a Typical Two-Point Trim](#)

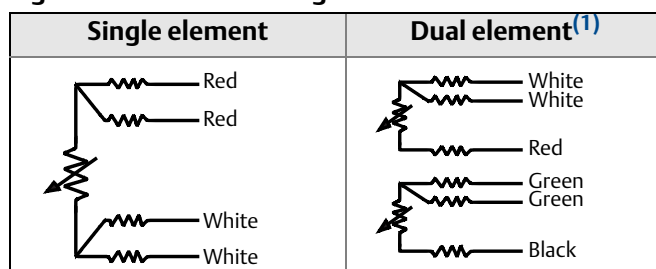
The wire-wound design and construction of the general-purpose Series 78 Sensor allows direct immersion in non-corrosive fluids at reasonable static pressures. For corrosive environments and in many industrial applications, these sensors are commonly used with standard thermowell assemblies.

Platinum element and lead wire configurations

Single-element high-temperature sensors have four lead wires and may be used in 2-, 3-, and 4-wire signal conditioning systems.

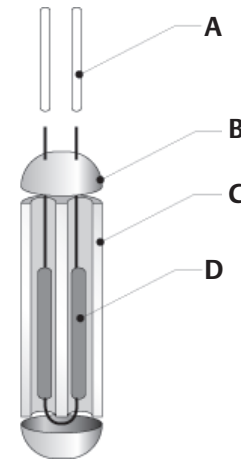
Dual-element sensors have redundant elements to provide separate readout and control signals from a single measurement point. Dual-element sensors have three lead wires for each element and may be used with 2- or 3-wire systems.

Figure 8. Lead Wire Configuration



(1) Dual element sensors are only available on Series 68Q and 78 Sensors.

Figure 9. Construction of a Platinum Wire-Wound RTD



- A. Lead Wires
- B. Seal
- C. High Purity Insulator
- D. Platinum Resistance Element

Specifications

Performance specifications

Temperature range

Series 78 single- and dual-element sensors may be used in temperatures from -200 to 500 °C (-328 to 932 °F). Series 78 single-element high-temperature sensors are provided for high-temperature service over the range of 0 to 600 °C (32 to 1112 °F).

Effect of temperature cycling

$\pm 0.04\%$ (0.10 °C or 0.18 °F) maximum ice-point resistance shift following 10 cycles between -200 and 500 °C (-328 to 932 °F).

Stability

$\pm 0.05\%$ maximum ice-point resistance shift following 1,000 hours at 400 °C (752 °F).

Table 22. Series 78 Interchangeability⁽¹⁾⁽²⁾

Standard series 78 IEC-751 Class B	Temperature
±0.80 °C (±1.44 °F)	-100 °C (-148 °F)
±0.30 °C (±0.54 °F)	0 °C (32 °F)
±0.80 °C (±1.44 °F)	100 °C (212 °F)
±1.80 °C (±3.24 °F)	300 °C (572 °F)
±2.30 °C (±4.14 °F)	400 °C (752 °F)
Series 78 with IEC-751 Class A option	Temperature
±0.35 °C (±0.63 °F)	-100 °C (-148 °F)
±0.15 °C (±0.27 °F)	0 °C (32 °F)
±0.35 °C (±0.63 °F)	100 °C (212 °F)
±0.75 °C (±1.35 °F)	300 °C (572 °F)
±0.95 °C (±1.71 °F)	400 °C (752 °F)

(1) Both tolerances valid from -200 to 500 °C.

(2) Class B tolerances valid from 0 to 600 °C on single- element high temperature sensor.

Maximum hysteresis

- Single- and dual-element, Nominal R0 100 Ohm Nominal alpha 0.00385 Ω/Ω °C: +/- 0.04% of range
- Single-element, high temperature: ±0.1% of range.

Time constant

4 seconds maximum required to reach 63.2% sensor response in water flowing at 3 ft/s (0.91 m/s), 9.5 seconds for single-element high-temperature sensors.

Self heating

18 mW minimum power dissipation required to cause a 1 °C (1.8 °F) temperature measurement error in water flowing at 3 ft/s, 25 mW for single-element high temperature sensors.

Insulation resistance

500 x 10⁶ ohms minimum insulation resistance when measured at 500 Vdc at room temperature [20 °C (68 °F)].

Environmental specifications

Humidity limits

Lead seal is capable of withstanding 100% relative humidity.

Vibration limits

Standard single- and dual-element sensors

- ±0.03% maximum ice-point resistance shift due to 30 minutes of 21 g peak vibration from 5 to 350 Hz continuous sweep at 20 °C (68 °F) for unsupported stem length of less than 5.5 inches (140 mm).

Single-element high-temperature sensors

- Meet ASTM E 1137-95. Cycling time is 3 hours per longitudinal axis, less the time spent at resonant dwells at the axis, from 5 to 500 Hz. The test level is 1.27 mm (0.05 in.) double amplitude displacement or peak g-level of 3, whichever is less.

Quality assurance

Each sensor is subjected to a resistance accuracy test at 0 °C and an insulation resistance test.

Enclosure ratings

When installed properly, Rosemount Series 78 Sensors are suitable for indoor and outdoor NEMA 4X and CSA Enclosure Type 4X installations. See [Hazardous area approvals](#) for complete installation information.

Physical specifications

Sheath material

Single and dual-element, 316 SST

Single element high temperature, 316SST and 321 SST

Lead wires

- Single and dual-element, PTFE-insulated, nickel-coated, 22-gauge stranded copper wire.
- Single element high temperature, PTFE insulated, silver plated, 24-gauge stranded copper wire.

Identification data

The model and serial numbers and up to six lines of permanent tagging information are etched on each sensor adapter. Stainless steel tags are available upon request.

Series 183 Thermocouple

Rosemount Series 183 Thermocouple Sensors measure from -180 to 1150 °C (-292 to 2102 °F).

Construction

The Series 183 Thermocouples are manufactured using Type J, K, E, or T wire with “special limits of error” accuracy. The junction of these wires is fusion-welded to form a pure joint, to maintain the integrity of the circuit, and to ensure the highest accuracy. Grounded junctions are available for improved response time and good thermal contact with protection from the environment. The ungrounded and isolated junctions provide electrical isolation from the sensor sheath (see Figure 10).

Rosemount thermocouples are encased in a protective metal sheath. The sheath material is 304 SST for types J, E, and T, used at temperatures up to 871 °C (1600 °F) and Inconel for type K, used at temperatures up to 1150 °C (2102 °F). Metallic oxide insulation is compacted into the sheath to mechanically support and electrically insulate the thermocouple wire. See Table 23 for more information on the different types of thermocouples.

Figure 10. Series 183 Junction Configurations

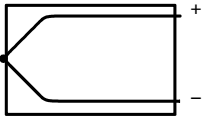
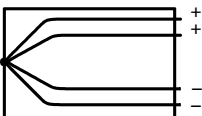
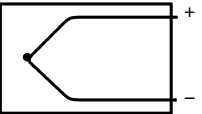
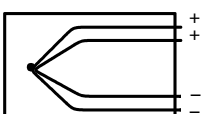
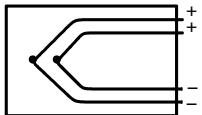
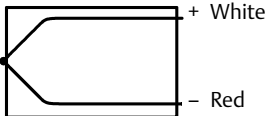
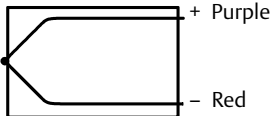
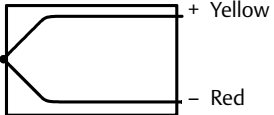
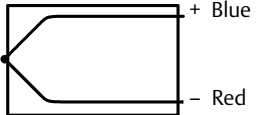
Single, grounded	Dual, grounded, unisolated
	
Single, ungrounded	Dual, ungrounded, unisolated
	
	Dual, ungrounded, isolated
	

Figure 11. Series 183 Lead Wire Configurations

Type J	Type E
	
Type K	Type T
	

Specifications

Performance specifications

The thermoelectric current relationship in a thermocouple is standardized and defined by ASTM E-230. All Series 183 Thermocouples conform to these standards with “special limits of error” accuracy. The particular characteristics of each ISA type thermocouple are outlined in Table 23.

Physical specifications

Sheath material

304 SST for types J, E, and T (used at temperatures up to 871 °C).
Inconel for type K (used at temperatures up to 1150 °C).

Lead wires

Thermocouple, External lead wires—20 AWG wire, PTFE-insulated. Color coded per lead wire configuration schematic shown in Figure 11.

Identification data

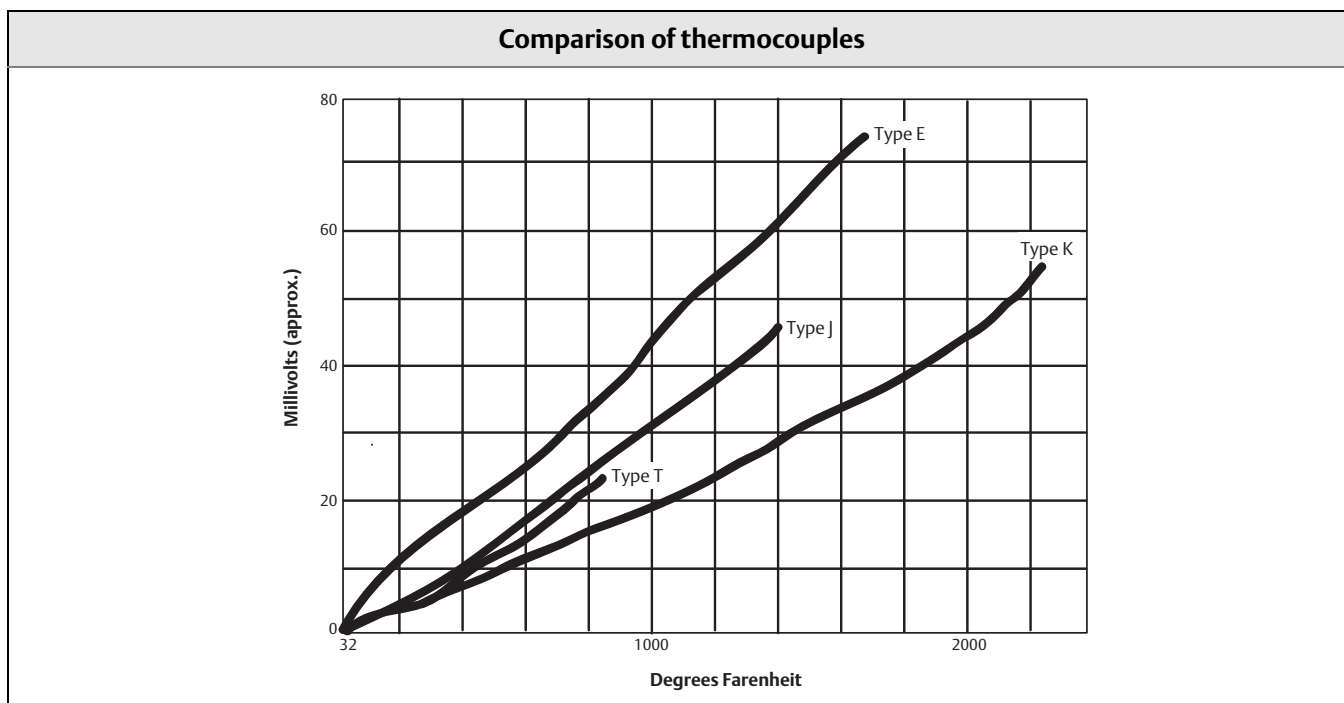
The model and serial numbers and up to six lines of permanent tagging information are etched on each sensor adapter. Stainless steel tags are available upon request.

Insulation resistance

100×10^6 ohms minimum insulation resistance when measured at 100 Vdc at room temperature.

Enclosure ratings

When installed properly, Rosemount Series 183 Sensors are suitable for indoor and outdoor NEMA 4X and installations. See [Hazardous area approvals](#) for complete installation information.



Thermocouple	Conditions for use
Type J Iron/Constantan	Maximum operating temperature of 760 °C (1400 °F). Used with or without protective tubing where deficiency of free oxygen exists. Protective tube not essential, but desirable for cleanliness and longer service.
Type K Chromel/Alumel	Suitable for extended use in temperatures reaching 1150 °C (2102 °F). Use of metal or ceramic protective tube desirable, especially in reducing atmospheres. In oxidizing atmospheres, protective tubing necessary only to promote cleanliness and longer service.
Type E Chromel/Constantan	Suitable for use at temperature up to 871 °C (1600 °F) in vacuum or inert, mildly oxidizing, or reducing atmosphere. Not subject to corrosion at cryogenic temperatures. Has highest EMF output per degree of all commonly used thermocouples.
Type T Copper/Constantan	Operating temperature range of -180 to 371 °C (-292 to 700 °F). Use in either oxidizing or reducing atmospheres. Protective tubing necessary only to promote cleanliness and longer service. Stable at lower temperature. Superior for a wide variety of uses in cryogenic temperatures.

Table 23. Characteristics of Series 183 Thermocouple Types

ISA thermocouple types	Thermocouple wire alloys	Temperature range		Limits of error (interchangeability)
		°C	°F	
J	Iron/Constantan	0 to 760	32 to 1400	±1.1 °C (2.0 °F) or ±0.4% of measured temperature, whichever is greater
K	Chromel/Alumel	0 to 1150	32 to 2102	±1.1 °C (2.0 °F) or ±0.4% of measured temperature, whichever is greater
E	Chromel/Constantan	0 to 871	32 to 1600	±1.0 °C (1.8 °F) or ±0.4% of measured temperature, whichever is greater
T	Copper/Constantan	-180 to 0	-292 to 32	±1.0 °C (1.8 °F) or ±1.5% of measured temperature, whichever is greater
		0 to 371	32 to 700	±0.5 °C (1.0 °F) or ±0.4% of measured temperature, whichever is greater

Series 68Q Sanitary Platinum RTD

Rosemount Series 68Q Sanitary RTD Temperature Sensors measure from -50 to 200 °C (-58 to 392 °F). Series 68Q Sensors are available in Tri-Clamp endcap designs in immersion lengths from 1.0 to 9.5 inches. Table 24 shows the interchangeability of the Series 68Q Sensor.

Accuracy

Table 24. Series 68Q interchangeability (IEC 751 Class B)

± 0.55 °C (± 0.99 °F) at -50 °C (-58 °F)
± 0.30 °C (± 0.54 °F) at 0 °C (32 °F)
± 0.80 °C (± 1.44 °F) at 100 °C (212 °F)
± 1.30 °C (± 2.34 °F) at 200 °C (392 °F)

Construction

Series 68Q Sensors conform to 3A Sanitary Standards and feature product contact surfaces designed for CIP cleaning. The response times of Series 68Q Sensors meet the Grade A Pasteurized Milk Ordinance (PMO) specification for thermometric response of an indicating thermometer on a pipeline.

Series 68Q Sensors are offered in a Tri-Clamp sanitary endcap configuration. The sensor capsule is welded into the 316 SST sanitary endcap/stem assembly. The product contact of this assembly is polished to a finish that exceeds No. 4 minimum finish as required by the 3A Sanitary Council Standard #74-02.

Platinum element and lead wire configurations

Single-element temperature sensors have four lead wires and may be used in 2-, 3-, and 4-wire signal conditioning systems. Dual-element sensors have six lead wires and may be used in 2- and 3-wire signal conditioning systems.

Specifications

Performance specifications

Temperature range

-50 to 200 °C (-58 to 392 °F)

Maximum hysteresis

$\pm 0.09\%$ of operating temperature range

Stability

Tri-Clamp O.D. tube size 1-in. and greater

$\pm 0.04\%$ maximum ice-point resistance shift following 1,000 hours at maximum specified temperature 392 °F (200 °C)

Tri-Clamp O.D. tube size $1/2$ - $3/4$ -in.

$\pm 0.08\%$ maximum ice-point resistance shift following 1,000 hours at maximum specified temperature 392 °F (200 °C)

Response time

Tri-Clamp O.D. tube size 1-in. and greater

Less than 3.5 seconds required to reach 63.2% sensor response in water flowing at 3 ft/s (0.91 m/s). Meets PMO specification

Tri-Clamp O.D. tube size $1/2$ - $3/4$ -in.

Less than 1.5 seconds required to reach 63.2% sensor response in water flowing at 3 ft/s (0.91 m/s)

Insulation resistance

500×10^6 ohms minimum insulation resistance when measured at 100 Vdc at room temperature

Surface finish

32R_A standard finish on product contact surfaces. Meets 3A requirements

15R_A high mechanical polish available with option code HP.

Environmental specifications

Humidity limits

Lead seal is capable of withstanding 100% relative humidity

Quality assurance

Each sensor is subjected to a resistance accuracy test at 0 °C

Physical specifications

Sheath material

316L SST

Lead wire

PTFE-insulated, nickel-coated, 24-gauge stranded copper wire

Identification data

The model and serial numbers and up to six lines of permanent tagging information are etched on each sensor adapter. Stainless steel tags are available upon request.

Dimensional drawings

68Q Sanitary Sensor with Tri-Clamp endcap	
<p>Stepped stem</p> <p>A. Tri-Clamp Endcap B. Stem</p>	<p>Straight stem</p> <p>A. Tri-Clamp Process Connection 1-in. to 3-in. O.D. tube size</p>
68Q Mini General Purpose Sensor with cable and strain relief	
<p>A. Vinyl Strain Relief B. Lead Wire Length C. Tri-Clamp Process Connection 1/2-in. to 3/4-in. O.D. tube size</p>	
68Q Mini General Purpose Sensor with 1/2-in. NPT threaded adapter	
<p>A. Tri-Clamp Process Connection 1/2-in. to 3/4-in. O.D. tube size</p>	
68Q Mini Spring Loaded Sensor with thermowell and replaceable sensor	
<p>Dimensions are in inches (millimeters).</p>	

Table 25. Series 68Q Spare Parts List

Mini spring-loaded sanitary replacement sensors and thermowells		
Immersion length (U)	Replacement sensor part number	Replacement thermowell part number
2.0	00068-4035-0020	00068-4035-1020
2.5	00068-4035-0025	00068-4035-1025
3.0	00068-4035-0030	00068-4035-1030

Series 58C Platinum RTD

Rosemount Series 58C Sensors are available in 12-, 24-, 36-, and 48-inch (X) lengths and may be shortened to any desired length with an ordinary tube cutter. This cut-to-fit feature eliminates the need to stock a large selection of sensors in many specific lengths. Table 26 shows the interchangeability of the Series 58C Sensor.

Table 26. Series 58C Interchangeability (IEC 751 Class B)

±0.55 °C (±0.99 °F) at -50 °C (-58 °F)
±0.30 °C (±0.54 °F) at 0 °C (32 °F)
±0.80 °C (±1.44 °F) at 100 °C (212 °F)
±1.30 °C (±2.34 °F) at 200 °C (392 °F)

Specifications

Performance specifications

Temperature range

-50 to 200 °C (-58 to 392 °F)

Maximum hysteresis

±0.09% of operating temperature range

Stability

±0.035% maximum ice-point resistance shift following 1,000 hours at maximum specified temperature (200 °C)

Insulation resistance

500 × 10⁶ ohms minimum insulation resistance when measured at 50 Vdc at room temperature

Environmental specifications

Humidity limits

No permanent rear seal is installed

Quality assurance

Each sensor is subjected to a resistance accuracy test at 0 °C and an insulation resistance test

Physical specifications

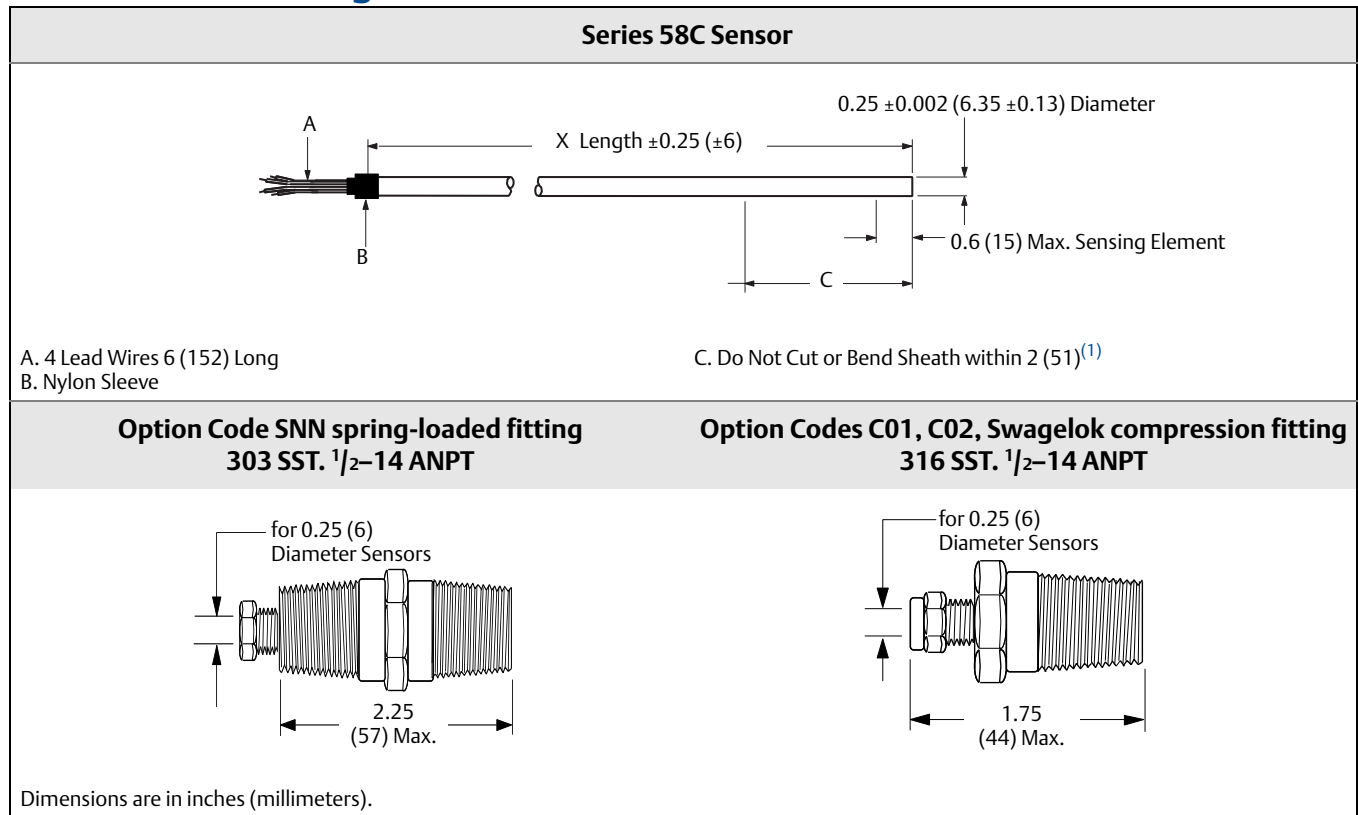
Sheath material

316 SST

Lead wires

PTFE-insulated, nickel-coated, 24-gauge stranded copper wire

Dimensional drawings



(1) Do not cut all the way through the sensor sheath when cutting the sensor to length. Damage to the sensor wires could result. To prevent damage to the sensor wires, score the sheath considerably with a tube cutter and gently break off the excess.

Calibration

Calibration options

Sensor calibration may be required for input to quality systems, or for control system enhancement. More frequently, it is used to improve the overall temperature measurement performance by matching the sensor to a temperature transmitter.

Transmitter-Sensor matching is available for RTD sensors used with Rosemount temperature transmitters where the inherent stability and repeatability of the RTD technology is well established.

Transmitter-sensor matching using Callendar-Van Dusen constants

Significant temperature measurement accuracy improvement can be attained using a temperature sensor that is matched to a temperature transmitter. This matching process entails *teaching* the temperature transmitter the relationship between resistance and temperature for a specific RTD sensor. This relationship, approximated by the Callendar-Van Dusen equation, is described as:

$$R_t = R_0 + R_0 \alpha [t - \delta(0.01t - 1)(0.01t) - \beta(0.01t - 1)(0.01t)^3],$$

where:

- R_t = Resistance (ohms) at Temperature t (°C)
- R_0 = Sensor-Specific Constant (Resistance at $t = 0$ °C)
- α = Sensor-Specific Constant
- δ = Sensor-Specific Constant
- β = Sensor-Specific Constant (0 at $t > 0$ °C, 0.11 at $t < 0$ °C)

The exact values for R_0 , α , δ , β , – known as Callendar-Van Dusen (CVD) constants – are specific to each RTD sensor, and are established by testing each individual sensor at various temperatures.

The calibration temperature values using the CVD equation are divided into two major temperature areas: above 0 °C and below 0 °C. The calibration for the temperature range between 0 and 660 °C is obtained from the following formula:

$$R_t = R_0 \left\{ 1 + a \left[t - d \left(\frac{t}{100} \right) \left(\frac{t}{100} - 1 \right) \right] \right\}$$

Note that this is a modification of the fourth-order CVD equation where $\beta = 0$ for temperatures greater than 0 °C. Since this modified equation is a second-order degree equation, at least three distinct temperature values are needed in order to curve fit the behavior of the RTD. For the temperature range from 0 to 100 °C, only these two end points are used, and an approximation is made to render the constants.

Once the sensor-specific constants are entered, the transmitter uses them to generate a custom curve to best describe the relationship between resistance and temperature for the particular sensor and transmitter system. Matching a Series 68 or 78 RTD Sensor to a Rosemount transmitter typically results in a 3- or 4-fold improvement in temperature measurement accuracy for the total system. This substantial system accuracy improvement is realized as a result of the transmitter's ability to use the sensor's *actual* resistance-vs.-temperature curve instead of an *ideal* curve.

An example of the benefits of using the sensor matching capability of a Rosemount 3144P Temperature Transmitter along with a matched Series 68 RTD Sensor are shown in [Typical transmitter-sensor matching uncertainty improvements](#).

Calibration uncertainty

Calibration uncertainties of the lab are equal to or better than $1/10$ IEC 751 Class B interchangeability:

$$\text{Uncertainty} = 0.03 + 0.0005x|t|$$

$$|t| = \text{absolute value of temperature in } ^\circ\text{C}$$

Typical transmitter-sensor matching uncertainty improvements

Transmitter: 3144 (has built-in sensor matching capabilities), span of 1 to 200 °C, accuracy = 0.1 °C

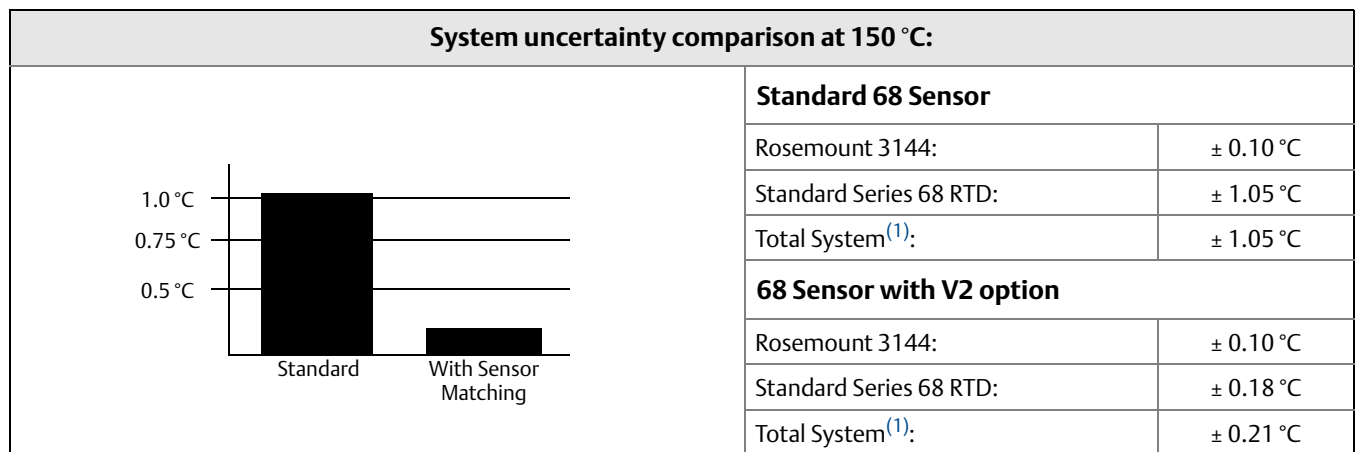
Sensor: Series 68 RTD

Callendar van Dusen Option: V2

Process Temperature: 150 °C

Temperature		Sensor interchangeability error		Total calibrated sensor uncertainty ⁽¹⁾	
°C	°F	°C	°F	°C	°F
0	32	±0.30	±0.54	±0.10	±0.18
50	122	±0.55	±0.99	±0.17	±0.31
100	212	±0.80	±1.44	±0.22	±0.40
150	302	±1.05	±1.89	±0.18	±0.32
200	392	±1.30	±2.34	±0.16	±0.29

(1) Includes calibration uncertainties of the lab, hysteresis, and repeatability.



(1) Calculated using RSS statistical method:

$$\text{SystemAccuracy} = \sqrt{(\text{TransmitterAccuracy})^2 + (\text{SensorAccuracy})^2}$$

Ordering information

Sensor characterization (calibration) schedules– Option Code V

Series 68, 68Q, and 78 RTD sensors can be ordered with an option (V1, V2,...V7, see [Option Code “V” Callendar-van Dusen Constants](#)), that provides Callendar-Van Dusen constants that are shipped with the sensor. When you order this option, the values of all four sensor-specific constants are physically attached to each sensor with a wire-on tag. Rosemount transmitters have a unique, built-in sensor matching capability. To use this capability, the four sensor-specific constants are programmed into the transmitter at the factory by ordering a C2 option on the transmitter, or easily entered and changed in the field using a Field Communicator or AMS. When these values are entered into a Rosemount transmitter, the sensor and transmitter become *matched*.

Each “V” option is specific to a particular temperature range for a given sensor type (see [Option Code “V” Callendar-van Dusen Constants](#)).

For applications requiring the increased accuracy obtainable through a matched sensor and transmitter, order the appropriate “V” option (see [Option Code “V” Callendar-van Dusen Constants](#)). To ensure optimal performance, select a “V” option such that the sensor’s range of actual operation is between the minimum and maximum calibration points.

Note

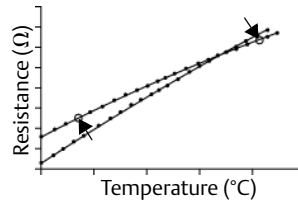
An RTD ordered with the V option is shipped with CVD constants only; it does not include calibration tables.

Option Code X8Q4

The X8Q4 option calibrates the sensor to a customer-specified temperature range. The exact range that the sensor is calibrated to is based on the calibration schedules available. At a minimum, the sensor calibration will encompass the requested calibration range. The X8Q4 report includes the Callendar-Van Dusen (CVD) constants (R_0 , α , δ , β), a resistance-versus-temperature table in one-degree increments, and a graph which includes the maximum errors due to the uncertainty of the calibration equipment, hysteresis, and repeatability. The values in the tables are calculated using Callendar-Van Dusen methodology. Two of the values on this table could be used to perform a two-point trim. The X8Q4 option also provides the CVD constants on a stainless steel tag attached to the sensor.

See [Figure 13](#).

Figure 13. Graph of a Typical Two-Point Trim



A two-point trim shifts the ideal curve up or down, and changes the slope based on the two characterized points.

Option X8Q4: sensor calibrated to a customer-specified temperature range

When you order an RTD with the X8Q4 option, you must specify a temperature range over which the sensor is to be calibrated. Before specifying the range, take careful note of the sensor temperature limits.

Table 28. Ordering Example

Typical Model Number	Model	Lead wire termination	Sensor type	Extension type	Extension length	Thermowell material	Immersion length	Additional options
	0068	N	11	N	00	N	045	X8Q4 X8X9Q4

If X8Q4 and X9Q4 are both required, do not repeat the “Q4” code in the model string. Include the following instead:

Calibrate from -10 to 120 °C

Option Code X9Q4

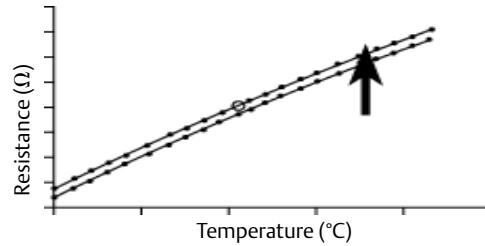
The X9Q4 option calibrates the sensor at a single customer-specified point. A calibration certificate with the resistance value at this point is supplied. This value could be used to perform a one-point trim on the transmitter. All characterizations are traceable to the National Institute of Standards and Technology (NIST). The calibration table is dated and marked with the sensor series and serial number.

See [Figure 14](#).

Note

The X9Q4 option can be ordered and used in conjunction with the X8Q4 option.

Figure 14. Graph of a Typical One-Point Trim



A one-point trim shifts the ideal curve up or down based on the single characterized point.

Option X9Q4: sensor calibrated to a customer-specified single point

When you order an RTD with the X9Q4 option, you must specify a single temperature point at which the sensor is to be calibrated. Before specifying the point, take careful note of the sensor temperature limits.

Table 29. Ordering Example

Typical Model Number	Model	Lead wire termination	Sensor type	Extension type	Extension length	Thermowell material	Immersion length	Additional options
	0068	N	11	N	00	N	045	X9Q4

If X8Q4 and X9Q4 are both required, do not repeat the “Q4” code in the model string. Include the following instead:

X8X9Q4 Calibrate at 50 °C

Table 30. Resistance vs. Temperature

IEC 751 Platinum 100, $\alpha = 0.00385$ RTD											
°F	Ohms	°F	Ohms	°F	Ohms	°C	Ohms	°C	Ohms	°C	Ohms
-330	18.04	210	138.08	690	235.15	-200	18.52	90	134.71	380	240.18
-320	20.44	220	140.19	700	237.09	-190	22.83	100	138.51	390	243.64
-310	22.83	230	142.29	710	239.02	-180	27.10	110	142.29	400	247.09
-300	25.20	240	144.39	720	240.95	-170	31.34	120	146.07	410	250.53
-290	27.57	250	146.49	730	242.87	-160	35.54	130	149.83	420	253.96
-280	29.93	260	148.58	740	244.79	-150	39.72	140	153.58	430	257.38
-270	32.27	270	150.67	750	246.71	-140	43.88	150	157.33	440	260.78
-260	34.61	280	152.75	760	248.62	-130	48.00	160	161.05	450	264.18
-250	36.94	290	154.83	770	250.53	-120	52.11	170	164.77	460	267.56
-240	39.26	300	156.91	780	252.44	-110	56.19	180	168.48	470	270.93
-230	41.57	310	158.98	790	254.34	-100	60.26	190	172.17	480	274.29
-220	43.88	320	161.05	800	256.24	-90	64.30	200	175.86	490	277.64
-210	46.17	330	163.12	810	258.14	-80	68.33	210	179.53	500	280.98
-200	48.46	340	165.18	820	260.03	-70	72.33	220	183.17	510	284.30
-190	50.74	350	167.24	840	263.80	-60	76.33	230	186.84	520	287.62
-180	53.02	360	169.30	850	265.68	-50	80.31	240	190.47	530	290.92
-170	55.29	370	171.35	860	267.56	-40	84.27	250	194.10	540	294.21
-160	57.55	380	173.40	870	269.44	-30	88.22	260	197.71	550	297.49
-150	59.81	390	175.45	880	271.31	-20	92.16	270	201.31	560	300.74
-140	62.06	400	177.49	890	273.17	-10	96.09	280	204.90	570	304.01
-130	64.30	410	179.53	900	275.04	0	100.00	290	208.48	580	307.25
-120	66.54	420	181.56	910	276.90	10	103.90	300	212.05	590	310.49
-110	68.77	430	183.59	920	278.75	20	107.79	310	215.61	600	313.71
-100	71.00	380	173.40	930	280.61	30	111.67	320	219.15	N/A	N/A
-90	73.22	390	175.45	940	282.46	40	115.54	330	222.68	N/A	N/A
-80	75.44	400	177.49	950	284.30	50	119.40	340	226.21	N/A	N/A
-70	77.66	410	179.53	960	286.14	60	123.24	350	229.72	N/A	N/A
-60	79.86	420	181.56	970	287.98	70	127.08	360	233.21	N/A	N/A
-50	82.07	430	183.59	980	289.82	80	130.90	370	236.70	N/A	N/A

IEC 751 Platinum 100, $\alpha = 0.00385$ RTD											
°F	Ohms	°F	Ohms	°F	Ohms	°C	Ohms	°C	Ohms	°C	Ohms
-40	84.27	450	187.65	990	291.65	<i>Note</i> To convert from °C to °F: $\{1.8 \times (°C)\} + 32 = °F$ Example: $(1.8 \times 100) + 32 = 212 °F$ To convert from °F to °C: $0.556 [(°F) - 32] = 100 °C$ Example: $0.556 (212 - 32) = 100 °C$					
-30	86.47	460	189.67	1000	293.48						
-20	88.66	470	191.68	1010	295.30						
-10	90.85	480	193.70	1020	297.12						
0	93.03	490	195.71	1030	298.94						
10	95.21	500	197.71	1040	300.75						
20	97.39	510	199.71	1050	302.56						
30	99.57	520	201.71	1060	304.37						
40	101.74	530	203.71	1070	306.17						
50	103.90	540	205.70	1080	307.97						
60	106.07	550	207.69	1090	309.77						
70	108.23	560	209.67	1100	311.56						
80	110.38	570	211.66	1110	313.35						
90	112.53	580	213.63	1120	315.14						
100	114.68	590	215.61	N/A	N/A						
110	116.83	600	217.58	N/A	N/A						
120	118.97	610	219.55	N/A	N/A						
130	121.11	620	221.51	N/A	N/A						
140	123.24	630	223.47	N/A	N/A						
150	125.37	640	225.42	N/A	N/A						
160	127.50	650	227.38	N/A	N/A						
170	129.62	660	229.33	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
180	131.74	670	231.27	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
190	133.86	680	233.21	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
200	135.97	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Mounting accessories

Rosemount connection head

The Rosemount Connection Head is for general-purpose and spring-loaded sensors. The terminal block has six terminals for either single or dual element sensors. If the sensor assembly is ordered assembled to a Rosemount 248 or 644H Head Mount Transmitter, then the terminal block is replaced by the transmitters.

Specifications

Sensor connection

- 1/2–14 ANPT mounting thread. Screw terminals for lead wire connections.

Electrical connection

- 1/2–14 ANPT conduit

Materials of construction

- Housing: Low copper aluminum or stainless steel
- Paint: Polyurethane (stainless steel not painted)
- Cover O-ring: Buna-N

Enclosure rating

- NEMA 4X, IP66, and IP68

Polypropylene connection head

The polypropylene connection head is designed for use with sanitary sensors. It is FDA-compliant, and is resistant to attack by acids, alkalis, and organic solvents.

Specifications

Sensor connection

- 1/2–14 NPT mounting thread. Screw terminals for lead wire connections

Electrical connection

- 1/2–14 NPT conduit

Materials of construction

- Housing: White polypropylene polymer
- O-Ring Seal: Silicone rubber
- Terminals: Nickel-plated brass

Temperature limits

- –10 to 92 °C (14 to 198 °F)

Connection head

The Extended Cover Connection Head provides the additional space required by sensors that have bayonet connectors. This model can also be used with general-purpose and spring-loaded sensors. The terminal block has six terminals for either single- or dual-element sensors.

The Flat Cover Connection Head is for general-purpose and spring-loaded sensors. The terminal block has six terminals for either single- or dual-element sensors.

Specifications

Sensor connection

- 1/2–14 ANPT mounting thread. Screw terminals for lead wire connections

Electrical connection

- 3/4–14 ANPT conduit

Materials of construction

- Housing: Low-copper aluminum alloy
- O-Ring Seal: Silicone rubber
- Terminals: Nickel-plated brass

Temperature limits

Head type	Unapproved	E5 option	E6 option	E1 option
Painted	–100 to 100 °C –148 to 212 °F	–50 to 85 °C –58 to 185 °F	–50 to 85 °C –58 to 185 °F	–40 to 65 °C –40 to 149 °F
Unpainted	–100 to 200 °C –148 to 392 °F	–50 to 85 °C –58 to 185 °F	–50 to 200 °C –58 to 392 °F	–40 to 65 °C –40 to 149 °F

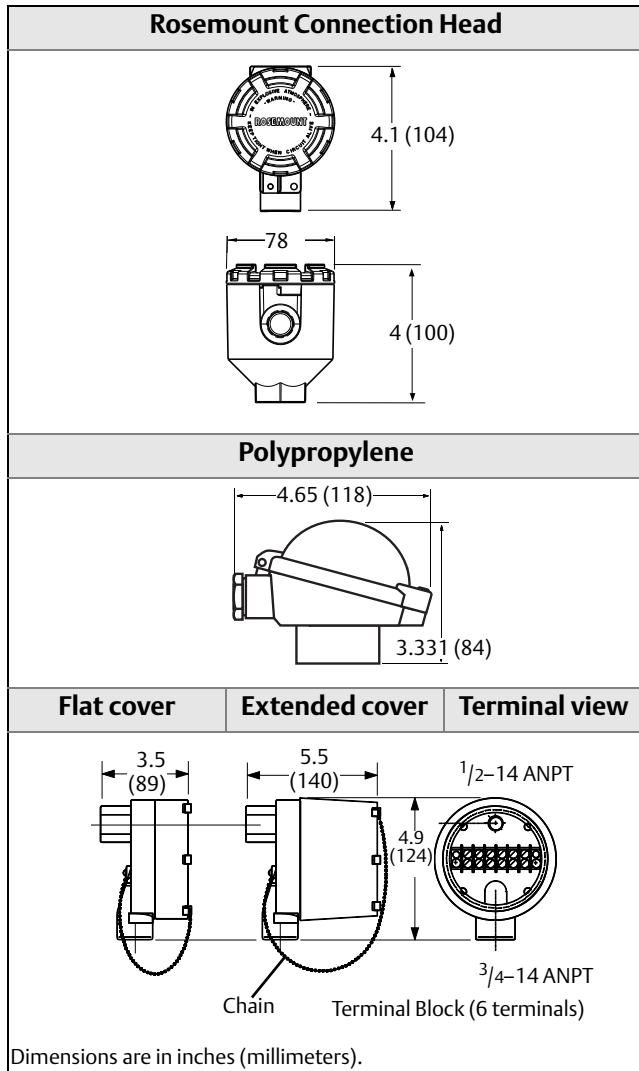
Enclosure ratings

When installed properly, painted connection heads are suitable for indoor and outdoor NEMA 4X installations. When installed properly, unpainted connection heads are suitable for NEMA 4 installations. See [Hazardous area approvals](#) for complete installation information.

Connection head model numbers

Part number	Description
00644-4410-0011	Rosemount Connection Head, painted aluminum
00644-4411-0011	Stainless Steel, Rosemount connection head, Standard cover, 1/2ANPTX1/2ANPT
007903252003	Six Terminals with Flat Cover, Unapproved, Unpainted
007903242003	Six Terminals with Extended Cover, Unapproved, Unpainted
007903250002	Six Terminals with Flat Cover, FM Approved, Unpainted
007903240002	Six Terminals with Extended Cover, FM Approved, Unpainted
007903250003	Six Terminals with Flat Cover, CSA Approved, Unpainted
007903240003	Six Terminals with Extended Cover, CSA Approved, Unpainted
007903252005	Six Terminals with Flat Cover, Unapproved, Painted
007903242005	Six Terminals with Extended Cover, Unapproved, Painted
007903250004	Six Terminals with Flat Cover, FM Approved, Painted
007903240004	Six Terminals with Extended Cover, FM Approved, Painted
007903250005	Six Terminals with Flat Cover, CSA Approved, Painted
007903240005	Six Terminals with Extended Cover, CSA Approved, Painted
00644-4198-0011	No Approval Options, White Polypropylene
00075-0003-3001	Round Terminal Block for Rosemount and Polypropylene heads
00644-4431-0001	External ground Screw Assembly for Rosemount Connection Head
00644-4435-0011	Polypropylene Connection Head with Terminal Block 1/2 in. NPT entries
00079-0329-0001	Kit of 12 Silicone Rubber O-rings for Flat/Extended Heads

Figure 15. Connection Head Dimensional Drawing

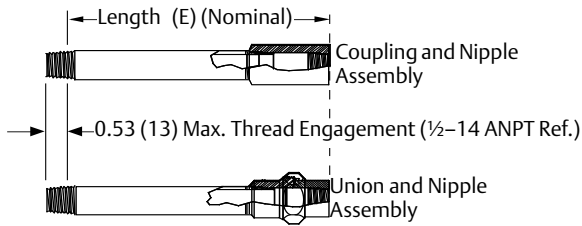


Extension fitting assemblies

Extension fitting assemblies are available in:

- Coupling and nipple assembly
- Union and nipple assembly

Figure 16. Extension Fitting



Dimensions are in inches (millimeters).

Table 31. Extension

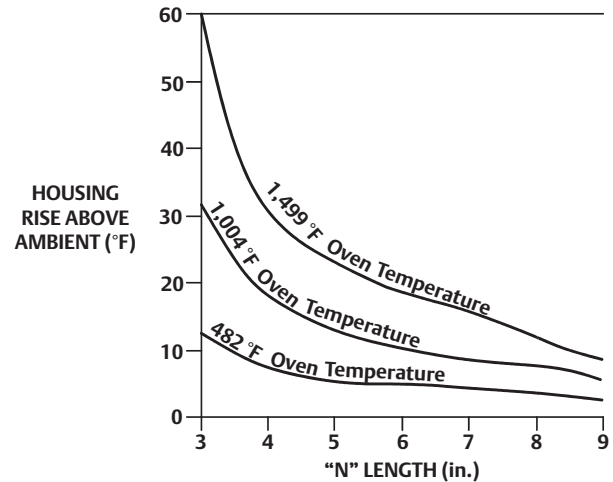
Coupling and nipple, SST		Union and nipple, SST	
Model number	Length (E)	Model number	Length (E)
007903540250	2.5-in.	007903550250	2.5-in.
007903540300	3.0-in. ⁽¹⁾	007903550300	3.0-in. ⁽¹⁾
007903540350	3.5-in.	007903550350	3.5-in.
007903540400	4.0-in.	007903550400	4.0-in.
007903540450	4.5-in.	007903550450	4.5-in.
007903540500	5.0-in.	007903550500	5.0-in.
007903540550	5.5-in.	007903550550	5.5-in.
007903540600	6.0-in. ⁽¹⁾	007903550600	6.0-in. ⁽¹⁾
007903540650	6.5-in.	007903550650	6.5-in.
007903540700	7.0-in.	007903550700	7.0-in.
007903540750	7.5-in.	007903550750	7.5-in.
007903540800	8.0-in.	007903550800	8.0-in.
007903540850	8.5-in.	007903550850	8.5-in.
007903540900	9.0-in.	007903550900	9.0-in.

(1) Standard configuration with best delivery. Also available for emergency requirements. Consult factory for information.

Choosing an extension

Aside from ambient temperature variations, the heat from the process is transferred from the thermowell to the transmitter housing. If the process temperature is near or beyond specification limits, consider the use of additional thermowell lagging, an extension nipple, or a remote mounting configuration to isolate the transmitter from the excessive temperatures. Use Figure 17 and the example below to determine an adequate extension length.

Figure 17. 3144P Transmitter Housing Temperature Rise versus Extension Length for a Test Installation



Example

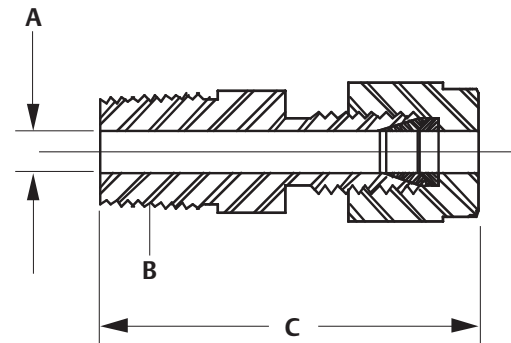
The rated ambient temperature specification is 85 °C. If the maximum ambient temperature is 40 °C and the process temperature to be measured is 540 °C, the maximum allowable housing temperature rise is the rated temperature specification limit minus the existing ambient temperature (85 – 40), or 45 °C.

As shown in Figure 17, an extension (E) dimension of 3.0-in (76 mm) will result in a housing temperature rise of 30 °C. An “E” dimension of 3-in. would therefore be the minimum recommended length, and would provide a safety factor of about 15 °C. A longer “E” dimension, such as 6-in. (152 mm), would be desirable in order to reduce errors caused by transmitter temperature effect, although in that case the transmitter would probably require extra support. If a thermowell with lagging is used, the “E” dimension may be reduced by the length of the lagging.

Mounting adapters for Series 58, 68, 78, and 183

M5–M7, sensor compression fittings, 316 SST

- For adjustable sensor length
- For low pressure applications (100 psig maximum)
- Fits ¼-inch diameter sensors
- Available with 1/8–27 (M5), 1/4–18 (M6), and 1/2–14 (M7) ANPT process threads
- Not available on spring-loaded sensors



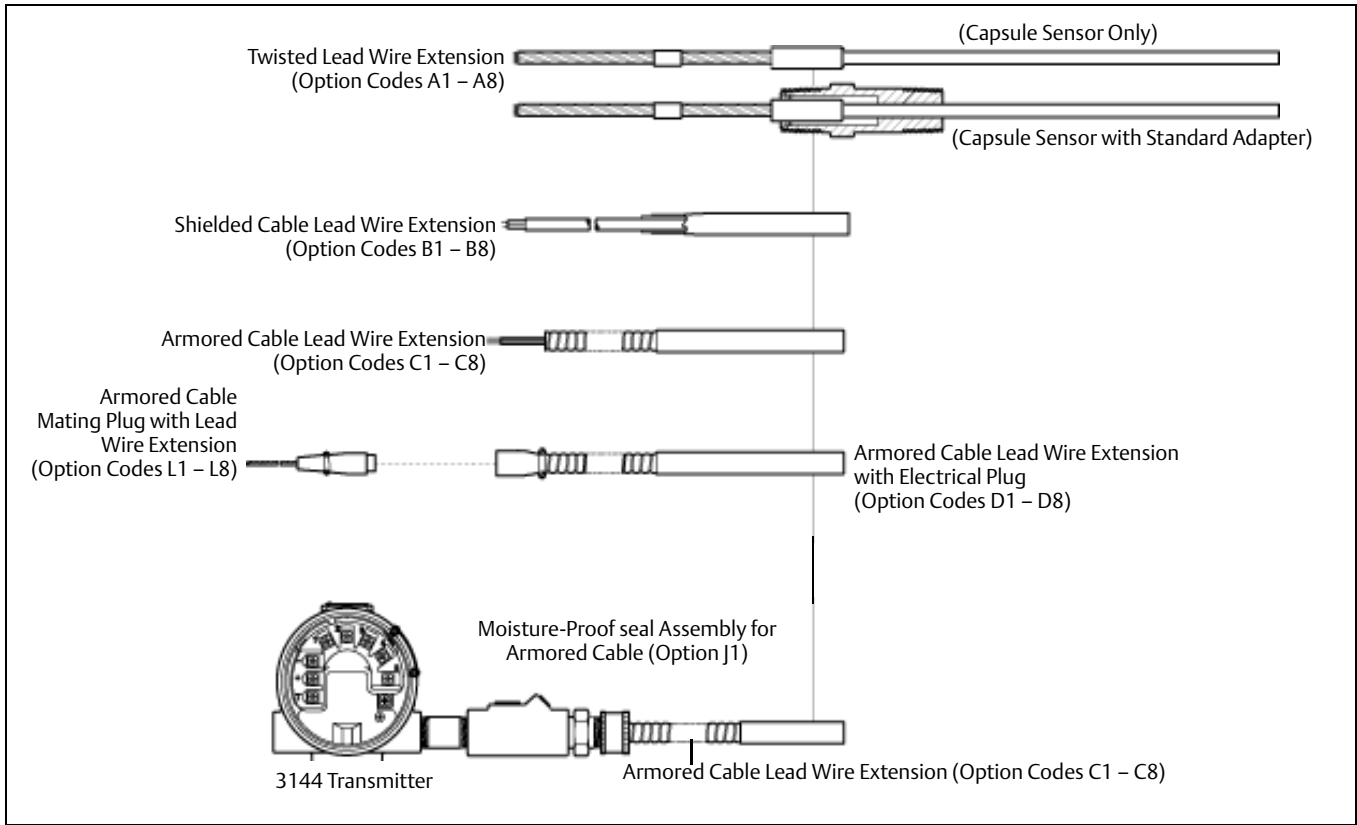
A. Fitting Diameter
B. Sensor Process Thread
C. Length

Table 32. Compression Fittings, 316 SST (for Attachment to the Stem of the Capsule)

Model number	Option code	Sensor process thread	Fitting diameter		Length	
			in.	mm	in.	mm
C07961-0005	M5	1/8–27 ANPT	0.25	6.35	1.31	33.27
C07961-0006	M6	1/4–18 ANPT	0.25	6.35	1.5	38.1
C07961-0008	M7	1/2–14 ANPT	0.25	6.35	1.75	44.45

Lead wire extensions, connectors, and seals

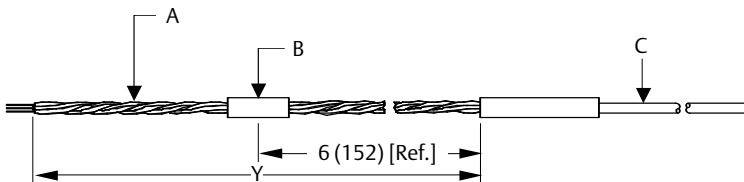
The following options are available on most Series 68 and 78 sensors. They are not available for use on Series 58C, 68Q, and 183 sensors or with IECEx or ATEX Flameproof approval (Option Codes E7 or E1).



A1–A8, twisted lead wire extension

- Lead wire connections are silver brazed and individually insulated by shrinkable PTFE tubes
- Withstands 95 percent relative humidity
- 200 °C (392 °F) maximum temperature
- Available with single or dual-element sensors

Option code	Y length (ft)	Option code	Y length (ft)
A1	1 ¹ / ₂	A5	24
A2	3	A6	50
A3	6	A7	75
A4	12	A8	100



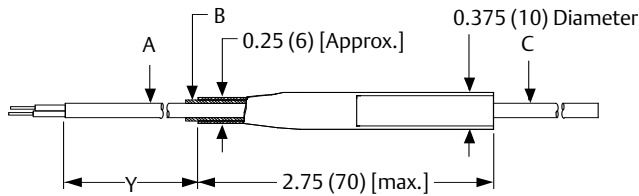
Dimensions are in inches (millimeters).

- A. 22-gauge PTFE Lead Wire
- B. PTFE
- C. Sensor

B1–B8, shielded cable lead wire extension

- Copper shielded cable prevents electrical noise distortions to sensor signal output
- Withstands 95 percent relative humidity
- 200 °C (392 °F) maximum temperature

Option code	Y length (ft)	Option code	Y length (ft)
B1	1 1/2	B5	24
B2	3	B6	50
B3	6	B7	75
B4	12	B8	100



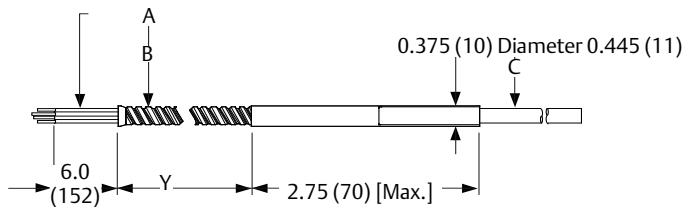
Dimensions are in inches (millimeters).

- A. Shielded Cable PTFE Jacket 22-Gauge PTFE-Insulated Wires
- B. Rubber Seal
- C. Sensor

C1–C8, armored cable lead wire extension

- Provides lead wire protection in heavy duty environments
- Withstands 95 percent relative humidity
- 200 °C (392 °F) maximum temperature
- Available with single or dual-element sensors

Option code	Y length (ft)	Option code	Y length (ft)
C1	1 1/2	C5	24
C2	3	C6	50
C3	6	C7	75
C4	12	C8	100



Dimensions are in inches (millimeters).

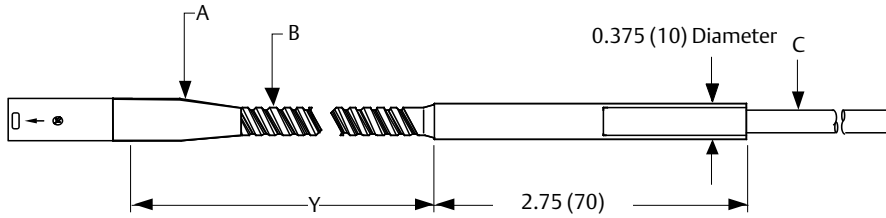
- A. 22-Gauge PTFE-Insulated Wire
- B. Armor Cable 0.34 (8.64) O.D.
- C. Sensor

D1–D8, armored cable lead wire extension with electrical plug

- Provides lead wire protection in heavy-duty environments
- Provides quick-disconnect capability
- Withstands 95 percent relative humidity

Option code	Y length (ft)
D1	1 1/2
D2	3
D3	6
D4	12

Option code	Y length (ft)
D5	24
D6	50
D7	75
D8	100



Dimensions are in inches (millimeters).

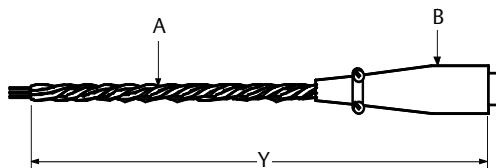
- A. Mates with Option Codes L1–L8
- B. Armor Cable 0.34 (8.64) OD
- C. Sensor

L1–L8, armored cable mating plug with lead wire extension

- Completes quick-disconnect capability for armored cable
- Withstands 95 percent relative humidity
- Twisted lead wire extension for lowest cost installation

Option code	Y length (ft)
L1	1 1/2
L2	3
L3	6
L4	12

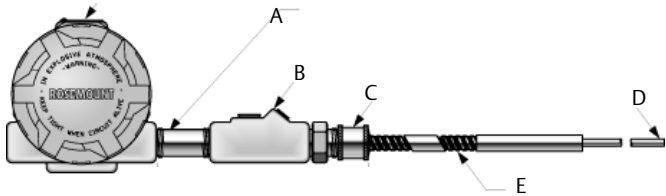
Option code	Y length (ft)
L5	24
L6	50
L7	75
L8	100



- A. 22-Gauge PTFE Lead Wire
- B. Mates with Option Codes D1–D8

J1, moisture-proof seal assembly for armored cable

- Prevents moisture migration through armored cable
- For use in humid environments but not for direct liquid immersion
- Non-disconnectable type assembly with armored cable and sensor



- A. Nipple, 304 SST, 1/2-14 ANPT 1.12 (28.45) Long
B. Nipple, 304 SST, 1/2-14 ANPT 1.12 (28.45) Long
C. Compression Fitting
D. Sensor
E. Armored Cable Lead Wire (Specify Option Codes C1-C8)

Note

Not available with FM or CSA explosion proof (options E5 or E6).

Moisture-proof seal assembly must be ordered with armored cable lead wire extension (option codes C1 - C8).

Thermowells

Materials

Rosemount Thermowells are supplied in most materials required for industrial applications. Standard materials are 316 SST, 304 SST, and C1018 carbon steel. For corrosive environments, special materials such as alloy and Inconel 600 are available. Consult factory for other material availability.

Strength (pressure and flow vibration)

The strength of a thermowell depends on several parameters that relate thermowell construction to the installation environment. For most industrial applications, standard Rosemount thermowells provide the necessary strength if the material, style, and length are correct for the application. The proper selection of a thermowell depends on fluid type, temperature, pressure, and fluid velocity. It is important to note that most thermowell failures are caused by vibration that is induced by fluid flow. If static pressure strength is a major consideration, refer to Table for standard material ratings for a 1/2-inch tip. Tapered thermowells are offered for additional strength.

Strength calculation

Emerson Process Management has the ability to perform thermowell frequency calculations to verify that the thermowell dimensions you provide are appropriate for your specific application. To take advantage of this calculation, fill out and return the Thermowell Calculation Configuration Data Sheet.

Construction

All thermowell bodies with an overall length less than 42-in. are machined from solid bar stock to ensure water-tightness. Flange mounts are welded to the thermowell body. Standard construction provides immersion lengths (U) from 2½ to 48 inches with overall lengths (L) from 4 to 59 inches respectively. Thermowells with overall lengths larger than 36-in. may be a 3-piece welded construction. Consult the factory for more information on welded 3-piece construction thermowells.

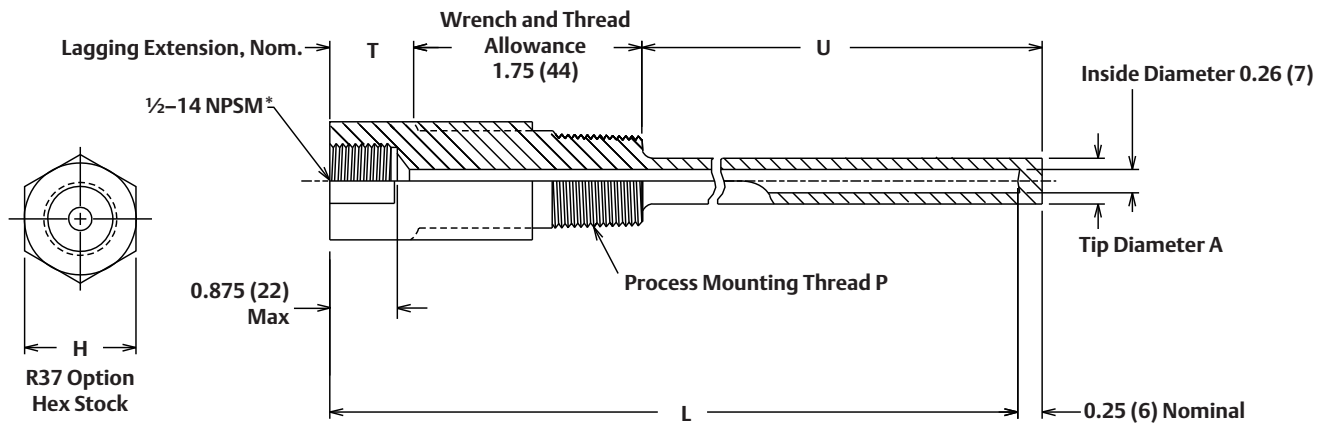
Identification data

The part number is etched on each thermowell. Additional tagging for specific customer requirements is available.

Installation

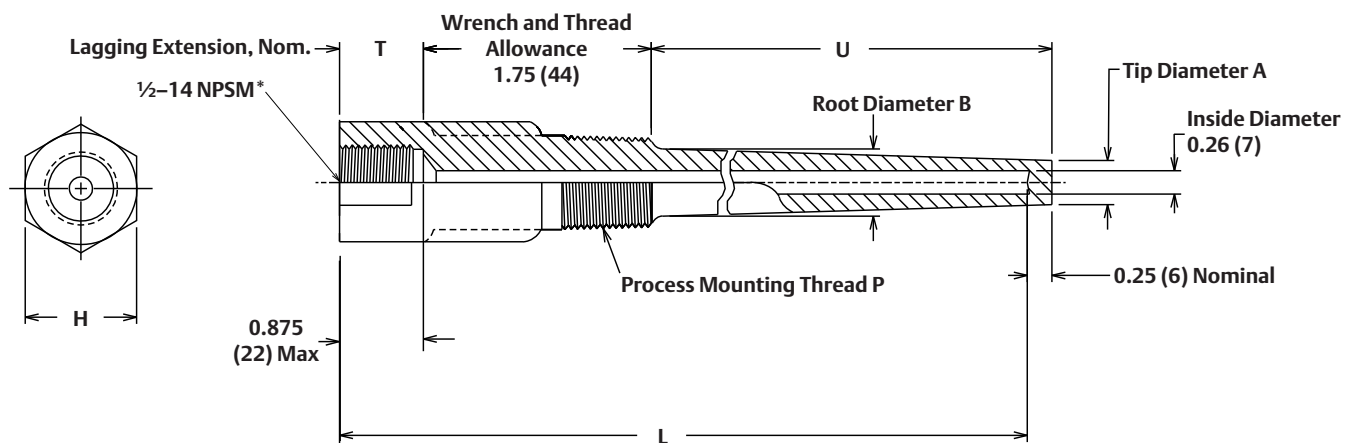
For dimensional drawings of Thread Mounted, Weld Mounted, and Flange Mounted Thermowells, refer to [Figure 19, 22, and 26](#).

Figure 18. Thread Mounted Thermowells - Straight⁽¹⁾



Dimensions are in inches (millimeters).

Figure 19. Thread Mounted Thermowells - Tapered⁽¹⁾

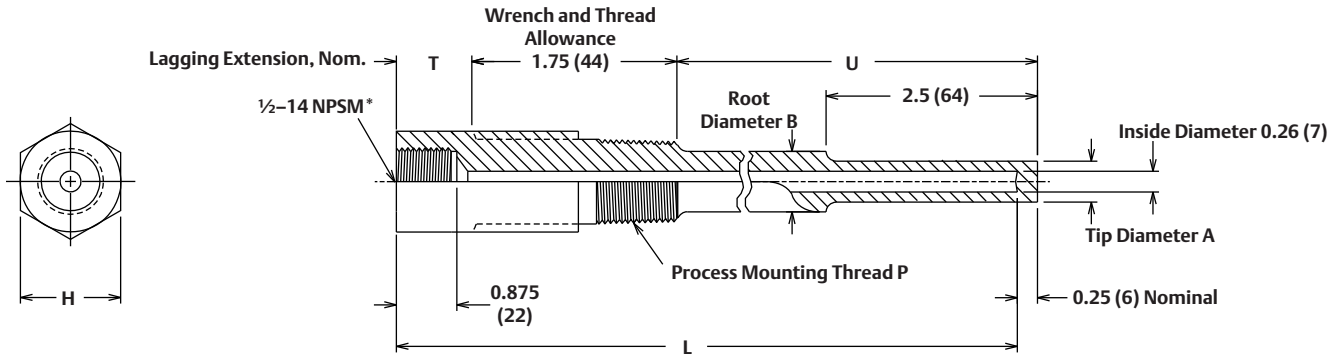


Dimensions are in inches (millimeters).

Thread (P)	Hex size inches (H)
0.5 – 0.75 ANPT	1.125
1–11.5 ANPT	1.375

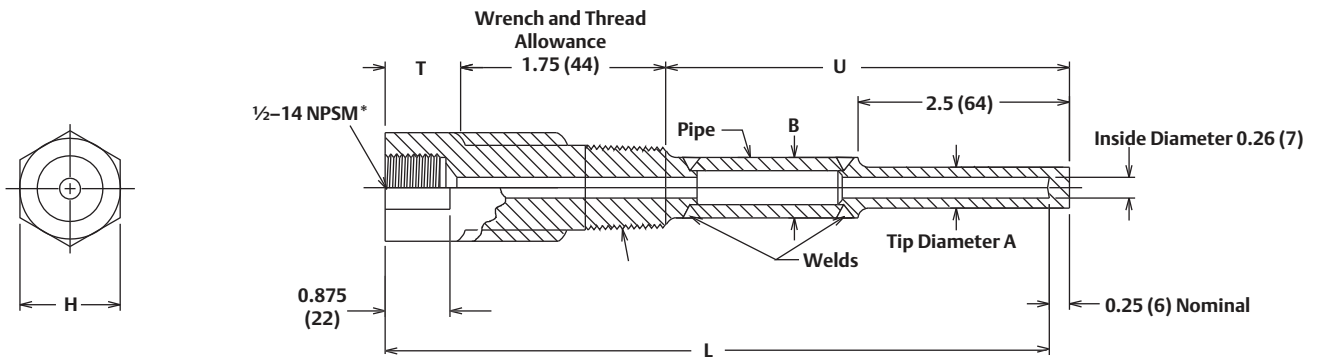
(1) 1/2-14 ANPT threads are available.

Figure 20. Thread Mounted Thermowells - Stepped⁽¹⁾



Dimensions are in inches (millimeters).

Figure 21. Thread Mounted Thermowells - Stepped, For Thermowells with Overall Length greater than 42-in. (3-Piece Construction)⁽¹⁾

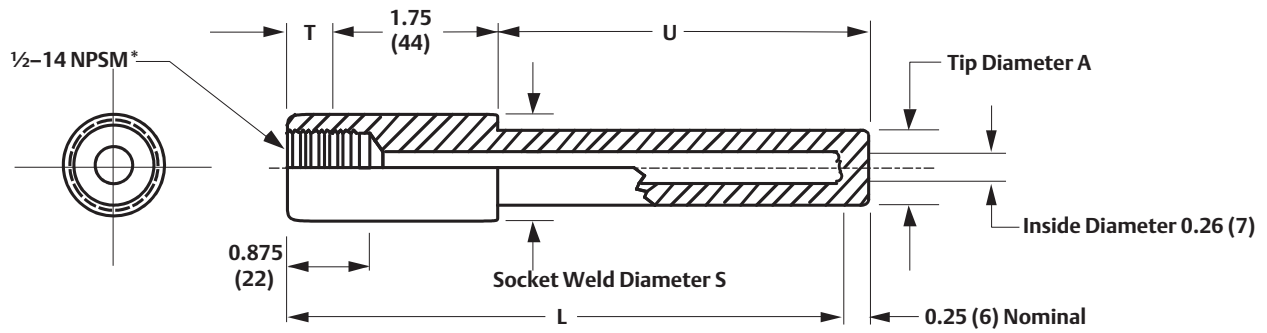


Dimensions are in inches (millimeters).

Thread (P)	Hex size inches (H)
0.5 – 0.75 ANPT	1.125
1–11.5 ANPT	1.375

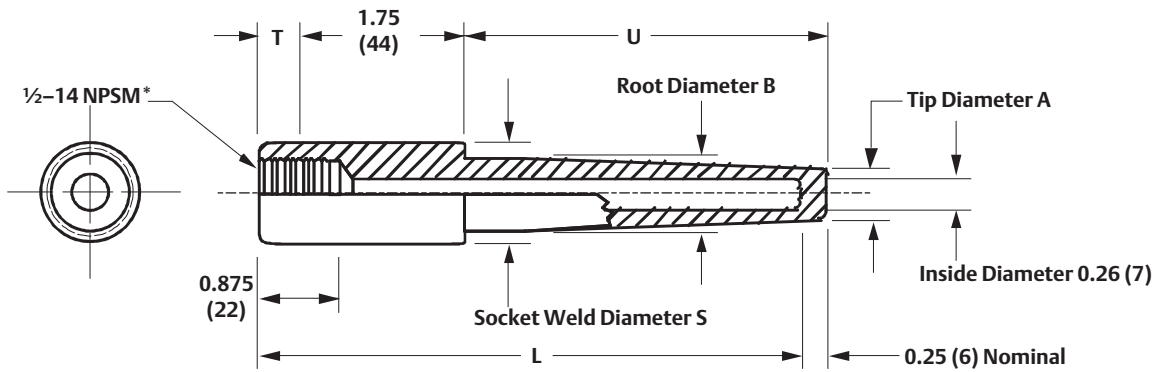
(1) ¹/₂-14 ANPT threads are available.

Figure 22. Weld Mounted Thermowells - Straight⁽¹⁾



Dimensions are in inches (millimeters).

Figure 23. Weld Mounted Thermowells - Tapered⁽¹⁾

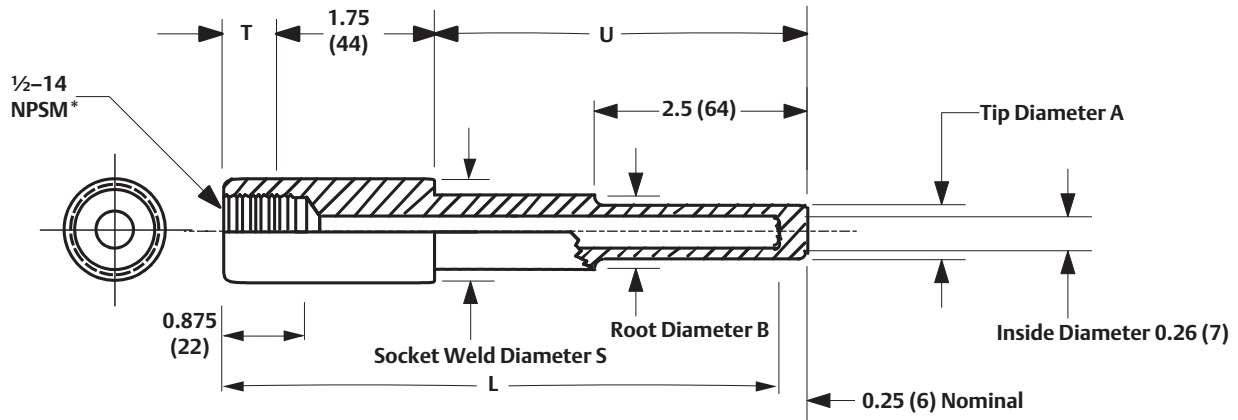


Dimensions are in inches (millimeters).

Pipe size	Socket size (S) diameter
0.75-in.	1.050 ±0.010
1-in.	1.315 ±0.010

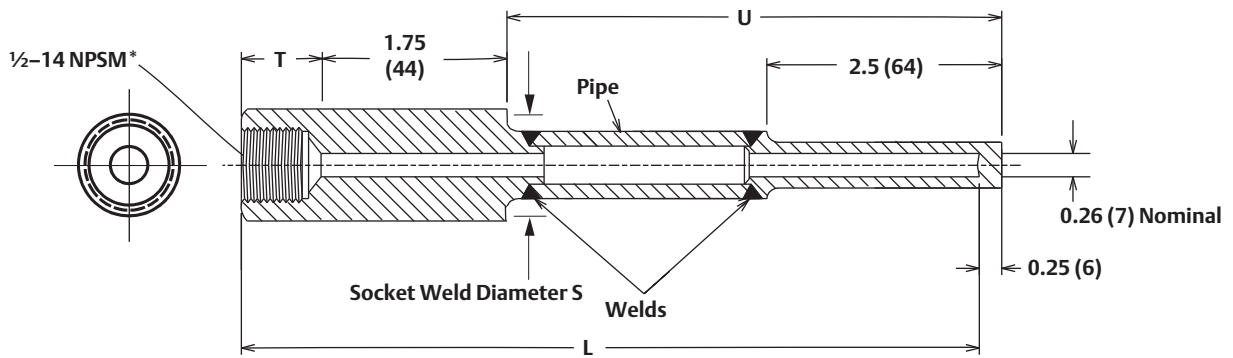
(1) 1/2-14 ANPT threads are available.

Figure 24. Weld Mounted Thermowells-Stepped⁽¹⁾



Dimensions are in inches (millimeters).

Figure 25. Weld Mounted Thermowells-Stepped, For Thermowells with Overall Length greater than 42-in. (3-Piece Construction)⁽¹⁾

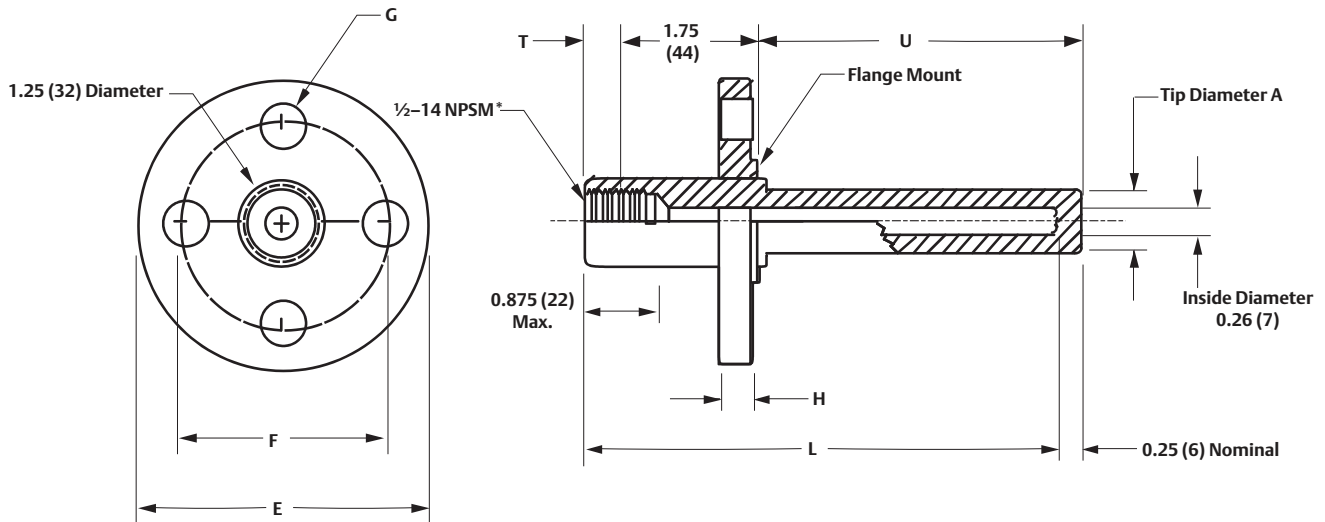


Dimensions are in inches (millimeters).

Pipe size	Socket size (S) diameter
0.75-in.	1.050 ±0.010
1-in.	1.315 ±0.010

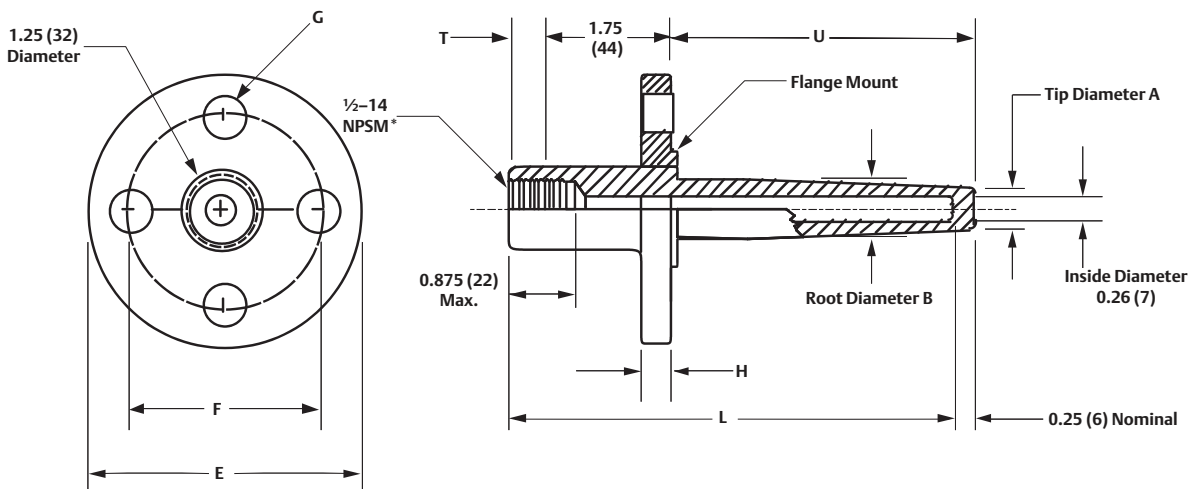
(1) 1/2-14 ANPT threads are available.

Figure 26. Flange Mounted Thermowells - Straight⁽¹⁾



Dimensions are in inches (millimeters).

Figure 27. Flange Mounted Thermowells - Tapered⁽¹⁾



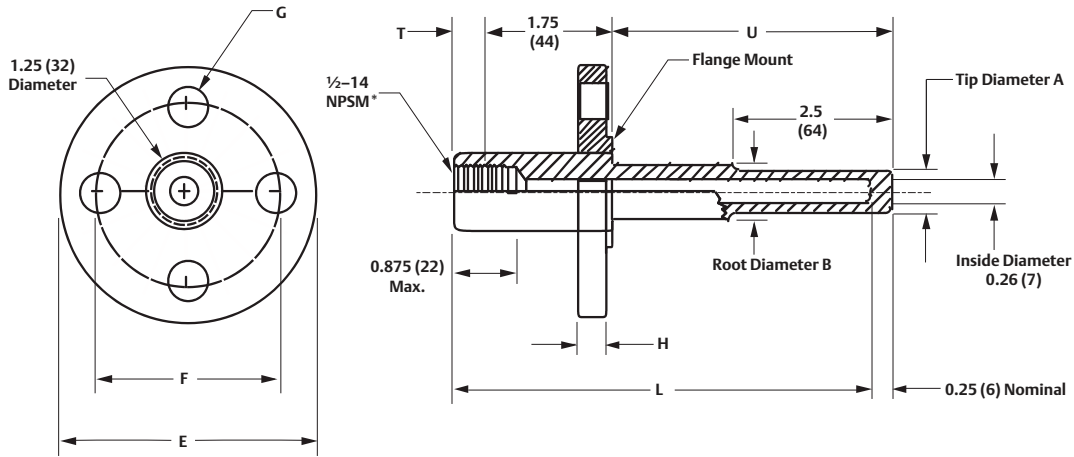
Dimensions are in inches (millimeters).

Size (in.)	O.D. (E)	Circle (F)	# of holes and diameter (G)	Thickness (in.) (H)
Class 150				
1.0	4.25	3.12	four-0.625	0.5625
1.5	5.0	3.88	four-0.625	0.6875
2.0	6.0	4.75	four-0.75	0.75
3.0	7.5	6.00	four-0.75	0.94
Class 300				
1.0	4.88	3.5	four-0.75	0.69
1.5	6.12	4.5	four-0.88	0.81
2.0	6.5	5.0	eight-0.75	0.88

Size (in.)	O.D. (E)	Circle (F)	# of holes and diameter (G)	Thickness (in.) (H)
Class 600				
1.0	4.88	3.5	four-0.75	0.94
1.5	6.12	4.5	four-0.88	1.13
2.0	6.5	5.0	eight-0.75	1.25
Class 900 and 1500				
1.5	7.0	4.88	four-1.12	1.5
Class 2500				
1.5	8.0	5.75	four-1.25	2.0

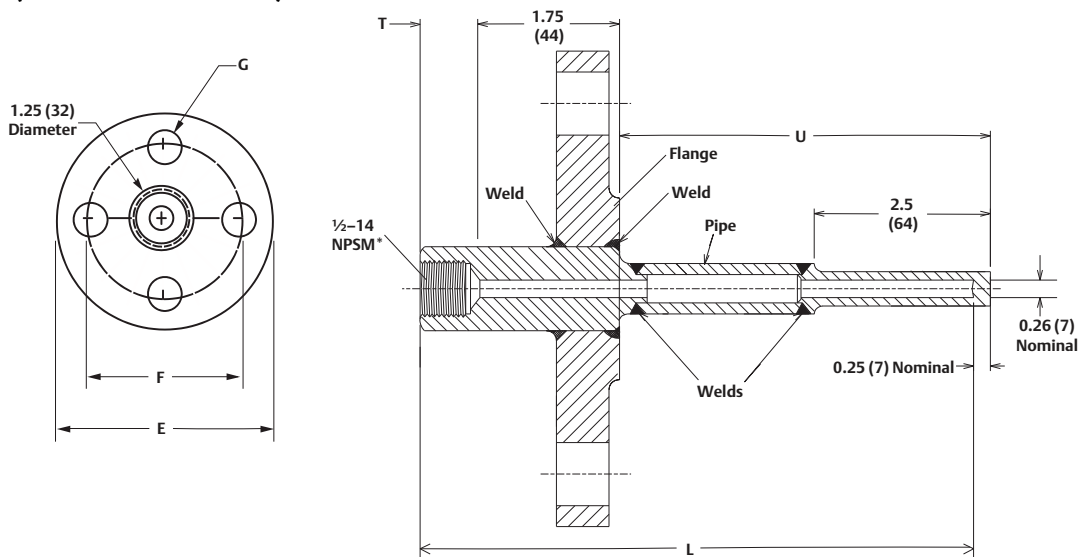
(1) 1/2-14 ANPT threads are available.

Figure 28. Flange Mounted Thermowells-Stepped⁽¹⁾



Dimensions are in inches (millimeters).

Figure 29. Flange Mounted Thermowells - Stepped, For Thermowells with Overall Length greater than 42-in. (3-Piece Construction)⁽¹⁾



Dimensions are in inches (millimeters).

Size (in.)	O.D. (E)	Circle (F)	# of holes and diameter (G)	Thickness (in.) (H)
Class 150				
1.0	4.25	3.12	four-0.625	0.5625
1.5	5.0	3.88	four-0.625	0.6875
2.0	6.0	4.75	four-0.75	0.75
3.0	7.5	6.00	four-0.75	0.94
Class 300				
1.0	4.88	3.5	four-0.75	0.69
1.5	6.12	4.5	four-0.88	0.81
2.0	6.5	5.0	eight-0.75	0.88

Size (in.)	O.D. (E)	Circle (F)	# of holes and diameter (G)	Thickness (in.) (H)
Class 600				
1.0	4.88	3.5	four-0.75	0.94
1.5	6.12	4.5	four-0.88	1.13
2.0	6.5	5.0	eight-0.75	1.25
Class 900 and 1500				
1.5	7.0	4.88	four-1.12	1.5
Class 2500				
1.5	8.0	5.75	four-1.25	2.0

(1) 1/2-14 ANPT threads are available.

Product Certifications

European Directive Information

A copy of the EC Declaration of Conformity can be found at the end of the Quick Start Guide. The most recent revision of the EC Declaration of Conformity can be found at www.rosemount.com.


Ordinary Location Certification from FM Approvals

As standard, the transmitter has been examined and tested to determine that the design meets the basic electrical, mechanical, and fire protection requirements by FM Approvals, a nationally recognized test laboratory (NRTL) as accredited by the Federal Occupational Safety and Health Administration (OSHA).

North America

- E5** FM Explosion proof, Dust-Ignition proof
Certificate: 0R7A2.AE
Standards: FM Class 3600: 2011; FM Class 3611: 2004; FM Class 3615: 2006; FM Class 3810: 2005; ANSI/NEMA - 250: 1991
Markings: **XP** CL I, Div 1, GP B, C, D; **DIP** CL II/III, Div 1, GP E, F, G; T6(-50 °C ≤ T_a ≤ 155 °C); when installed per Rosemount drawing 00068-0013; Type 4X
- E6** CSA Explosion proof and Dust-Ignition proof
Certificate: 1063635
Standards: CSA C22.2 No. 0-M91; CSA C22.2 No. 25-1966; CSA C22.2 No. 30-M1986; CSA C22.2 No. 94-M91; CSA C22.2 No. 142-M1987; CSA C22.2 No. 213-M1987
Markings: **XP** CL I, Div 1, GP B, C, D; **DIP** CL II/III, Div 1, GP E, F, G; **CL I, Div 2**, GP A, B, C, D; (-50 °C ≤ T_a ≤ 85 °C); when installed per Rosemount drawing 00068-0033; Type 4X (Spring loaded sensors must be installed in a thermowell to maintain Type 4X and Cl. II/III rating)

Europe

- E1** ATEX Flameproof
Certificate: FM12ATEX0065X
Standards: EN 60079-0: 2012, EN 60079-1: 2007, EN 60529:1991 +A1:2000
Markings:  II 2 G Ex d IIC T6...T1 Gb, T6(-50 °C ≤ T_a ≤ +40 °C), T5...T1(-50 °C ≤ T_a ≤ +60 °C);

Technical Regulations Customs Union (EAC)

- EM** Contact an Emerson Process Management representative for additional information

Special Conditions for Safe Use (X):

1. See certificate for ambient temperature range.
2. The non-metallic label may store an electrostatic charge and become a source of ignition in Group III environments.
3. Guard the LCD display cover against impact energies greater than 4 joules.
4. Consult the manufacturer if dimensional information on the flameproof joints is necessary.

International

- E7** IECEx Flameproof
Certificate: IECEx FMG 12.0022X
Standards: IEC 60079-0:2011, IEC 60079-1:2007-04, IEC 60079-31:2008
Markings: Ex d IIC T6...T1 Gb, T6(-50 °C ≤ T_a ≤ +40 °C), T5...T1(-50 °C ≤ T_a ≤ +60 °C); Ex tb IIIC T130 °C Db, (-40 °C ≤ T_a ≤ +70 °C); IP66;

Special Conditions for Safe Use (X):

1. See certificate for ambient temperature range.
2. The non-metallic label may store an electrostatic charge and become a source of ignition in Group III environments.
3. Guard the LCD display cover against impact energies greater than 4 joules.
4. Consult the manufacturer if dimensional information on the flameproof joints is necessary.

Brazil

- E2** INMETRO Flameproof
Certificate: NCC 12.1147 X
Standards: ABNT NBR IEC 60079-0: 2008; ABNT NBR IEC 60079-1: 2009
Markings: Ex d IIC T6/T1 Gb IP66W (-40 °C ≤ T_a ≤ 65 °C)

Special Conditions for Safe Use (X):

1. For information on the dimensions of the flameproof joints the manufacturer shall be contacted.
2. Special care must be taken to ensure that the connection head temperature does not exceed 85 °C, when thermocouples or RTDs are assembled with transmitters listed in Table 1 (certificate).
3. The user should evaluate the use conditions of the rod considering its mechanical and chemical characteristics in order to avoid making efforts that deteriorate the rod or process fluids that may cause its corrosion.

Combinations

- KF** Combination of E1 and E6 (not available with Rosemount 0183 sensors)

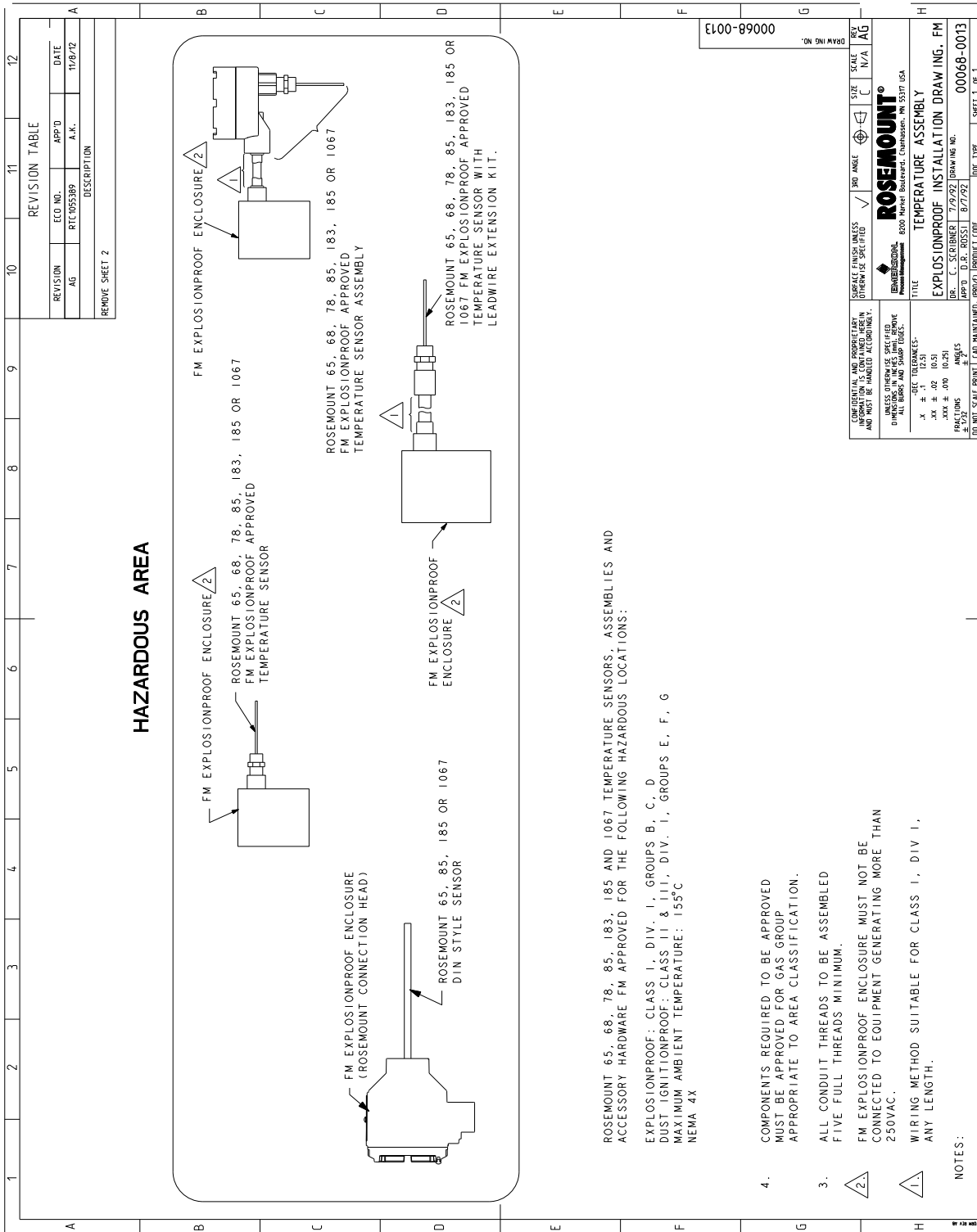
Table 33. Available Safety Approvals with Connection Heads

Refer to this table to determine which approvals are available with each connection head.

Code	Connection head	Approval code				
		E1	E2	E5	E6	E7
R	Aluminum connection head, six terminals, flat cover, unpainted	Y	N	Y	Y	N
T	Aluminum connection head, six terminals, extended cover, unpainted	N	N	Y	Y	N
P	Aluminum connection head, six terminals, flat cover, painted	Y	N	Y	Y	N
L	Aluminum connection head, six terminals, extended cover, painted	N	N	Y	Y	N
N	Sensor only with 6-in. PTFE-insulated, 24 gauge leadwires	Y	Y	Y	Y	Y
D	Rosemount aluminum connection head with 1/2-in. entries	Y	Y	Y	Y	Y
C	Polypropylene connection head	N	N	N	N	N
G	Rosemount SST connection head with 1/2-in. entries	Y	Y	Y	Y	Y

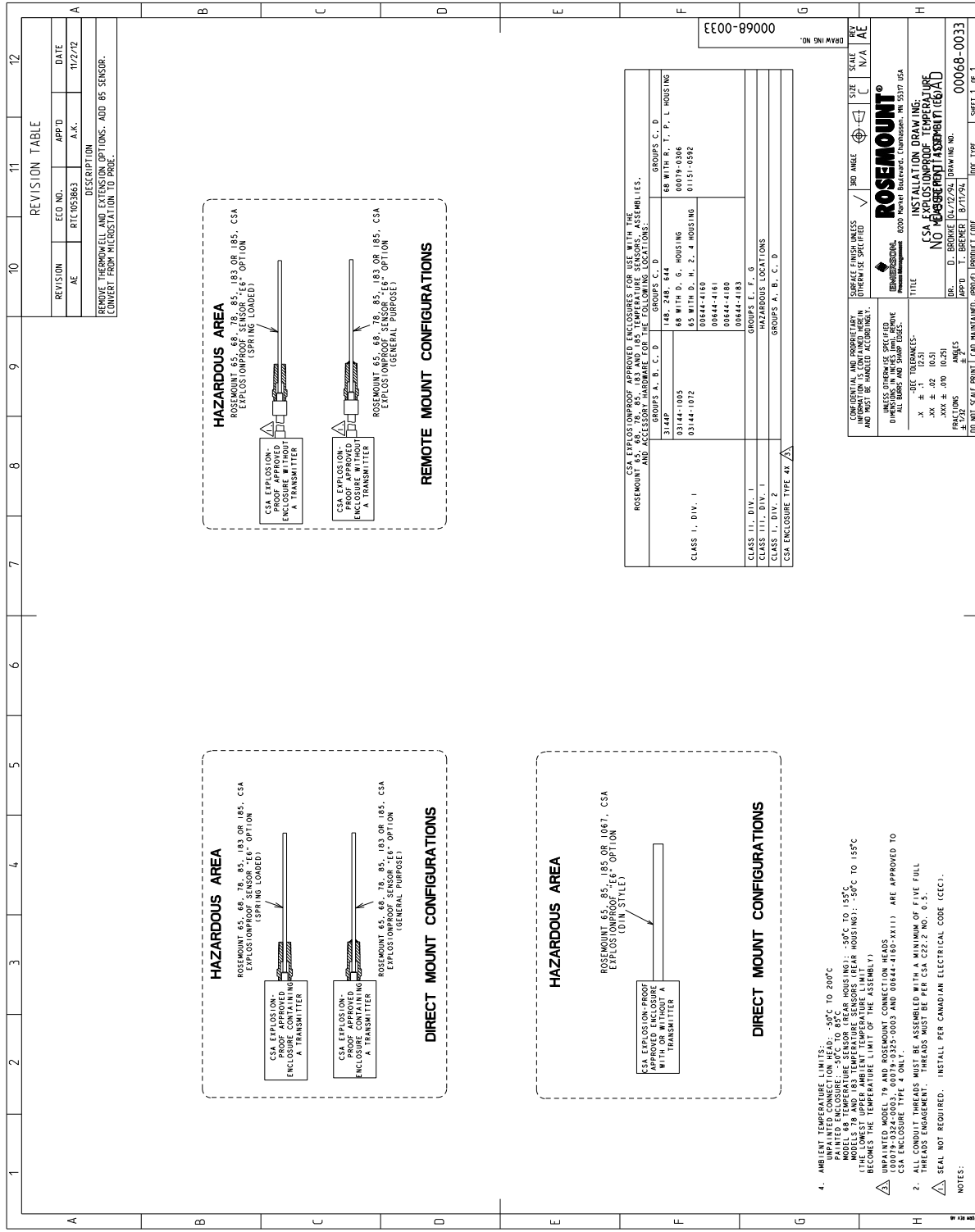
Factory Mutual (FM) Explosion-Proof

Figure 30. Installation Drawing 00068-0013, Rev. AG



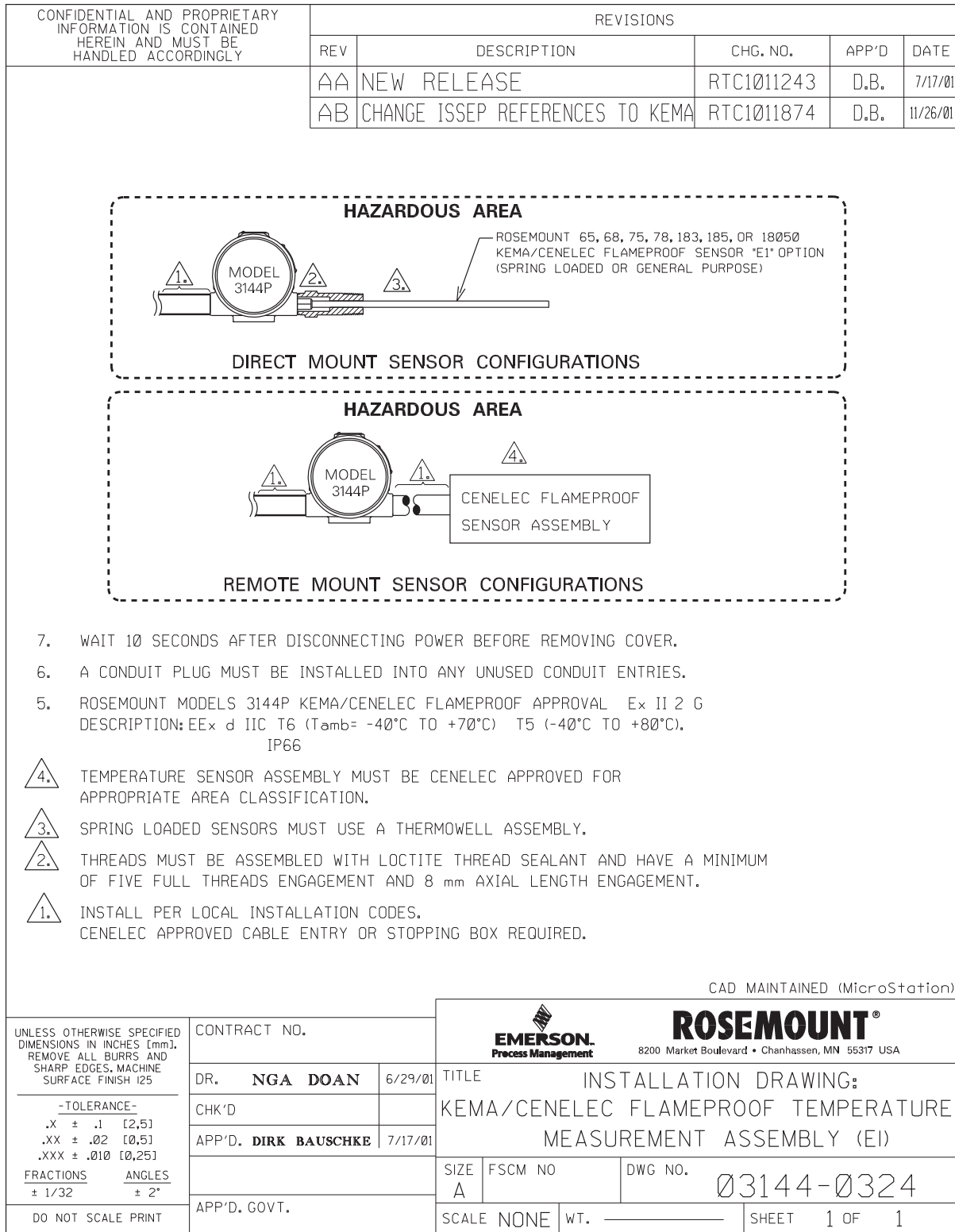
Canadian Standards Association (CSA) Explosion-Proof

Figure 31. Installation Drawing 00068-0033, Rev. AE



ATEX Flameproof

Figure 32. Installation Drawing 03144-0324, Rev. AB



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Hazloc Heaters™

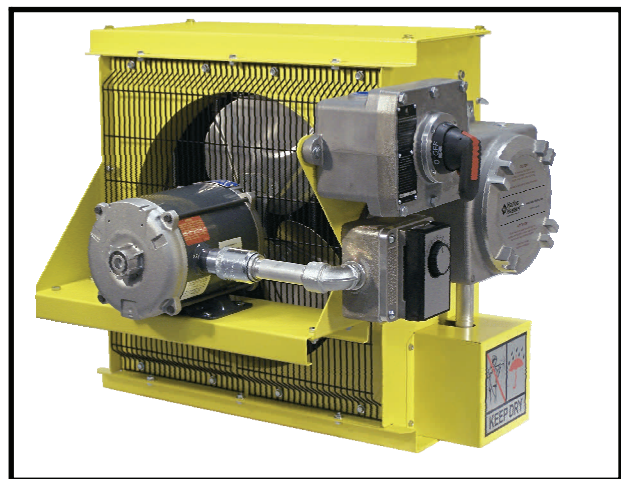
Safe heat when you need it!



XEU1

Electric Forced-Air Explosion-Proof Heater Owner's Manual, Version: XEU1-OM-D

This manual covers installation, maintenance,
repair, and replacement parts.



Forced-Air Heater for Hazardous Locations



Class I, Divisions 1 & 2, Groups C & D
Class II, Divisions 1 & 2, Groups F & G
Temperature Code T3B (35 kW = T3A)

Class I, Zones 1 & 2, Groups IIA & IIB, T3



235730

WARNING!

Please adhere to all instructions published in this manual.
Failure to do so may be dangerous and may void your warranty.

*Note: XEU1 heaters should not be exposed to rain or snow. This applies to installed & stored heaters.
The XEU1 heater should not be modified in any way.*

www.HazlocHeaters.com

XEU1 Specifications By Model Size

Model		XEU1-12			XEU1-16		XEU1-20		
Fan Diameter	in. (mm)	12 (304.8)			16 (406.4)		20 (508.0)		
Nominal kW		5	7.5	10	15	20	25	30	35
Air Delivery	CFM	400	600	800	1200	1700	2100	3000	
	m ³ /hr	680	1019	1359	2039	2888	3568	5097	
Approx. Air Velocity	FPM	479	718	958	808	1145	916	1309	
	m/s	2.4	3.6	4.9	4.1	5.8	4.6	6.6	
Approx. Horizontal Air Throw	ft	15	22	30	33	46	41	61	
	m	4.6	6.7	9.1	10.1	14.0	12.5	18.6	
Motor Power	HP (Watts)	¼ (186)			¼ (186)		½ (373)		
Maximum Mounting Height (to underside of heater)	ft	7	7.5	9.5	10	11	12	15	
	m	2.1	2.3	2.9	3.0	3.4	3.6	4.6	
Approx. Net Weight Lbs (kg)	(without disconnect)	129 (58.5)		133 (60.3)	161 (73.0)		192 (87.1)		
	(with disconnect)	142 (64.4)		146 (66.2)	174 (78.9)		205 (92.9)		
Approx. Shipping Weight Lbs (kg)	(without disconnect)	188 (85.3)		192 (87.1)	224 (101.6)		261 (118.4)		
	(with disconnect)	201 (91.2)		205 (93.0)	237 (107.5)		274 (124.3)		

XEU1 General Specifications

Approvals	Certification	CSA _{CIUS} 235730 - Certified to Canadian and U.S. standards.
	North American Hazardous Location Classifications	Class I, Divisions 1 & 2, Groups C & D Class II, Divisions 1 & 2, Groups F & G Temperature Code T3B (35 kW =T3A)
	Temperature Code	Division System - T3B 165°C (329°F); [35 kW = T3A 180°C (356°F)] Zone System - T3 200°C (392°F)
Cabinet	Cabinet Material	14-gauge (0.075 in.) (1.9 mm) steel. Yellow epoxy/polyester powder coated with five-stage pretreatment, including iron phosphate.
	Fan Guard	Split design with close wire spacing. A 3/8 in. (9.5 mm) diameter probe will not enter. Black polyester powder coated.
	Louver Blades	Anodized extruded aluminum.
	Conduit Materials & Fittings	Plated steel and aluminum alloy for corrosion resistance.
	Fasteners	Zinc plated steel for corrosion resistance.
	Enclosures	Cast aluminum (non-copper alloy) NEMA Type 7 & 9 with O-ring.
	Mounting Holes	9/16" diameter holes – Four located on the top face of heater.
Motor/Fan	Motor Type	Explosion-proof, thermally protected, 1725 RPM permanently lubricated ball bearing type with 56 frame and "easy-off" fan blade replacement feature.
	Fan	Three-blade aluminum, steel spider and hub with 5/8 in. bore
Heat Exchanger	Heating Elements	Long-life, low watt-density, high grade metal-sheathed elements.
	Heat Transfer Fluid	Ethylene glycol and water including corrosion inhibitors.
	Header Material	Carbon steel.
	ExCaliber™ Core	Carbon steel shells and carbon steel tubes with copper-free, roll-formed aluminum fins @ 10 fins per in. Evacuated and sealed. Sprayed with black, high heat enamel paint.
Protection	Temperature High Limits	One automatic reset rated for 100,000 cycles, and one manual reset. Both are snap-action bimetal type, open on temperature rise.
	Pressure Relief	High-quality preset 100 psig (689 kPa) stainless steel pressure relief device.
Controls	Control Circuit	Built in 120 V control. Optional 24V control (recommended) is available.
	Control Contactor	40 FLA (50 A resistive per pole) Definite Purpose. Rated for 500,000 mechanical operations.
	Control Transformer	Multitap primary, 120V or 24V secondary.
	Fuse Protection	Thermal delay fuse with spare, .25" x 1.25", 120V = 1/4 A, 24V = 1 A.
	Room Thermostat (optional)	Built in, TBX1 explosion-proof thermostat, 40°F to 80°F (5°C to 27°C)
Load Isolation	Disconnect Switch (optional)	Built-in, XDC-01 explosion-proof disconnect switch, 600V, 50A max with lock-out feature. Also available in a wall mount version.
Operating Limits	Ambient Temperature	-40°F to 104°F (-40°C to 40°C). Storage: -40°F to 140°F (-40°C to 60°C)
	Maximum Altitude	10,000 ft (3048 m) above sea level.

— **WARNING!** —

Read and follow the instructions in this manual. Failure to do so may result in severe or fatal injury.

IMPORTANT SAFETY INFORMATION

1. Heater is to be connected and serviced only by qualified electrician experienced with hazardous location equipment. It is the responsibility of the installer to verify the safety and suitability of the installation.
2. Installation and wiring of the heater must adhere to all applicable codes. Heater must be effectively grounded to eliminate shock hazard.
3. Heater is to be used only in atmospheres having an ignition temperature higher than the heater's maximum rated operating temperature as shown on the heater data plate. For details of hazardous locations with potential for explosion, refer to the Canadian Electrical Code, Part 1, Section 18 or Articles 500 through 516 of the National Electrical Code.
4. Do not operate heater in ambient temperatures above 40°C (104°F).
5. Do not plug heater outlet with gloves, clothing, etc. or operate heater with louvers fully closed.
6. **Explosion/Electric Shock Hazard.** Disconnect heater from power supply or fuse box before opening enclosures or servicing heater. Lock the switch in the "OFF" (open) position and/or tag the switch to prevent unexpected power application.
7. Operate the heater only while it is permanently mounted in an upright position. Failure to comply will cause overheating of the heat exchanger and shutting down of the unit by tripping the high temperature cutout.
8. **This heater is equipped with two bimetal thermal high-limit cutouts**, one automatic reset type and one manual reset type. The heater is not to be operated with the high-limit cutouts disabled or disconnected from the control circuit.
9. Keep all electrical enclosure covers tightly closed and secured with all bolts and threads. Cover joints must be clean before replacing covers. Keep away from rain or snow. Heater is for dry indoor use only.
10. All unused threaded openings not used for supply wiring or remote mount room thermostat must be fitted with threaded plugs approved for use in hazardous locations.
11. The heat exchanger is a factory vacuum-sealed unit. Do not attempt to loosen or tighten the vacuum plug or pressure relief device. A loss of vacuum could cause nuisance tripping of the thermal cutouts or high pressures which will cause the relief device to actuate with an accompanying loss of fluid.
12. The heat exchanger is filled with a mixture of water and inhibited **ethylene glycol** which **is poisonous**. Contact with the fluid at operating temperatures may produce a burn hazard. Suggested first aid consists of flushing eyes with plenty of water and to wash off skin in flowing water or shower. If any fluid leakage occurs from the heater, disconnect it from the power supply and have the heat exchanger replaced with a factory supplied unit.
13. Heater must be kept clean. When operating in a dirty environment, regularly clean the fin tubes, fan, and fan guard. Refer to recommended maintenance procedures.
14. Do not operate heater in atmospheres which are corrosive to aluminum or steel.
15. See applicable electrical codes for seal requirements in field installed conduits. Factory installed conduits require no further sealing.
16. **Crackling or pinging noises within the heat exchanger during start up may occur. This is normal.**
17. Air discharge at the bottom of the heater may be warmer than at the top. This is normal.
18. Do not attempt to install a Remote Fan Only Switch. **Do not modify the heater in any way.**
19. Use factory approved replacement parts only.
20. Contact factory for any questions or concerns.

— WARNING! —

Read and follow the instructions in this manual. Failure to do so may result in severe or fatal injury.

— INSTALLATION —
Mechanical

Location

Please follow guidelines below for optimum heating results:

1. Do not install heaters such that airflow is blocked or impeded by equipment or walls.
2. For occupant comfort, position heaters so that air discharge is directed across areas of highest heat loss, such as doors, windows, and outside walls.
3. For large areas, arrange heaters such that the air discharge of one heater is directed towards the inlet of the next heater. This sets up a rotational airflow with air circulation in the central area of the building.
4. For equipment freeze protection, direct air discharge at equipment.
5. For large workshops or warehouses it may be acceptable to use fewer, larger heaters.
6. Locate remote mount room thermostat on interior partition walls or posts away from cold drafts, internal heat sources, and away from heater discharge air streams.

Mounting

1. A variety of mounting brackets are available from the factory to aid in installation.
2. The heater is designed to be installed in an upright and level position. All models should not be more than ± 15 degrees or 2.5 in. (63.5 mm) from level when measured front-to-back, and ± 5 degrees 1.7 in. (43.2 mm) on 5 to 10 kW models, 2.0 in. (50.8 mm) on 15 to 20 kW models, and 2.4 in. (60.9 mm) on 25 to 35 kW models from level when measured side-to-side. Failure to comply will cause high limit shut down. Refer to heater data plate for tilt angles.
3. If using mounting hardware or a supporting structure not supplied by the factory, the unit should be suspended through the four 9/16 in. (14 mm) mounting holes on top of the unit with 1/2 in. UNC bolts. Lock washers should be used on all mounting nuts and bolts to ensure they don't vibrate or work loose due to fan vibration or other vibration transmitted to the heater. If in doubt consult factory.
4. It is essential that adequate structural support be provided for installation. **The mounting structure must be strong enough to support the heaters weight**, provide sufficient stiffness to prevent excessive vibration, and withstand all probable abusive situations such as transportable installations where truck off-loading impacts, etc. may occur. Refer to table on Page 3, XEU1 Specifications by Model Size, for heater net weights.

Mounting Heights and Clearances

1. To ensure that warm air reaches the floor observe the recommended maximum mounting heights in table on Page 3, XEU1 Specifications by Model Size. Heaters may be mounted at higher elevations and still provide warm air at floor level however, the maximum mounting elevation at which this occurs depends on location and operational conditions.
2. Louvers may be adjusted to provide greater downward deflection of the discharge air. However, louvers must not be set less than 30 degrees of the closed position.
3. Leave at least 10 in. (254 mm) clearance between the rear of the motor and the nearest obstruction.
4. For easy removal of the core, leave clearance beneath the heater equal to the height of the heater cabinet plus 2 in. (51 mm).

— WARNING! —

Read and follow the instructions in this manual. Failure to do so may result in severe or fatal injury.

**— INSTALLATION —
Electrical**

1. Heater is to be connected and serviced only by qualified electrician experienced with hazardous location equipment. It is the responsibility of the installer to verify the safety and suitability of the installation.
2. **Explosion/Electric Shock Hazard.** Disconnect heater from power supply or fuse box before opening enclosures or servicing heater. Lock the switch in the "OFF" (open) position and/or tag the switch to prevent unexpected power application.
3. Use copper conductors only for supply wires and approved explosion-proof means of wiring during installation. Use minimum 90°C rated wire. Refer to "Supply Wire Requirements" table and heater data plate for conductor wire rating.

XEU1 Supply Wire Requirements

Model	kW	Volts	Ø	Total Current Amps	Minimum Circuit Ampacity	Max Fuse Amps	Supply Wire 90°C (AWG)
XEU1-12-050-208160-	5	208	1	26.5	33.2	35	8
XEU1-12-050-240160-	5	240	1	23.3	29.2	30	10
XEU1-12-050-208360-	5	208	3	14.6	18.2	20	12
XEU1-12-050-240360-	5	240	3	12.7	15.9	20	12
XEU1-12-050-480360-	5	480	3	6.7	8.4	15	14
XEU1-12-050-600360-	5	600	3	5.5	6.9	15	14
XEU1-12-075-208160-	7.5	208	1	38.6	48.2	50	6
XEU1-12-075-240160-	7.5	240	1	33.8	42.2	50	8
XEU1-12-075-208360-	7.5	208	3	21.5	26.9	30	10
XEU1-12-075-240360-	7.5	240	3	18.7	23.4	30	10
XEU1-12-075-480360-	7.5	480	3	9.7	12.2	15	14
XEU1-12-075-600360-	7.5	600	3	7.9	9.9	15	14
XEU1-12-100-240160-	10	240	1	44.2	55.2	60	6
XEU1-12-100-208360-	10	208	3	28.5	35.6	40	8
XEU1-12-100-240360-	10	240	3	24.8	30.9	35	8
XEU1-12-100-480360-	10	480	3	12.7	15.9	20	12
XEU1-12-100-600360-	10	600	3	10.3	12.9	15	14
XEU1-16-150-208360-	15	208	3	42.3	52.9	60	6
XEU1-16-150-240360-	15	240	3	36.8	46.0	50	6
XEU1-16-150-480360-	15	480	3	18.7	23.4	25	10
XEU1-16-150-600360-	15	600	3	15.1	18.9	20	12
XEU1-16-200-480360-	20	480	3	24.8	30.9	35	8
XEU1-16-200-600360-	20	600	3	19.9	24.9	25	10
XEU1-20-250-480360-	25	480	3	31.1	38.8	40	8
XEU1-20-250-600360-	25	600	3	25.1	31.3	35	8
XEU1-20-300-480360-	30	480	3	37.1	46.4	50	6
XEU1-20-300-600360-	30	600	3	29.9	37.3	40	8
XEU1-20-350-480360-	35	480	3	43.1	53.9	60	6
XEU1-20-350-600360-	35	480	3	34.7	43.3	50	6

4. Installation must include appropriate over-current protection devices (fusing or circuit breakers) as required by the CEC or NEC. Refer to "Supply Wire Requirements" table and heater data plate for current ratings. Supply voltage is to be within 10% of the data plate voltage.
5. Confirm that the electrical power supply matches the nameplate voltage, phase, amperage and frequency rating of the heater to be connected.
6. Supply conductors and ground conductor pass through the 1 in. NPT rigid conduit opening on the control enclosure.
7. Proper installation of the heater requires that an adequate grounding conductor be connected to the ground terminal. This terminal is made of copper and is located on the top right-hand corner of the printed circuit board within the control enclosure.
8. Heater may be supplied with a factory installed integral room thermostat (See Figure 1). On heaters not supplied with this option, it is recommended that an **external explosion-proof room thermostat** be used. The wiring to the external thermostat must be copper wire, 16 gauge minimum (for Class II) or 14 gauge minimum (for Class I). Thermostat conductors may also be passed through the 1 in. NPT conduit opening or through the convenient 3/4 in. NPT dedicated external thermostat conduit opening in the enclosure. Connect the external thermostat conductors to the printed circuit board terminal block marked "T'STAT". The built-in control transformer supplies the heater with either 120V or 24V for internal unit operation. This voltage will appear across the thermostat contacts when they are open. The minimum thermostat contact rating should be 1 amp @ 120 VAC. Refer to nameplate for control voltage of unit.
9. Refer to wiring diagram on Page 9 to ensure that all connections are as required and securely fastened.
10. For heaters supplied with a factory installed integral disconnect switch (See Figure 1), field wiring is as follows:
 - a. Remove the Disconnect cover assembly from the base by removing the six (6) cover bolts. Set the cover assembly aside. CAUTION: Damaging the mating surfaces of the enclosure could destroy the flame path and jeopardize the integrity of the flame proof enclosure.
 - b. Supply conductors and ground conductor pass through the 1 in. NPT rigid conduit opening located on the top or bottom of Disconnect Enclosure. Supply conductors to be wired to DIN rail mounted Disconnect Switch inside. Ground conductor to be wired to Ground Lug fastened to inside of Disconnect Enclosure. Refer to wiring diagram on Page 9.
 - c. Attach cover to the enclosure using the six (6) bolts. **Tighten to 150 inch-pounds ± 5 in-lbs.**

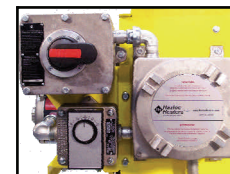


Figure 1

11. **All** unused threaded openings in enclosures, not used for supply wiring or external room thermostat, must be fitted with threaded plugs approved for use in hazardous locations (included). Factory installed conduits require no additional sealing.
12. Installer must seal each conduit run within 18" (457 mm) of enclosure. This seal must be suitable and listed for hazardous locations.
13. Ensure that input conductors and conduit have adequate strain relief at installation.
14. Before application of electrical power, recheck all connections to ensure compliance with the wiring diagram and any code requirements. Remove any foreign objects from the control box and heater. Reinstall cover tightly.
15. **On all three-phase heaters, it is necessary to verify that the fan rotation is correct** (counter clockwise when facing the rear of the heater). If air delivery is not from the front of the heater, reverse any two supply leads at the main power contactor located in the control enclosure.
16. The explosion-proof control enclosure and element enclosures are designed with O-rings, threaded joints and metal-to-metal contact at the lid or cover joint to prevent an explosion. Do not attempt to install gasket material of any type at these joints. A light coating of anti-seize compound may be applied to the threads to prevent seizing.

— WARNING! —

Heater is to be serviced only by qualified electrician experienced with hazardous location equipment.

Explosion/Electric Shock Hazard. Disconnect heater from power supply or fuse box before opening enclosures or servicing heater. Lock the switch in the “OFF” (open) position and/or tag the switch to prevent unexpected power application.

— Repair and Replacement —

Heat Exchanger Replacement

The heat exchanger has been air evacuated, fluid filled, and sealed at factory and is not field repairable. Replacement heat exchangers are available from the factory and are inspected and electrically tested for correct heat output and proper operation of the high-limits.

1. **Explosion/Electric Shock Hazard.** Disconnect heater from power supply or fuse box before opening enclosures or servicing heater. Lock the switch in the “OFF” (open) position and/or tag the switch to prevent unexpected power application.
2. To prevent burn hazard, be sure heat exchanger and fluid has been allowed to cool before proceeding.
3. Remove cabinet bottom panel, element housing cover, element enclosure cover, & control enclosure cover.
4. From the control enclosure, disconnect two high-limit wires from printed circuit board terminal block marked 3 & 4 and disconnect three output heating element wires from contactor terminals marked T1, T2, & T3.
5. Slightly loosen all cabinet bolts and louver screws to prevent heat exchanger from binding.
6. The heat exchanger is secured by three 1/4 in. bolts on the right-side cabinet panel (when facing front of heater) and one 1/4 in. bolt located on the left side of heater. On 5 - 10kW models the left-side bolt is located at the top right-hand foot of control enclosure. On 15 - 35kW models the left-side bolt is located above the control enclosure. With an assistant supporting the weight of the heat exchanger remove these 4 bolts. Carefully lower the heat exchanger from the cabinet.
7. Reverse the above procedure when installing a new heat exchanger.

Temperature High-Limit Replacement

This heat-exchanger includes one automatic reset & one manual reset temperature high-limit that are wired in series. The automatic reset high-limit is rated for 100,000 cycles and is for a temporary failure condition. Continuous nuisance tripping of the automatic reset is generally not the fault of the high-limit but is usually caused by incorrect operating voltage, blocked air inlet or outlet, fan/motor malfunction, high ambient temperatures, excessively dirty heat exchanger or leaking heat exchanger. **Care should be taken to determine the exact reason that the automatic reset high-limit control tripped so the problem can be resolved immediately.** The automatic reset high-limit normally fails in the open position, however, it can also fail closed.

If the automatic reset fails in the open position the heater will not function and the high-limit should be replaced. **The occurrence of the manual reset high-limit control to trip is an abnormal condition and indicates that the automatic reset high-limit has failed in the closed position. If this occurs remove the heater from service immediately and replace the automatic reset high-limit. Determine the exact reason that the automatic reset high-limit control tripped so the problem can be resolved immediately.** If the manual reset high-limit shuts down the heater it will have to be reset by pressing on the small reset button protruding from the center of the high-limit device.

1. De-energize the heater electrical supply circuit.
2. Remove element housing cover, and element enclosure cover.
3. Remove spade connection from the automatic reset high limit lugs.
4. Remove automatic reset high-limit assembly by unscrewing, and clean the inside of the thermowell. A clean thermowell ensures good thermal contact.
5. Replace high-limit with a factory supplied unit only. Apply a small drop of heat sink conductive cement around the base of the high-limit, but not on the threads, and screw into thermowell. Attach spades to automatic reset high-limit .
6. Replace control enclosure cover, element housing cover, and element enclosure cover.
7. Energize the heater electrical supply circuit and let run for 15 minutes to reach a stable operating temperature.
8. If heater operation appears to be normal, place unit into service.

— WARNING! —

Heater is to be serviced only by qualified electrician experienced with hazardous location equipment.

Explosion/Electric Shock Hazard. Disconnect heater from power supply or fuse box before opening enclosures or servicing heater. Lock the switch in the “OFF” (open) position and/or tag the switch to prevent unexpected power application.

— Repair and Replacement, Continued —

Fan, Fan Guard or Motor Replacement

The motor is a sealed unit that requires no lubrication. If the motor is defective, it must be replaced with an original factory supplied motor.

1. Remove four bolts holding motor to the motor mount, and covers from junction box and control enclosure. On units with an integral room thermostat, remove 4 bolts on front face of thermostat enclosure .
2. Detach and remove two-piece fan guard assembly by removing top and bottom screws that attach the fan guard to the cabinet.
3. Loosen fan blade set screw and remove fan blade from end of motor shaft leaving it in fan panel opening.
4. Unscrew the expansion union fitting between motor and motor enclosure (or integral thermostat enclosure).
5. **If replacing motor**, note wire connections for future reference and cut all wires leading to the motor close to the terminations. All motor wires are permanently marked according to the nameplate on the motor. Lift the motor assembly off the motor mount.
6. **If replacing fan blade only** do not cut any wires and move the motor assembly back sufficient to assist fan blade removal.
7. To reassemble, place fan blade inside fan panel opening and then place motor onto motor mount. Slip fan blade onto motor shaft and ensure fan hub is flush with end of motor shaft. Tighten set screw to 150 in-lbs torque.
8. Fasten the two-piece fan guards to the cabinet.
9. Tighten conduit fittings between motor and motor enclosure (or integral thermostat enclosure). Center fan in fan-panel opening and leave approximately 1/16” to 3/16” (1.6 to 4.8 mm) gap between motor face and fan guard.
10. Bolt motor to motor mount, tighten nuts to 250 in-lbs torque. Manually spin the fan blade to ensure it rotates freely before reconnecting heater to power supply. Fan must rotate counterclockwise when viewed from rear of heater.

Torque Settings	
Item	Torque (in-lbs)
Fan blade set screw (1 only)	150
5/16 - 18 UNC motor nuts	250
5/16 - 18 UNC motor mount bolts	250
1/4 - 20 UNC fan panel bolts	100
1/4 - 20 UNC fan guard self tapping screws	100
#10 - 24 UNC louver blade screws	28

Contactors

1. Loosen, but do not remove contactor mounting screws. Slide contactor off mounting screws.
2. Replace with a factory supplied contactor of the same rating.

Transformer

1. Replace with a factory supplied transformer of the same rating.
2. On the new transformer, select primary wires to match heater voltage. Ensure that the correct transformer secondary lead is grounded (see wiring diagram). Individually terminate all unused wires using closed end connections.

Printed Circuit Board

1. Replace with a factory supplied P.C. Board.

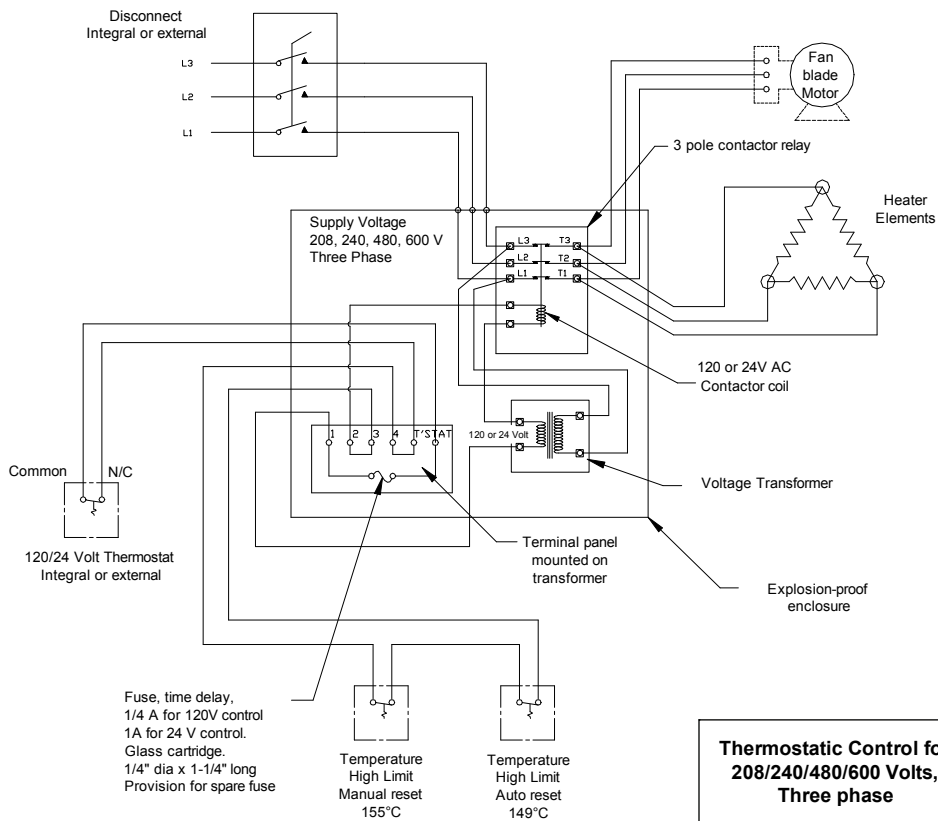
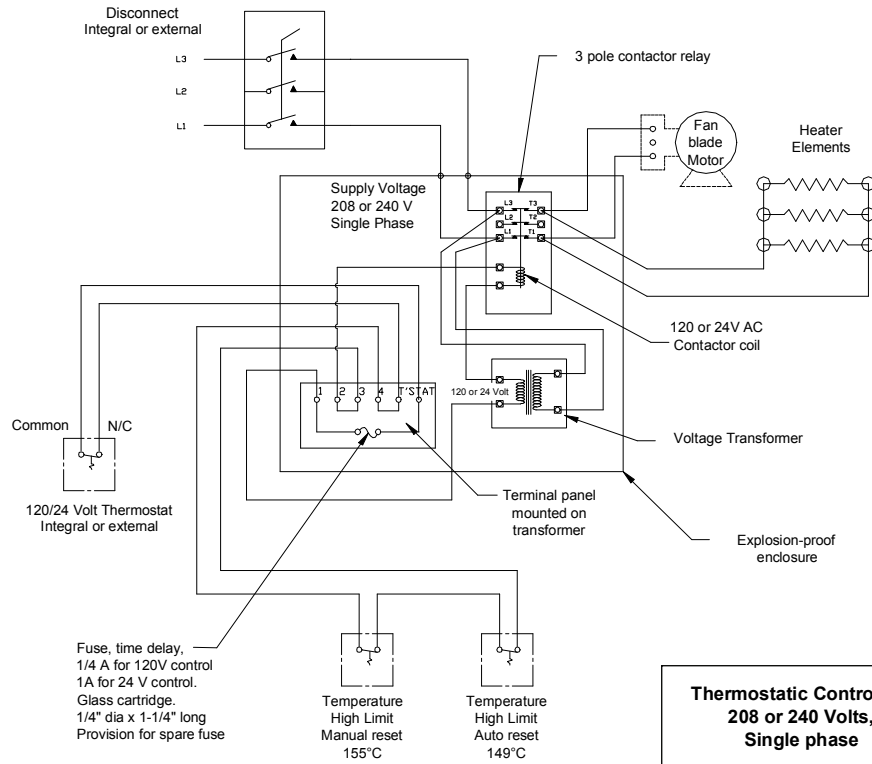
Thermal Delay Fuse

1. Replace fuse with one of the same type and rating as indicated on P.C. Board or refer to parts list. An extra fuse should be stored in the clips marked “SPARE”.

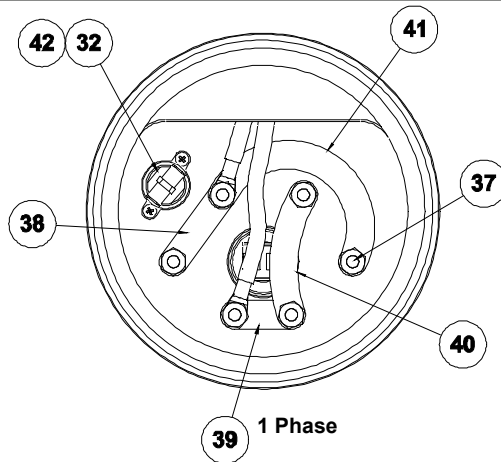
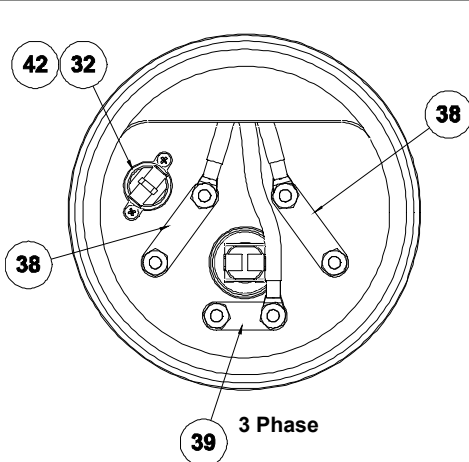
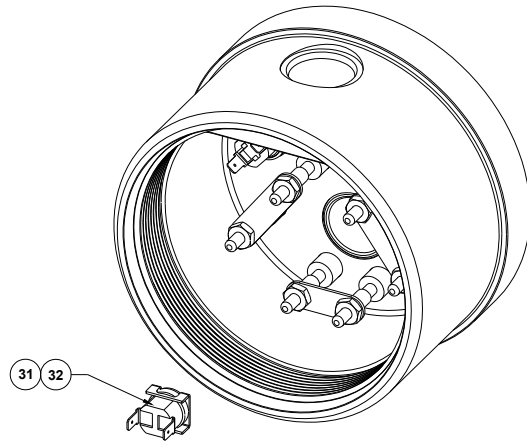
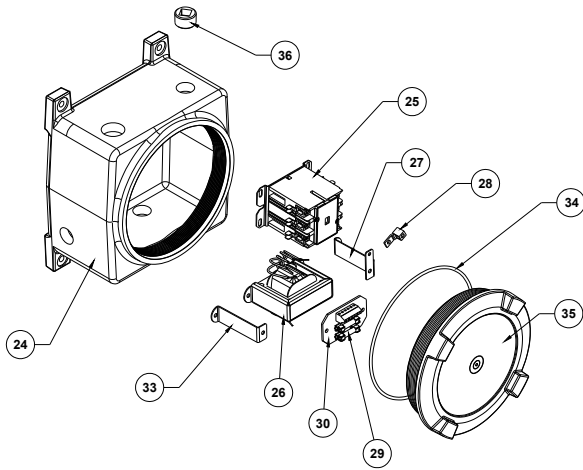
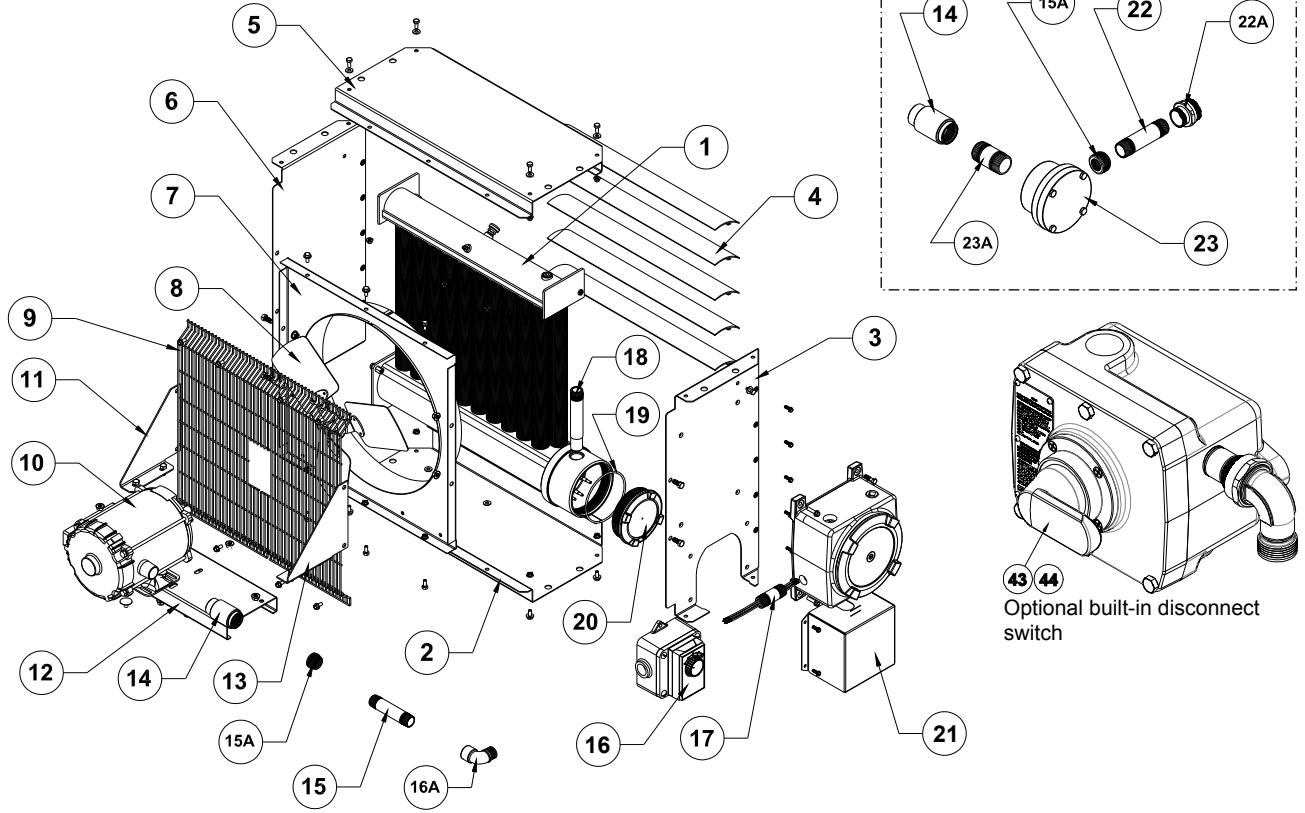
— Warning —

Wiring should only be connected by qualified personnel experienced in electrical work.

— Electrical Wiring —



— Assembly Diagram —



— Parts List —

***** Please have model & serial number available before calling *****

Item No.	Description	12" fan size		16" fan size	20" fan size
		5 & 7.5 kW	10 kW	15 & 20 kW	25, 30 & 35 kW
1	Core assembly (with bus bars)	Specify Voltage, phase, and kilowatts (V-Ph-kW)			
2	Bottom panel	XEU1-12-2		XEU1-16-2	XEU1-20-2
3	Left side panel	XEU1-12-3		XEU1-16-3	XEU1-20-3
4	Louver blades	XEU1-12-4		XEU1-16-4	XEU1-20-4
5	Top panel	XEU1-12-5		XEU1-16-5	XEU1-20-5
6	Right side panel	XEU1-12-6		XEU1-16-6	XEU1-20-6
7	Fan panel	XEU1-12-7		XEU1-16-7	XEU1-20-7
8	Fan blades	5.0 kW = XEU-12-050 7.5 kW = XEU-12-075	10.0 kW = XEU-12-100	15.0 kW = XEU-16-150 20.0 kW = XEU-16-200	25.0 kW = XEU-20-250 30.0 & 35.0 kW = XEU-20-300
9	Fan guard (2 pieces)	XEU1-12-9		XEU1-16-9	XEU1-20-9
10	Motor, explosion-proof	115/208-230V, 1Ø, 60Hz = G639 208-230/460V, 3Ø, 60Hz = G646 575V, 3Ø, 60Hz = G664			208-230/460V, 3Ø, 60Hz = G649 575V, 3Ø, 60Hz = G666
11	Right side motor bracket	XEU1-11			
12	Motor base	XEU1-12-12		XEU1-16-12	XEU1-20-12
13	Left side motor bracket	XEU1-13			
14	Expansion union, female	XEU1-14			
15	Conduit, expansion union to elbow	XEU1-12-15		XEU1-16-15	XEU1-20-15
15A	Reducing bushing	XEU1-15A			
16	Thermostat, ex-proof	TBX1			
16A	Elbow, 90°	XEU1-16A			
17	Conduit, potted	XEU1-12-17 with thermostat XEU1-12-17A without thermostat			XEU1-20-17 with thermostat XEU1-20-17A without thermostat
18	Conduit, vertical	XEU1-12-18		XEU1-16-18	XEU1-20-18
19	O-ring, element enclosure cover	XEU1-19			
20	Cover, element enclosure	XEU1-20			
21	Guard, element enclosure	XEU1-21			
22	Conduit, motor box to enclosure	XEU1-12-22			XEU1-20-22
22A	Union	XEU1-22A			
23	Box, motor outlet	XEU1-23			
23A	Conduit, motor to motor box	XEU1-12-23A		XEU1-16-23A	XEU1-20-23A
24	Enclosure, control	XEU1-24			
25	Contactor	120V = XEU1-25,		24V = XEU1-25A	
26	Transformer	120V = XEU1-26,		24V = XEU1-26A	
27	Bracket, Transformer ground	XEU1-27			
28	Grounding lug	XEU1-28			
29	Fuse	120V = 1/4 Amp (XEU1-29),		24V = 1 Amp (XEU1-29A)	
30	Printed circuit board assembly	120V = XEU1-30,		24V = XEU1-30A	
31	High limit, automatic reset	XEU1-31 (also requires Part # XEU1-32)			
32	Conductive cement, high limit	XEU1-32			
33	Bracket, transformer	XEU1-33			
34	O-ring, control enclosure cover	XEU1-34			
35	Cover, control enclosure	XEU1-35			
36	Plug, 3/4" NPT explosion-proof	XEU1-36			
37	Nut, bus bar	XEU1-37			
38	Bus bar, long straight	XEU1-38			
39	Bus bar, short straight	XEU1-39			
40	Bus bar, short curved	XEU1-40			
41	Bus bar, long curved	XEU1-41			
42	High limit, manual reset	XEU1-42 (also requires Part # XEU1-32)			
43	Handle, Disconnect	XEU1-43			
44	Switch, Disconnect 60A Non-Fused	XEU1-44			

— WARNING! —

Heater should only be service by qualified personnel experienced in electrical work.

Disconnect unit heater from power supply before starting any service or repair work. Lock the disconnect switch in the "OFF" (open) position and/or tag the switch to prevent unexpected power application. Failure to follow these procedures may result in severe or fatal injury.

— Maintenance Program —

Regular inspection, based on a schedule determined by the amount of dirt in the atmosphere, assures maximum operating economy and heating capacity.

Annual Inspection (before each heating season)

1. Check all terminal connections and electrical conductors for damage, looseness, defects, fraying, etc. and replace or tighten where applicable.
2. Inspect contactor contacts. If badly pitted, burned or welded shut, replace with factory supplied contactor. It is recommended that the contactor be replaced every three (3) years.
3. Inspect thermal delay fuses. Fuse rating and type are printed on circuit board. Correct fuse must be in the "ACTIVE" fuse clip. An extra fuse should be stored in the clips marked "SPARE".
4. Check for fluid leakage from heat-exchanger. The heat exchanger is filled with a mixture of water and inhibited **ethylene glycol, which is poisonous**, and is factory vacuum-sealed. If fluid leakage occurs, remove heater from service and have the heat-exchanger replaced by a factory replacement unit. Refer to "Repair and Replacement" section for complete details. Do not attempt to loosen or tighten the vacuum plug or pressure relief device. A loss of vacuum could cause nuisance tripping of the thermal cutouts or high pressures which will cause the relief device to actuate with an accompanying loss of fluid.
5. Check all explosion-proof conduit and fittings. Replace damaged components. All threaded conduit connections must have a minimum 5 turns of engagement. Taper threaded connections must be at least hand tight. Inside of enclosures must be clean, dry, and free from any foreign materials. Enclosure covers must also be completely on and tight.
6. Check electrical resistance on all load side legs. Reading should be balanced ($\pm 5\%$).
7. Check motor shaft bearing play. Replace motor if play is excessive or if motor does not run quietly and smoothly. Motor bearings are permanently lubricated.
8. Check fan blade. Replace immediately if cracked or damaged.
9. Check louvers. Louver screws should be tight. Louvers must not be set less than 30 degrees of the closed position.
10. Check the tightness of all hardware. All nuts and bolts, including mounting hardware, must be tightened to correct torque settings on Page 8.
11. Turn heater motor on for a minimum of 10 minutes. Crackling or pinging noises within heater during start-up are normal. Check for air exiting heater through louvers and smooth running of motor.

Periodic Maintenance (before and as required during heating season)

1. Clean the following (remove dust using compressed air):
 - Finned tubes
 - Fan
 - Fan Guard
 - Motor
 - Louvers
2. Check the following:
 - Motor for smooth and quiet operation
 - Louvers for proper angle and tightness
 - All explosion-proof covers and fittings for tightness
 - Contactor for signs of wear or pitting



NOTES



NOTES



Limited 36-Month Warranty

Hazloc Heaters™ warrants all **XEU1** series of explosion-proof electric heaters against defects in materials and workmanship under normal conditions of use for a period of thirty-six (36) months from date of purchase based on the following terms:

1. The heater must not be modified in any way.
2. The heater must be stored, installed and used only in accordance with the owner's manual and attached data plate information.
3. Replacement parts will be provided free of charge as necessary to restore any unit to normal operating condition, provided that the defective parts be returned to us freight prepaid and that the replacement parts be accepted freight collect.
4. The complete heater may be returned to our manufacturing plant for repair or replacement (at our discretion), freight charges prepaid.
5. Components damaged by contamination from dirt, dust, etc. or corrosion will not be considered as defects.
6. This warranty shall be limited to the actual equipment involved and, under no circumstances, shall include or extend to installation or removal costs, or to consequential damages or losses.



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Instructions

95-8527

Protect•IR® Multispectrum IR Flame Detector
X3301



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AUTOMATIC *oi*

Protect•IR® Multispectrum IR Flame Detector X3301

IMPORTANT

Be sure to read and understand the entire instruction manual before installing or operating the flame detection system. Any deviation from the recommendations in this manual may impair system performance and compromise safety.

ATTENTION

*The X3301 includes the Automatic *oi*® (Optical Integrity) feature — a calibrated performance test that is automatically performed once per minute to verify complete detector operation capabilities. **Testing with an external test lamp is not approved or required.***

DESCRIPTION

The X3301 Protect•IR® is a multispectrum infrared (IR) flame detector. It provides unsurpassed detection of fires from light to heavy hydrocarbon fuels combined with the highest degree of false alarm rejection. The detector has Division and Zone explosion-proof ratings and is suitable for use in indoor and outdoor applications.

The X3301 contains three IR sensors with their associated signal processing circuitry. The standard output configuration includes fire, fault and auxiliary relays. Output options include:

- 0 to 20 mA output (in addition to the three relays)
- Pulse output for compatibility with existing Detector Electronics Corporation (Det-Tronics®) controller based systems (with fire and fault relays)
- Eagle Quantum Premier® (EQP) compatible model (no analog or relay outputs)
- HART communication



A tri-color LED on the detector faceplate indicates normal condition and notifies personnel of fire alarm or fault conditions.

Microprocessor controlled heated optics increase resistance to moisture and ice.

The X3301 housing is available in copper-free aluminum or stainless steel, with NEMA/Type 4X and IP66/IP67 rating.

OUTPUTS

Relays

The standard detector is furnished with fire, fault and auxiliary relays. All three relays are rated 5 amperes at 30 Vdc.

The Fire Alarm relay has redundant terminals and normally open / normally closed contacts, normally de-energized operation, and latching or non-latching operation.

The Fault relay has redundant terminals and normally open contacts, normally energized operation, and latching or non-latching operation.

The Auxiliary relay has normally open / normally closed contacts, and is configurable for energized or de-energized operation, and latching or non-latching operation.

0 to 20 mA Output

A 0 to 20 mA output is available as an option (in addition to the three relays). This option provides a 0 to 20 mA dc current output for transmitting detector status information to other devices. The circuit can be wired in either an isolated or non-isolated configuration and can drive a maximum loop resistance of 500 ohms from 18 to 19.9 Vdc and 600 ohms from 20 to 30 Vdc. Table 1 indicates the detector status conditions represented by the various current levels. The output is calibrated at the factory, with no need for field calibration. A model with relays and 0-20 mA with HART is also available. Refer to Addendum number 95-8577 for complete details.

NOTE

The output of the 0 to 20 mA current loop is not monitored by the fault detection circuitry of the X3301. Therefore, an open circuit on the loop will not cause the fault relay to change state or the detector status LED to indicate a fault. The status of the LED always follows the status of the relays.

An alarm condition will normally over-ride a fault condition, unless the nature of the fault condition impairs the ability of the detector to generate or maintain an alarm output, i.e. loss of operating power.

Table 1—Detector Status Conditions Indicated by Current Level

Current Level (± 0.3 mA)	Detector Status
0 mA	Power Fault
1 mA	General Fault
2 mA	oi Fault
3 mA	Hi Background IR Fault
4 mA	Normal Operation
20 mA	Fire Alarm

LON/SLC Output

The EQP model is designed for use exclusively with Det-Tronics' Eagle Quantum Premier system. The detector communicates with the system controller over a digital communication network or LON/SLC (Local Operating Network / Signaling Line Circuit). The LON/SLC is a fault tolerant, two wire digital communication network arranged in a loop configuration. Analog and relay outputs are not available on this model.

LED

A tri-color LED on the detector faceplate indicates normal condition and notifies personnel of fire alarm or fault conditions. Table 2 indicates the condition of the LED for each status.

Table 2—Detector Status Indicator

Detector Status	LED Indicator
Power On/Normal Operation (no fault or fire alarm)	Green
Fault	Yellow
Fire (Alarm)	Red
Low Sensitivity	One Yellow Flash During Power-up
T-Low Sensitivity	Three Yellow Flashes During Power-up
Medium Sensitivity	Two Yellow Flashes During Power-up
Very High Sensitivity	Four Yellow Flashes During Power-up

NOTE: See "Detector Sensitivity Levels" for additional information.

oi (OPTICAL INTEGRITY)

Automatic oi

The X3301 includes the Automatic **oi** feature — a calibrated performance test that is automatically performed once per minute to verify complete detector operation capabilities. No testing with an external test lamp is required. The detector automatically performs the same test that a maintenance person with a test lamp would perform — once every minute, 60 times per hour. However, a successful Automatic **oi** test does not produce an alarm condition.

The Protect•IR signals a fault condition when less than half of the detection range remains. This is indicated by the Fault output and is evident by the yellow color of the LED on the face of the detector. The **oi** fault condition is self-clearing if the optical contamination is temporary. If the contamination is not automatically cleared and the **oi** fault remains, the detector may require cleaning or service. See the "Troubleshooting" section for further information.

Magnetic oi / Manual oi

The detector also incorporates both Magnetic **oi** (Mag **oi**) and Manual **oi** (Man **oi**) features that provide the same calibrated test as the Automatic **oi**, and in addition actuates the Alarm output to verify operation for preventive maintenance requirements. These features can be performed at any time and eliminate the need for testing with a non-calibrated external test lamp.

 **CAUTION**

These tests require disabling of all extinguishing devices to avoid release resulting from a successful test.

The Mag **oi** test is performed by placing a magnet at the location marked "MAG OI" on the outside of the detector (see Figure 2). The Man **oi** test is accomplished by connecting the **oi** lead (terminal 22) to power supply minus via an external switch. The magnet or switch must be held in place for a minimum of 6 seconds to complete the test. Either of these test methods activates the calibrated IR emitters. If the resulting signal meets the test criteria, indicating that greater than half of the detection range remains, the Alarm output changes state, the indicating LED changes to red, and the 0-20 mA current output goes to 20 mA. This condition remains until the magnet is removed or the switch is released, regardless of whether the relays are set for latching or non-latching operation.

If less than half of the detection range remains, no alarm is produced and a fault is generated. The fault indication can be reset by momentarily applying the Mag **oi** or Man **oi** switch.

NOTE

*Refer to Appendix A for FM verification of Det-Tronics' **oi** function.*

COMMUNICATION

The X3301 is furnished with an RS-485 interface for communicating status and other information with external devices. The RS-485 supports MODBUS protocol, with the detector configured as a slave device.

For HART communication, connect a HART communicator across a 250 ohm resistor in the 0-20 mA loop.

NOTE

The EQP model uses LON/SLC communication. RS-485 and HART communication are not available on the EQP model.

DATA LOGGING

Data logging capability is also provided. Status conditions such as normal, power down, general and **oi** faults, pre-alarm, fire alarm, time and temperature are recorded. Each event is time and date stamped, along with the temperature and input voltage. Event data is stored in non-volatile memory when the event becomes active, and again when the status changes. Data is accessible using Det-Tronics' Inspector Connector accessory, RS-485, or the EQP Controller.

INTEGRAL WIRING COMPARTMENT

All external wiring to the device is connected within the integral junction box. The detector is furnished with four conduit entries, with either 3/4 inch NPT or M25 threads.

DETECTOR SENSITIVITY LEVELS

There are four factory configured sensitivity levels available for the X3301 Flame Detector:

Very High, Medium, Low, and T-Low.

The following criteria should be considered when choosing a sensitivity level for the intended application:

- Detector placement
- Speed of response based on fuel type and fire size (see Appendix A for response times)
- Distance between the hazard and the flame detector

Recommended sensitivity guidelines are as follows:

Very High: Offshore, Warehousing

Medium: General Duty, Compressors

Low: Offshore, close proximity/high IR backgrounds

T-Low: Turbine Enclosures

Additional information on X3301 Flame Detector performance results and sensitivities can be found in Appendix A, the FM Approval and Performance Report.

Consult the factory with any questions on how to choose the optimum sensitivity level for the intended application.

GENERAL APPLICATION INFORMATION

RESPONSE CHARACTERISTICS

Response is dependent on the detector's sensitivity setting, distance, type of fuel, temperature of the fuel, and time required for the fire to come to equilibrium. As with all fire tests, results must be interpreted according to an individual application.

See Appendix A for third-party approved fire test results. Additional fire test results are available from Det-Tronics.

IMPORTANT APPLICATION CONSIDERATIONS

In applying any type of sensing device as a fire detector, it is important to know of any conditions that can prevent the device from responding to fire, and also to know what other sources besides fire can cause the device to respond.

Welding

Arc welding should not be performed within 40 feet (12.2 m) of the detector configured to very high sensitivity, within 10 feet (3.0 m) at medium sensitivity, within 5 feet (1.5 m) at T-Low sensitivity, or within 5 feet (1.5 m) at Low sensitivity. It is recommended that the system be bypassed during welding operations in situations where the possibility of a false alarm cannot be tolerated. Gas welding mandates system bypass, since the gas torch is an actual fire. Arc welding rods can contain organic binder materials in the flux that burn during the welding operation and are detectable by the X3301. Welding rods with clay binders do not burn and will not be detected by the X3301. However, system bypass is always recommended, since the material being welded may be contaminated with organic substances (paint, oil, etc.) that will burn and possibly cause the X3301 to alarm.

Artificial Lighting

The X3301 should not be located within 3 feet (0.9 m) of artificial lights. Excess heating of the detector could occur due to heat radiating from the lights.

EMI/RFI Interference

The X3301 is resistant to interference by EMI and RFI, and is EMC Directive compliant. It will not respond to a 5 watt walkie-talkie at distances greater than 1 foot (0.3 m). Do not operate a walkie-talkie within 1 foot (0.3 m) of the X3301.

Non-Carbon Fires

The X3301 is a multiple spectrum IR device with detection limited to carbonaceous fuels. It should not be used to detect fires from fuels that do not contain carbon, such as hydrogen, sulfur, and burning metals.

IMPORTANT SAFETY NOTES

WARNING

Do not open the detector assembly in a hazardous area when power is applied. The detector contains limited serviceable components and should never be opened. Doing so could disturb critical optical alignment and calibration parameters, possibly causing serious damage.

CAUTION

The wiring procedures in this manual are intended to ensure proper functioning of the device under normal conditions. However, because of the many variations in wiring codes and regulations, total compliance to these ordinances cannot be guaranteed. Be certain that all wiring complies with the NEC as well as all local ordinances. If in doubt, consult the authority having jurisdiction before wiring the system. Installation must be done by a properly trained person.

CAUTION

To prevent unwanted actuation or alarm, extinguishing devices must be disabled prior to performing system tests or maintenance.

CAUTION

The multispectrum IR flame detectors are to be installed in places where the risk of mechanical damage is low.

ATTENTION

Remove the protective cap from the front of the detector before activating the system.

ATTENTION

Observe precautions for handling electrostatic sensitive devices.

INSTALLATION

NOTE

The recommended lubricant for threads and O-rings is a silicone free grease (p/n 005003-001) available from Det-Tronics. Under no circumstances should a lubricant containing silicone be used.

DETECTOR POSITIONING

Detectors should be positioned to provide the best unobstructed view of the area to be protected. The following factors should also be taken into consideration:

- Identify all high risk fire ignition sources.
- Be sure that enough detectors are used to adequately cover the hazardous area.
- Be sure that the unit is easily accessible for cleaning and other periodic servicing.
- Verify that all detectors in the system are properly located and positioned so that any fire hazards are within both the Field of View (FOV) and detection range of the detector. Det-Tronics' Q1201C Laser Aimer is recommended for establishing the detector's FOV. Refer to Appendix A for specific information regarding detector range and FOV.
- The detector should be aimed downward at least 10 to 20 degrees to allow lens openings to drain. See Figure 1. **The detector should be positioned so that its FOV does not cover areas outside the hazardous area.** This will minimize the possibility of false alarms caused by activities outside the area requiring protection.
- The detector must be mounted on a rigid surface in a low vibration area.

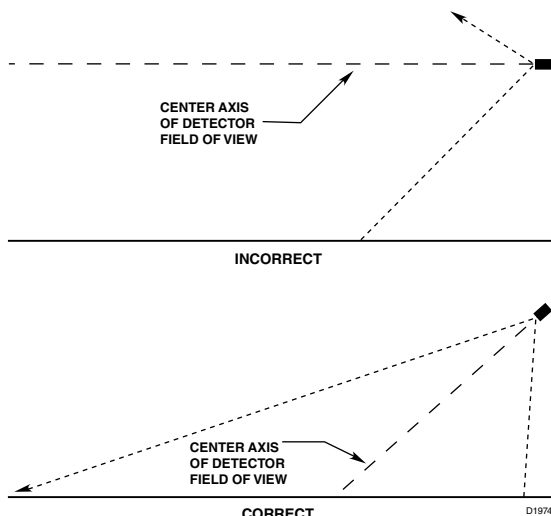


Figure 1—Detector Orientation Relative to Horizon

- Dense fog, rain or ice can absorb IR radiation and reduce the sensitivity of the detector. To ensure optimum performance, be certain that the internal optical heater is enabled on detectors that are used in applications where snow, ice, and/condensation are likely to occur.
- Although IR detectors are less affected by smoke than other detectors, the X3301 should not be placed where rising combustion products can obscure its vision. If smoke is expected before fire, smoke or other alternative detectors should be used in conjunction with the X3301. For indoor applications, if dense smoke is expected to accumulate at the onset of a fire, mount the detector on a side wall at least a few feet (approximately 1 meter) down from the ceiling.
- If possible, fire tests can be conducted to verify correct detector positioning and coverage.
- For ATEX installations, the X3301 Flame Detector housing must be electrically connected to earth ground.

DETECTOR ORIENTATION

Refer to Figure 2 and ensure that the **oi** plate will be oriented as shown when the X3301 is mounted and sighted. This will ensure proper operation of the **oi** system and will also minimize the accumulation of moisture and contaminants between the **oi** plate and the viewing windows.

IMPORTANT

If removed, the **oi** plate must be securely tightened to ensure proper operation of the **oi** system (40 oz.linches [28.2 N·cm] recommended).

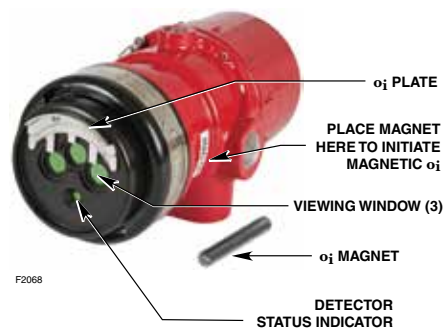


Figure 2—Front View of the X3301

PROTECTION AGAINST MOISTURE DAMAGE

It is important to take proper precautions during installation to ensure that moisture will not come in contact with the electrical connections or components of the system. The integrity of the system regarding moisture protection must be maintained for proper operation and is the responsibility of the installer.

If conduit is used, we recommend installing drains, according to local codes, at water collection points to automatically drain accumulated moisture. It is also recommended to install at least one breather, according to local codes, at upper locations to provide ventilation and allow water vapor to escape.

Conduit raceways should be inclined so that water will flow to low points for drainage and will not collect inside enclosures or on conduit seals. If this is not possible, install conduit drains above the seals to prevent the collection of water or install a drain loop below the detector with a conduit drain at the lowest point of the loop.

Conduit seals are not required for compliance with explosion-proof installation requirements, but are highly recommended to prevent water ingress in outdoor applications. Units with M25 threads must use an IP66/IP67 washer to prevent water ingress.

WIRING PROCEDURE

Wire Size and Type

The system should be wired according to local codes. The wire size selected should be based on the number of detectors connected, the supply voltage and the cable length. Typically 16 AWG or 2.5 mm² shielded cable is recommended. Wires should be stripped 3/8 inch (9 mm). A minimum input voltage of 18 Vdc must be present at the X3301.

NOTE

Refer to "Power Consumption" in the "Specifications" section of this manual.

The use of shielded cable is required to protect against interference caused by EMI and RFI. When using cables with shields, terminate the shields as shown in Figures 7 through 12, and Figure 15. Consult the factory if not using shielded cable.

In applications where the wiring cable is installed in conduit, the conduit must not be used for wiring to other electrical equipment.

If disconnection of power is required, separate disconnect capability must be provided.

CAUTION

Installation of the detector and wiring should be performed only by qualified personnel.

Detector Mounting

Install the mounting arm assembly on a rigid surface. The ideal installation surface should be free of vibration and suitable to receive 3/8 inch (M9) bolts with a length of at least 1 inch (25 mm). The surface must also have sufficient capacity to hold the detector and mounting arm weights (see "Specifications" section). Refer to the Q9033 Mounting Arm and Collar Attachment manual (95-8686) for additional mounting information. See Figure 3 for dimensions.

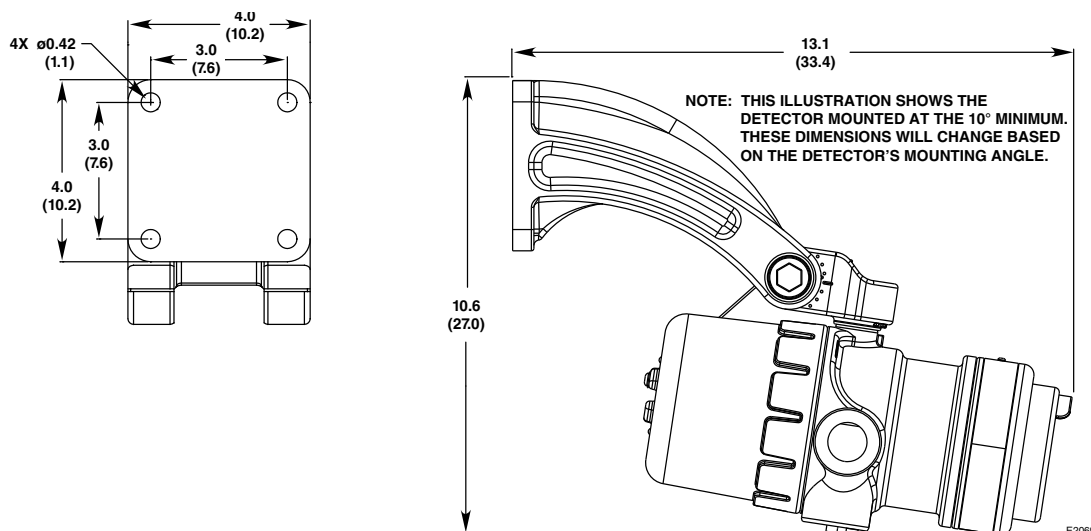


Figure 3—Q9033 Mounting Arm without Collar Attachment Dimensions in Inches (cm)
(See Figure 1 for Correct Detector Orientation.)

Relay and 0-20 mA Output Models

Follow the instructions below to install the X3301.

1. Make field connections following local ordinances and guidelines in this manual.
 - Figure 4 shows the wiring terminal strip located inside the detector's integral junction box.
 - Figure 5 shows the wiring terminal identification for the X3301 Flame Detector.
 - Figure 6 shows an EOL resistor installed within the integral wiring compartment of the detector (refer to "EOL Resistors" for details).
 - Figures 7 and 8 provide examples of typical installations with a X3301 wired to a fire alarm panel.
 - If the detector is equipped with a 0 to 20 mA output, refer to Figures 9 through 12.
2. Check all field wiring to be sure that the proper connections have been made.

IMPORTANT

Do not test any wiring connected to the detector with a meg-ohmmeter. Disconnect wiring at the detector before checking system wiring for continuity.

3. Make the final sighting adjustments and use a 14 mm hex wrench to ensure that the mounting arm assembly is tight.

EOL Resistors (Not Used with EQP Model)

To ensure that the insulating material of the wiring terminal block will not be affected by the heat generated by EOL resistors, observe the following guidelines when installing the resistors.

1. Required EOL resistor power rating must be 5 watts minimum.

NOTE

*EOL resistors must be ceramic, wirewound type, rated 5 watts minimum, with actual power dissipation not to exceed 2.5 watts. **This applies to ATEX/IEC installations only.***

2. Resistor leads should be cut to a length of approximately 1 1/2 inches (40 mm).
3. Bend the leads and install the EOL resistor as shown in Figure 6
4. Maintain a 3/8 inch (10 mm) minimum gap between the resistor body and the terminal block or any other neighboring parts.

NOTE

The EOL resistor can only be used within the flameproof terminal compartment. Unused conduit entries shall be closed with suitable blanking elements.



Figure 4—X3301 Terminal Block

9	4-20 mA +	19	4-20 mA –	29	SPARE
8	4-20 mA + REF	18	4-20 mA – REF	28	SPARE
7	COM FIRE	17	COM FIRE	27	COM AUX
6	N.O. FIRE	16	N.O. FIRE	26	N.O. AUX
5	N.C. FIRE	15	N.C. FIRE	25	N.C. AUX
4	COM FAULT	14	COM FAULT	24	RS-485 A
3	N.O. FAULT	13	N.O. FAULT	23	RS-485 B
2	24 VDC +	12	24 VDC +	22	MAN O _i
1	24 VDC –	11	24 VDC –	21	24 VDC –

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Figure 5—X3301 Wiring Terminal Identification

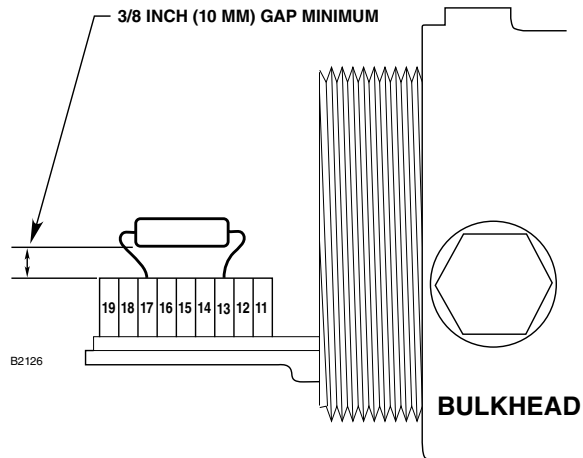
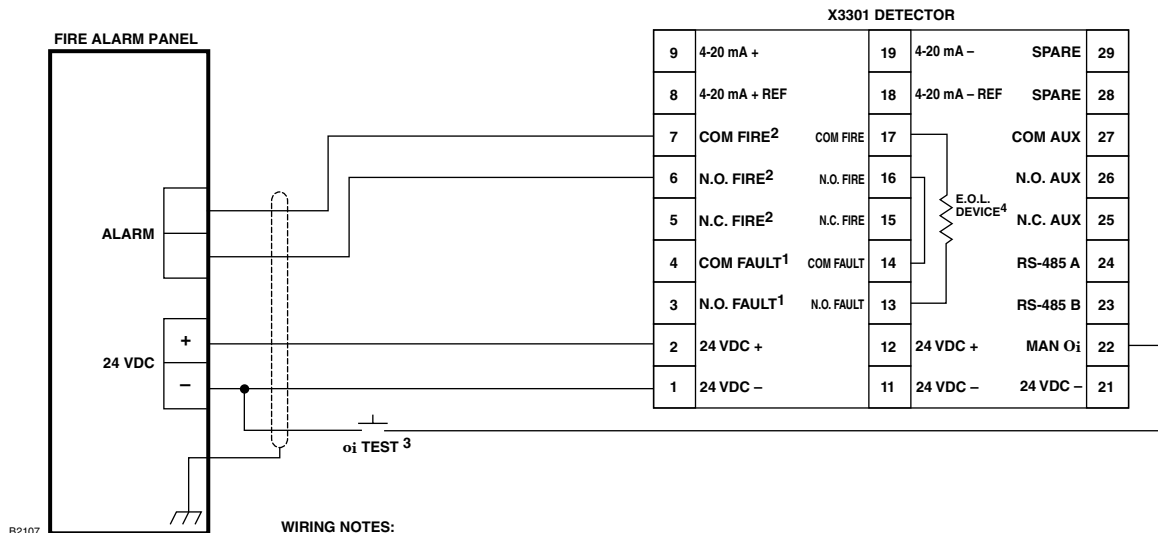


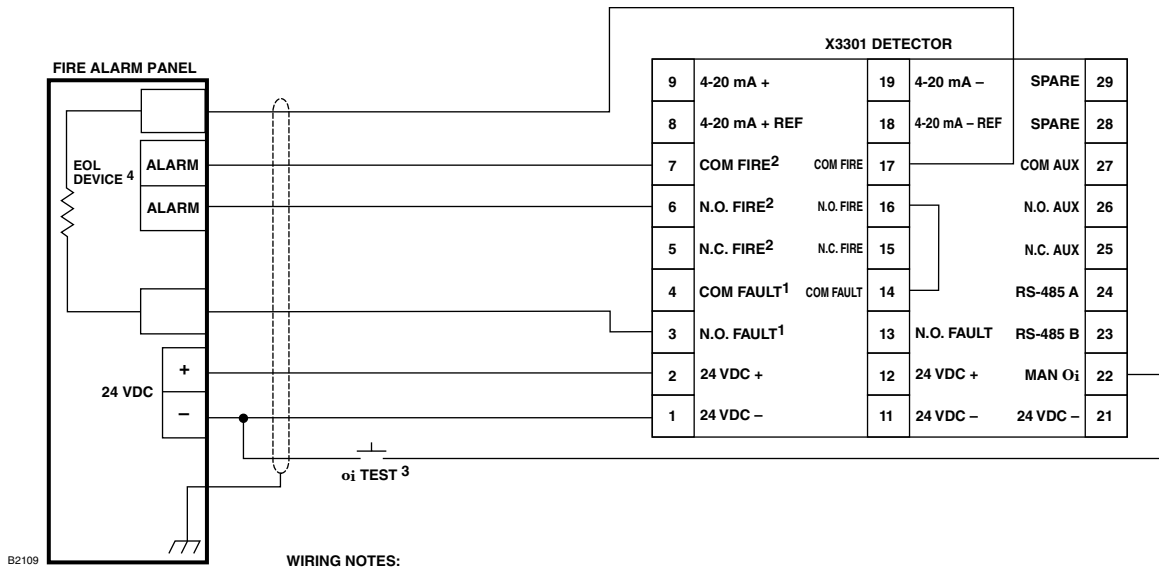
Figure 6—EOL Resistor Installation (For Ex d Wiring only)



WIRING NOTES:

- 1 IN NORMAL OPERATION WITH NO FAULTS OCCURRING, THE FAULT RELAY COIL IS ENERGIZED AND THE NORMALLY OPEN (N.O.) AND COMMON (COM) CONTACTS ARE CLOSED.
- 2 ALARM RELAY IS NORMALLY DE-ENERGIZED WITH NO ALARM CONDITION PRESENT.
- 3 INDIVIDUAL MANUAL oi TEST SWITCHES CAN BE INSTALLED REMOTELY OR A DETECTOR SELECTOR AND ACTIVATION SWITCH CAN BE INSTALLED AT THE FIRE PANEL. TEST SWITCHES ARE NOT SUPPLIED.
- 4 REFER TO SPECIFICATIONS SECTION FOR EOL RESISTOR VALUES. REFER TO EOL RESISTORS SECTION FOR INSTALLATION DETAILS.

Figure 7—Ex d Wiring Option



WIRING NOTES:

- 1 IN NORMAL OPERATION WITH NO FAULTS OCCURRING, THE FAULT RELAY COIL IS ENERGIZED AND THE NORMALLY OPEN (N.O.) AND COMMON (COM) CONTACTS ARE CLOSED.
- 2 ALARM RELAY IS NORMALLY DE-ENERGIZED WITH NO ALARM CONDITION PRESENT.
- 3 INDIVIDUAL MANUAL oi TEST SWITCHES CAN BE INSTALLED REMOTELY OR A DETECTOR SELECTOR AND ACTIVATION SWITCH CAN BE INSTALLED AT THE FIRE PANEL. TEST SWITCHES ARE NOT SUPPLIED.
- 4 EOL RESISTOR SUPPLIED BY PANEL.

Figure 8—Ex d e Wiring Option

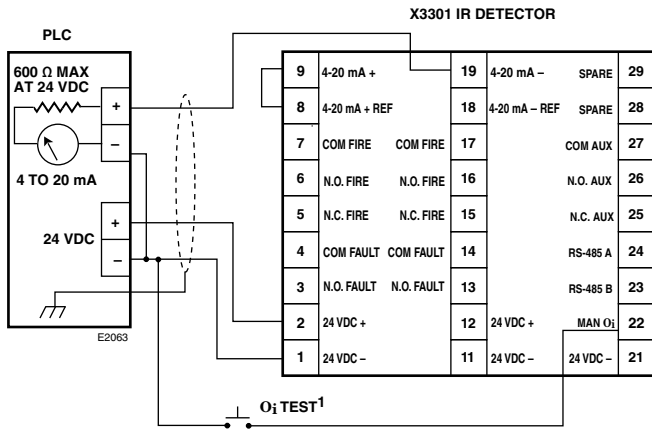


Figure 9—X3301 Detector Wired for Non-Isolated 0 to 20 mA Current Output (Sourcing)

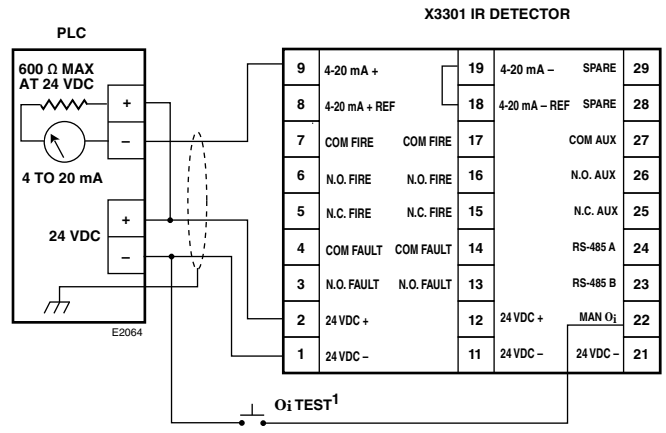


Figure 10—X3301 Detector Wired for Non-Isolated 0 to 20 mA Current Output (Sinking)

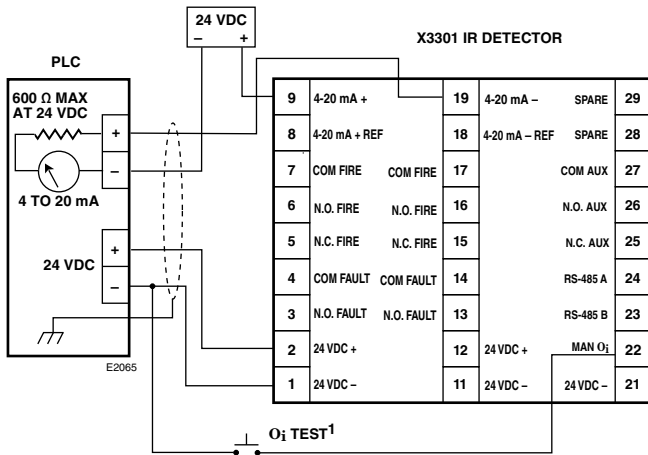


Figure 11—X3301 Detector Wired for Isolated 0 to 20 mA Current Output (Sourcing)

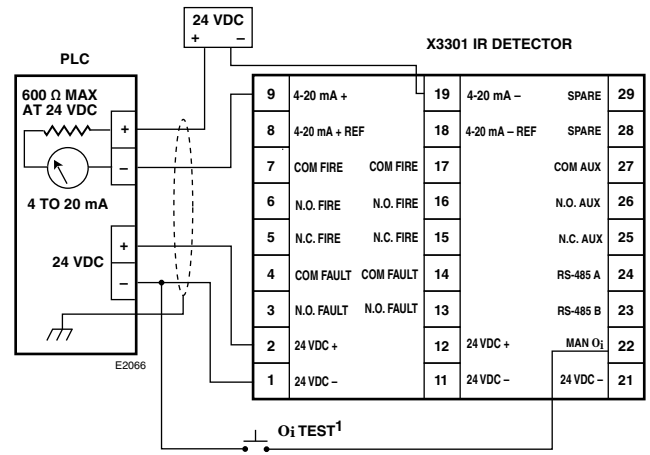


Figure 12—X3301 Detector Wired for Isolated 0 to 20 mA Current Output (Sinking)

NOTES: 1. INDIVIDUAL MANUAL o_i TEST SWITCHES CAN BE INSTALLED REMOTELY OR A DETECTOR SELECTOR AND ACTIVATION SWITCH CAN BE INSTALLED AT THE FIRE PANEL. TEST SWITCHES ARE NOT SUPPLIED.

EQP Model

1. Connect external wires to the appropriate terminals inside the device junction box, shown in Figure 13. See Figure 14 for terminal identification.
2. Connect the shield of the power cable to “earth ground” at the power source.
3. Connect shields for the LON cable as indicated. See Figure 15

NOTE

DO NOT ground any shields at the detector housing.

4. With input power disconnected, set the device network address (see the “Setting Device Network Addresses” section of this manual for switch setting procedure).

5. Check all field wiring to be sure that the proper connections have been made.
6. Replace the device cover and apply input power.
7. Make the final sighting adjustments and use a 14 mm hex wrench to ensure that the mounting arm assembly is tight.

NOTE

Refer to the Eagle Quantum Premier system manual (95-8533) for information regarding power requirements, network communication cable requirements, and configuration.



Figure 13—X3301 Terminal Block (EQP Model)

6	COM SHIELD	16	COM SHIELD
5	COM 1 A	15	COM 2 A
4	COM 1 B	14	COM 2 B
3	POWER SHIELD	13	POWER SHIELD
2	24 VDC +	12	24 VDC +
1	24 VDC -	11	24 VDC -

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Figure 14—Wiring Terminal Identification for X3301 EQP Model

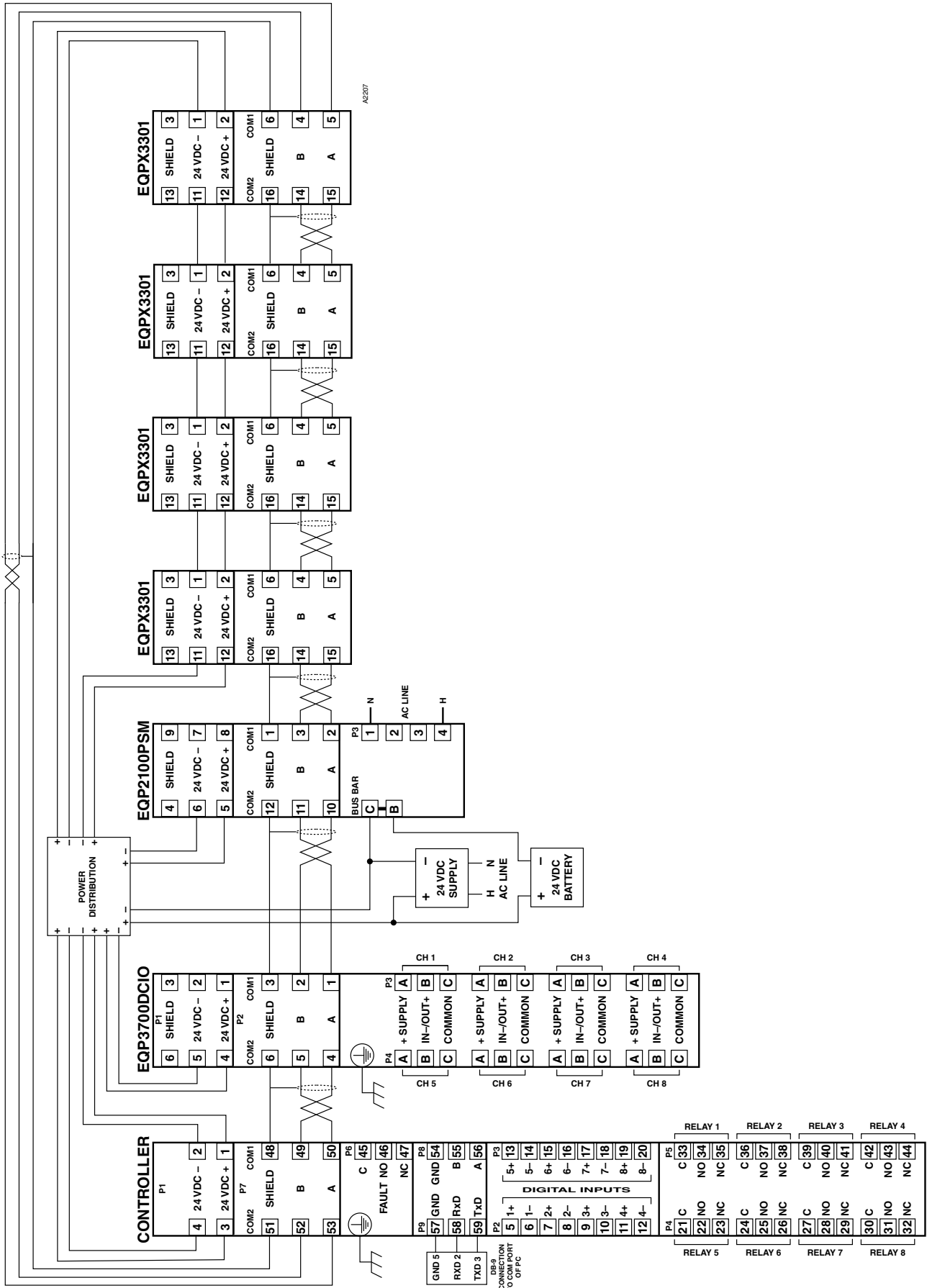


Figure 15—A Typical EQP System

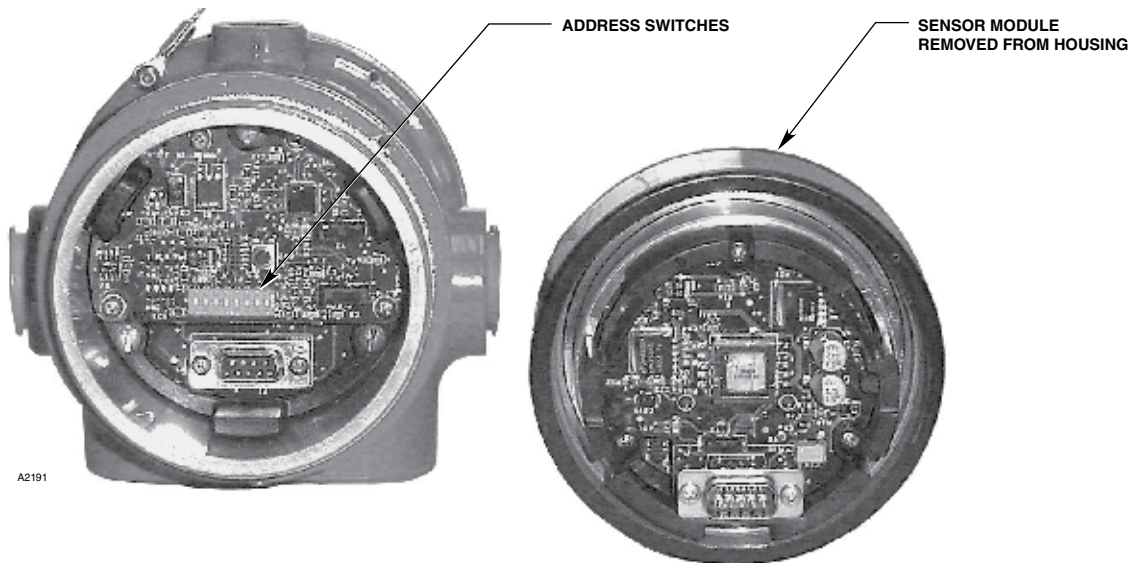


Figure 16—Location of Address Switches

SETTING DEVICE NETWORK ADDRESSES (EQP Model Only)

Overview of Network Addresses

Each device on the LON must be assigned a unique address. Addresses 1 to 4 are reserved for the controller. Valid addresses for field devices are from 5 to 250.

IMPORTANT

If the address is set to zero or an address above 250, the switch setting will be ignored.

Duplicated addresses are not automatically detected. Modules given the same address will use the number given and report to the controller using that address. The status word will show the latest update, which could be from any of the reporting modules using that address.

Setting Field Device Addresses

Selection of the node address is done by setting rocker switches on an 8 switch “DIP Switch Assembly” within the detector’s housing. Refer to Figure 16 for switch location.

⚠ WARNING

The network address switches are located within the detector housing. Disassembly of the detector head that contains powered electrical circuits is required to gain access to the network address switches. For hazardous areas, the area must be de-classified before attempting disassembly of the device. Always observe precautions for handling electrostatic sensitive devices.

The address number is binary encoded with each switch having a specific binary value with switch 1 being the LSB (Least Significant Bit), see Figure 17. The device’s LON address is equal to the added value of all closed rocker switches. All “Open” switches are ignored.

Example: for node No. 5, close rocker switches 1 and 3 (binary values 1 + 4); for node No. 25, close rocker switches 1, 4 and 5 (binary values 1 + 8 + 16).

NOTE

*The field device sets the LON address only when power is applied to the device. Therefore, it is important to set the switches **before** applying power. If an address is ever changed, system power must be cycled before the new address will take effect.*

After setting address switches, record the address number and device type.

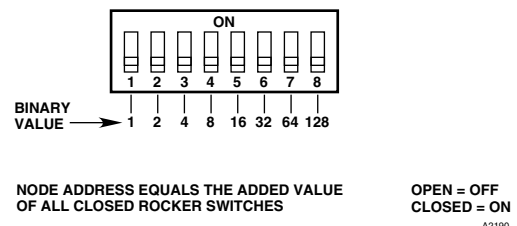


Figure 17—Address Switches for X3301

STARTUP PROCEDURE

When installation of the equipment is complete, perform the “Fire Alarm Test” below.

FIRE ALARM TEST

1. Disable any extinguishing equipment that is connected to the system.
2. Apply input power to the system.
3. Initiate an **oi** test (see “Magnetic **oi** / Manual **oi**” under Optical Integrity in the Description section of this manual).
4. Repeat this test for all detectors in the system. If a unit fails the test, refer to the “Troubleshooting” section.
5. Verify that all detectors in the system are properly aimed at the area to be protected. (Det-Tronics' Q1201C Laser Aimer is recommended for this purpose.)
6. Enable extinguishing equipment when the test is complete.

TROUBLESHOOTING

WARNING

The sensor module (“front” half of the detector) contains no user serviceable components and should never be opened. The terminal compartment is the only part of the enclosure that should be opened by the user in the field.

1. Disable any extinguishing equipment that is connected to the unit.
2. Inspect the viewing windows for contamination and clean as necessary. The detector is relatively insensitive to airborne contaminants, however, thick deposits of ice, dirt, or oil will reduce sensitivity. (Refer to the “Maintenance” section for complete information regarding cleaning of the detector viewing windows.)

Table 3—Current Level Output Troubleshooting Guide

Current Level (±0.3 mA)	Status	Action
0 mA	Power Fault	Check system wiring
1 mA	General Fault	Cycle power ¹
2 mA	oi Fault	Clean windows ²
3 mA	Hi Background IR Fault	Remove IR source or aim detector away from IR source
4 mA	Normal Operation	
20 mA	Fire Alarm	

¹ If fault continues, return device to factory for repair.

² See “Maintenance” section for cleaning procedure.

3. Check input power to the unit.
4. If the fire system has a logging function, check the fire panel log for output status information. See Table 3 for information regarding 0 to 20 mA output.
5. Turn off the input power to the detector and check all wiring for continuity. **Important: Disconnect wiring at the detector before checking system wiring for continuity.**
6. If all wiring checks out and cleaning of the **oi** plate/window did not correct the fault condition, check for high levels of background IR radiation by covering the detector with the factory supplied cover or aluminum foil. If the fault condition clears within 6 minutes or less, extreme background IR is present. Re-adjust the view of the detector away from the IR source or relocate the detector.

If none of these actions corrects the problem, return the detector to the factory for repair.

NOTE

It is highly recommended that a complete spare be kept on hand for field replacement to ensure continuous protection.

MAINTENANCE

IMPORTANT

Periodic flamepath inspections are not recommended, since the product is not intended to be serviced and provides proper ingress protection to eliminate potential deterioration of the flamepaths.

WARNING

The sensor module (“front” half of the detector) contains no user serviceable components and should never be opened. The terminal compartment is the only part of the enclosure that should be opened by the user in the field.

NOTE

Refer to the X3301 Safety manual (95-8582) for specific requirements and recommendations applicable to the proper installation, operation, and maintenance of all SIL-Certified X3301 Flame Detectors.

To maintain maximum sensitivity and false alarm resistance, the viewing windows of the X3301 must be kept relatively clean. Refer to the following procedure for cleaning instructions.

CLEANING PROCEDURE

CAUTION

Disable any extinguishing equipment that is connected to the unit to prevent unwanted actuation.

To clean the windows and **oi** plate, use Det-Tronics' window cleaner (p/n 001680-001) and a soft cloth, cotton swab or tissue and refer to the following procedure:

1. **Disable any extinguishing equipment that is connected to the unit.**
2. Since the X3301 is less affected by contamination than other detectors, removal of the **oi** plate is needed only under extreme conditions. In addition, it is not necessary to achieve perfect cleanliness, because IR is not significantly absorbed by slight films of oil and/or salt. If a fault condition is still indicated after cleaning, remove and clean the **oi** plate using the **oi** Plate Removal and Replacement procedure.
3. In all environments, clean all three viewing windows and reflector surfaces thoroughly. Use a cotton swab and Det-Tronics' window cleaning solution. Use Isopropyl alcohol for contaminations that the Det-Tronics window cleaning solution can not remove.

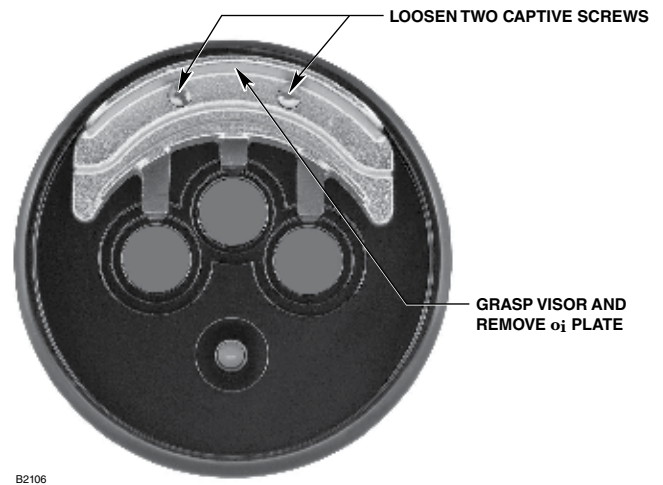


Figure 18—**oi** Plate Removal

IMPORTANT

When used in extreme environments, the reflective surface of the detector **oi** plate may eventually deteriorate, resulting in reoccurring **oi** faults and the need for **oi** plate replacement.

oi PLATE REMOVAL AND REPLACEMENT

1. **Disable any extinguishing equipment that is connected to the unit.**
2. Loosen the two captive screws, then grasp the **oi** plate by the visor and remove it from the detector. See Figure 18.
3. Install the new (or cleaned) **oi** plate.

NOTE

When installing the stainless steel plate, ensure that the gasket is present and correctly seated to prevent moisture or contaminants from penetrating behind the plate. To ensure even seating, tighten both screws equally.

4. Recalibrate the detector's **oi** system. Refer to the Inspector Monitor manual (95-8581) for instructions regarding **oi** plate replacement and **oi** system recalibration.

CAUTION

Do not replace the **oi reflector plate without also recalibrating the **oi** system.**

Recalibration of the **oi** system requires the use of the Inspector Connector Cable and Inspector Monitor Software. These two items are included in the **oi** replacement kit, or they can be purchased separately. See Ordering Information for details.

X3301 Reflector Plates

X3301 models are supplied with either a black or a stainless steel reflector plate. These plates are **not** interchangeable. Order the replacement that matches the reflector plate on your X3301 Flame Detector.

PERIODIC CHECKOUT PROCEDURE

In compliance with SIL 2, a checkout of the system using the Mag **oi** or Man **oi** feature should be performed regularly to ensure that the system is operating properly. Refer to Table 1 in the X3301 Safety manual (95-8582) for frequency of proof tests. To test the system, perform the "Fire Alarm Test" as described in the "Startup Procedure" section of this manual.

CLOCK BATTERY

The real time clock has a backup battery that will operate the clock with no external power. Return the device to the factory for battery replacement if needed.

NOTE

If the backup battery is depleted, there is no effect on the operation of the flame detector, but the time stamping of the data log may be affected.

FEATURES

- Long detection range to carbonaceous fires
- Unequaled false alarm rejection
- Responds to a fire in the presence of modulated blackbody radiation (i.e. heaters, ovens, turbines) without false alarm
- Microprocessor controlled heated optics for increased resistance to moisture and ice
- Automatic, manual, or magnetic **oi** testing
- Easily replaceable **oi** plate
- Fire, fault and auxiliary relays standard
- 0 to 20 mA isolated output (optional)
- Eagle Quantum Premier LON/SLC output (optional)
- HART communication (optional)
- FDT/DTM capable
- Multiple sensitivity levels
- A tri-color LED on the detector faceplate indicates normal condition and notifies personnel of fire alarm or fault conditions
- Operates under adverse weather conditions and in dirty environments
- Mounting arm allows easy sighting
- Integral wiring compartment for ease of installation
- Explosion-proof/flame-proof detector housing. Meets FM, CSA, ATEX Directive and CE certification requirements
- Class A wiring per NFPA-72
- Meets NFPA-33 response requirement for under 0.5 second (available when model selected)
- 5 year warranty
- RFI and EMC Directive compliant

Associated Manuals

List of X3301 related manuals:

TITLE	FORM NUMBER
Pulse	95-8528
EQP	95-8533
SIL 2 (Safety)	95-8582
HART Addendum	95-8577
Automotive Addendum	95-8534
Hangar	95-8548
Q9033 Mounting Arm and Collar Attachment	95-8686
Inspector Monitor Software for X-Series Flame Detectors	95-8581
Q1130 Flange Mount	95-8662

SPECIFICATIONS

OPERATING VOLTAGE—

24 Vdc nominal (18 Vdc minimum, 30 Vdc maximum).
Maximum ripple is 2 volts peak-to-peak.

POWER CONSUMPTION—

Without heater: 4 watts at 24 Vdc nominal;
5.2 watts at 24 Vdc in alarm.
4.5 watts at 30 Vdc nominal;
6.5 watts at 30 Vdc in alarm.

Heater only: 8 watts maximum.

Total power: 17 watts at 30 Vdc with EOL resistor installed
and heater on maximum.

EOL resistor must be ceramic, wirewound type, rated
5 watts minimum, with actual power dissipation not to
exceed 2.5 watts.

For HART model, refer to Addendum number 95-8577.

POWER UP TIME—

Fault indication clears after 0.5 second; device is ready
to indicate an alarm condition after 30 seconds.

OUTPUT RELAYS—

Fire Alarm relay, Form C, 5 amperes at 30 Vdc:

The Fire Alarm relay has redundant terminals and
normally open / normally closed contacts, normally
de-energized operation, and latching or non-
latching operation.

Fault relay, Form A, 5 amperes at 30 Vdc:

The Fault relay has redundant terminals and normally
open contacts, normally energized operation, and
latching or non-latching operation.

Auxiliary relay, Form C, 5 amperes at 30 Vdc:

The auxiliary relay has normally open/normally
closed contacts, normally energized or de-energized
operation, and latching or non-latching operation.

CURRENT OUTPUT (OPTIONAL)—

0 to 20 milliampere (± 0.3 mA) dc current, with a maximum
loop resistance of 500 ohms from 18 to 19.9 Vdc and 600
ohms from 20 to 30 Vdc.

LON OUTPUT—

Digital communication, transformer isolated (78.5 kbps).

TEMPERATURE RANGE—

Operating: -40°F to $+167^{\circ}\text{F}$ (-40°C to $+75^{\circ}\text{C}$).
Storage: -67°F to $+185^{\circ}\text{F}$ (-55°C to $+85^{\circ}\text{C}$).
Hazardous location ratings from -55°C to $+125^{\circ}\text{C}$.

HUMIDITY RANGE—

0 to 95% relative humidity, can withstand 100%
condensing humidity for short periods of time.

CONE OF VISION—

The detector has a 90° cone of vision (horizontal) with
the highest sensitivity lying along the central axis. Unlike
conventional detectors, the X3301 provides full coverage
at a minimum of 70% of the maximum detection distance.

Perfect cone of vision for methane fire detection — 100
feet (30.5 m) on and off axis on “very high” setting.

Refer to Appendix A for FM Approved cone of vision data.

RESPONSE TIME—

Typical response times are under 10 seconds. Models
are available that can respond to automotive paint
gun fires in under 0.5 seconds. See Appendix A and
“Automotive Addendum” (95-8534) for actual response
times.

DIMENSIONS—

See Figure 19.

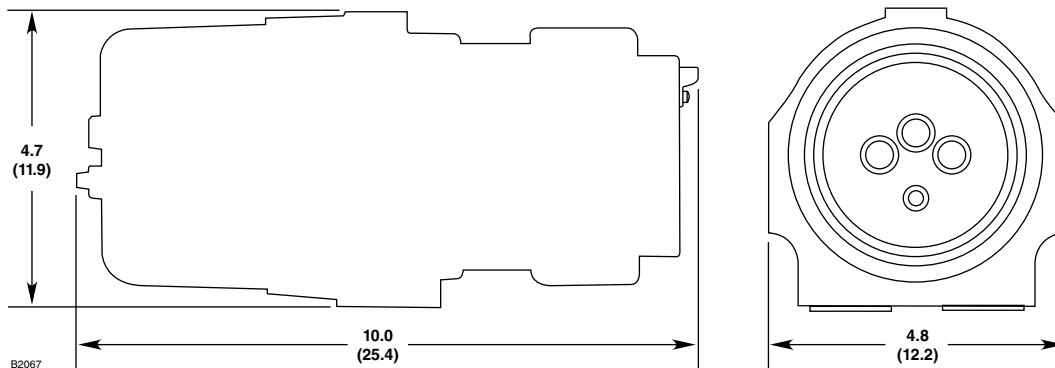


Figure 19—X3301 Dimensions in Inches (cm)

ENCLOSURE MATERIAL—

Copper-free aluminum (painted) or Stainless Steel (316/CF8M Cast).

VIBRATION—

Conformance per FM 3260: 2000, MIL-STD 810C (Curve AW), DNV Note 2.4 (Class B).

WIRING—

Field wiring screw terminals are UL/CSA rated for up to 14 AWG wire, and are DIN/VDE rated for 2.5 mm² wire. Screw terminal required torque range is 3.5–4.4 in.-lbs. (0.4-0.5 N·m).

Important: 18 Vdc minimum must be available at the detector. For ambient temperatures below -10°C (14°F) and above +60°C (140°F) use field wiring suitable for both minimum and maximum ambient temperature.

THREAD SIZE—

Conduit connection: Four entries, 3/4 inch NPT or M25. Conduit seal not required.

SHIPPING WEIGHT (Approximate)—

- Aluminum: 7 pounds (3.2 kilograms).
- Stainless Steel: 13.8 pounds (6.3 kilograms).
- Mounting Arm (AL): 6 pounds (2.75 kilograms).
- Mounting Arm (SS): 14 pounds (6.4 kilograms).

WARRANTY PERIOD—

5 years.

CERTIFICATION—



For complete approval details, refer to the appropriate Appendix:

- Appendix A - FM
- Appendix B - CSA
- Appendix C - ATEX/CE
- Appendix D - IECEx
- Appendix E - EN54
- Appendix F - Offshore
- Appendix G - Additional approvals

REPLACEMENT PARTS

The detector is not designed to be repaired in the field. If a problem should develop, refer to the Troubleshooting section. If it is determined that the problem is caused by an electronic defect, the device must be returned to the factory for repair.

REPLACEMENT PARTS

Part Number	Description
009208-001	oi Replacement kit for X3301 (5 Black Reflector Plates) with Inspector Connector and Monitor
010831-001	oi Replacement kit for X3301 (5 Stainless Steel Reflector Plates) with Inspector Connector and Monitor
007307-001	Replacement oi Reflector Plates for X3301 with Black plate (requires Inspector Connector to calibrate)
010830-001	Replacement oi Reflector Plates for X3301 with Stainless Steel plate (requires Inspector Connector to calibrate)

NOTE: Refer to instruction manual 95-8530 to determine the correct oi Replacement Plate.

DEVICE REPAIR AND RETURN

Prior to returning devices, contact the nearest local Detector Electronics office so that a Return Material Identification (RMI) number can be assigned. **A written statement describing the malfunction must accompany the returned device or component to assist and expedite finding the root cause of the failure.**

Pack the unit properly. Always use sufficient packing material. Where applicable, use an antistatic bag as protection from electrostatic discharge.

NOTE

Det-Tronics reserves the right to apply a service charge for repairing returned product damaged as a result of improper packaging.

Return all equipment transportation prepaid to the factory in Minneapolis.

NOTE

It is highly recommended that a complete spare be kept on hand for field replacement to ensure continuous protection.

ORDERING INFORMATION

When ordering, please specify:

X3301 IR Flame Detector

Refer to the X3301 Model Matrix for details

Q9033 Mounting Arm is required:

- Q9033A for aluminum detectors only
- Q9033B for aluminum and stainless steel detectors

ACCESSORIES

Part Number	Description
000511-029	Converter RS485 to RS232
103881-001	Converter RS485 to USB
007819-001	W6300B1002 Serial Inspector Connector (Inspector Monitor software included)
007819-002	W6300B1003 USB Inspector Connector (Inspector Monitor software included)
009207-001	Flame Inspector Monitor CD
103922-001	Model 475 HART Communicator
102740-002	Magnet
008082-001	Magnet and Adapter for Extension Pole
007739-001	Magnet and Extension Pole
007240-001	Q1116A1001, Air Shield (AL)
007818-001	Q1118A1001 Aluminum Air Shield/Flange Mount (AL)
007818-002	Q1118S1001 Stainless Steel Air Shield/Flange Mount (SS)
009177-001	Q1120A1001 Paint Shield mounting ring (AL)
010857-001	Q1130A1001 Flange Mount Assembly
006097-001	Q1201 Laser
102871-001	Laser Battery, 3V Lithium (laser)
007255-001	Q1201C1001 X-Series Laser Holder (AL/Plastic)
007338-001	Q2000A1001 X-Series Weather Shield (AL)
007338-010	Q2033A10R X3301/X3302 FOV Limiter 10° (AL)
007338-020	Q2033A20R X3301/X3302 FOV Limiter 20° (AL)
007338-030	Q2033A30R X3301/X3302 FOV Limiter 30° (AL)
007912-010	Spare Restrictor Plate 10° (AL)
007912-020	Spare Restrictor Plate 20° (AL)
007912-030	Spare Restrictor Plate 30° (AL)
007290-001	Q9033B Stainless Steel Mounting Arm Assembly is for aluminum and stainless steel detectors
007290-002	Q9033A Aluminum Mounting Arm Assembly is for aluminum detectors only
011385-001	Q9033 Collar Attachment
101197-001	Stop Plug, 3/4" NPT, AL
101197-004	Stop Plug, 3/4" NPT, SS
101197-005	Stop Plug, M25, AL, IP66
101197-003	Stop Plug, M25, SS, IP66
010816-001	Stop Plug, 20 Pack, 3/4" NPT, AL
010817-001	Stop Plug, 20 Pack, 3/4" NPT, SS
010818-001	Stop Plug, 20 Pack, M25, AL, IP66
010819-001	Stop Plug, 20 Pack, M25, SS, IP66
103363-001	14 mm Hex Wrench (Steel)
103406-001	Screwdriver
107427-040	O-ring - Rear Cover (Viton)
005003-001	1 oz grease for detectors (non-silicon)
001680-001	Window cleaner (6 pack)

X3301 MODEL MATRIX

MODEL	DESCRIPTION	
X3301	Multispectrum IR Flame Detector	
	TYPE	MATERIAL
	A	Aluminum
	S	Stainless Steel (316)
	TYPE	THREAD TYPE
	4M	4 Port, Metric M25
	4N	4 Port, 3/4" NPT
	TYPE	OUTPUTS
	11	Relay
	13	Relay and 4-20 mA
	14	Eagle Quantum Premier (EQP)
	15	Relay and Pulse
	16	Addressable Module Only (Third Party Type)*
	21	Relay-Automotive
	22	EQP Automotive
	23	HART, Relay and 4-20 mA
	TYPE	APPROVALS***
B	INMETRO (Brazil)	
R	VNIIPO/VNIIFTRI (Russia)	
T	SIL/FM/CSA/ATEX/CE/IECEX	
W	FM/CSA/ULC**/ATEX/CE/IECEX	
TYPE	CLASSIFICATION	
1	Division/Zone Ex d e	
2	Division/Zone Ex d	

*The Addressable Module Only (Type 16) is not FM approved.

**ULC approval applies to output types 11, 13, 15, 21, and 23.

***Type Approvals can use one or more letters to designate the approvals of the product.

APPENDIX A

FM APPROVAL AND PERFORMANCE REPORT

THE FOLLOWING ITEMS, FUNCTIONS AND OPTIONS DESCRIBE THE FM APPROVAL:

- Explosion-proof for Class I, Div. 1, Groups B, C and D (T4A) Hazardous (Classified) Locations per FM 3615.
- Dust-ignition proof for Class II/III, Div. 1, Groups E, F and G (T4A) Hazardous (Classified) Locations per FM 3615.
- Nonincendive for Class I, Div. 2, Groups A, B, C and D (T3C) Hazardous (Classified) Locations per FM 3611.
- Nonincendive for Class II, Div. 2, Groups F and G (T3C) Hazardous (Classified) Locations per FM 3611.
- Enclosure rating NEMA/Type 4X per NEMA 250.
- Ambient Temperature Limits: -40°F to +167°F (-40°C to +75°C).
- Automatic Fire Alarm Signaling Performance verified per FM 3260 (2000).

Flameproof per ANSI/ISA 60079-0, -1, -7

for Class I, Zone 1 -

AEx d e IIC Gb; T6 (Tamb -40°C to +60°C); T5 (Tamb -40°C to +75°C)

AEx d IIC Gb; T6 (Tamb -40°C to +60°C); T5 (Tamb -40°C to +75°C)

for Zone 21 -

AEx tb T130°C

Tamb -40°C to +75°C

Degree of protection provided by Enclosure IP66/67, Hazardous Locations for us in the U.S.

The following accessories are FM approved for use with the X3301 Flame Detector:

Part Number	Description
102740-002	Magnet
007739-001	Magnet and Extension Pole
010857-001	Q1130A1001 Flange Mount Assembly
007290-001	Q9033B Stainless Steel Mounting Arm Assembly is for aluminum and stainless steel detectors
007290-002	Q9033A Aluminum Mounting Arm Assembly is for aluminum detectors only
011385-001	Q9033 Collar Attachment

The following performance criteria were verified:

AUTOMATIC OPTICAL INTEGRITY TEST:

The detector generated an optical fault in the presence of contamination on any single or combination of lens surfaces resulting in a loss of approximately 50% of its detection range, verifying that the detector performs a calibrated Automatic **oi** test for each sensor. Upon removal of the contamination, the detector fault was cleared and the detector was verified to detect a fire.

MANUAL OPTICAL INTEGRITY TEST:

The Manual / Magnetic **oi** performs the same calibrated test as the Automatic **oi**, and additionally actuates the alarm relay to verify output operation. If there is a 50% loss of its detection range, an alarm signal is not generated.

The **oi** test procedure, as described in the "Magnetic **oi** / Manual **oi**" section of this instruction manual, is the approved external optical test method for this detector to verify end-to-end detector function. This test replaces the function and need of a traditional external test lamp.

FM Approval and Performance Report – Continued

RESPONSE CHARACTERISTICS

Very High Sensitivity

Fuel	Size	Distance feet (m)	Average Response Time (seconds)***
n-Heptane	1 x 1 foot	210 (64)*	11
n-Heptane**	1 x 1 foot	210 (64)*	6
n-Heptane	1 x 1 foot	100 (30.5)	3
n-Heptane	6 in. x 6 in.	80 (24.4)	3
Isopropanol	6 in. x 6 in.	70 (21.3)	4
Diesel**	1 x 1 foot	150 (45.7)*	14
Ethanol	1 x 1 foot	210 (64)	11
Methanol	6 in. x 6 in.	40 (12.2)	3
Methanol	1 x 1 foot	150 (45.7)*	18
Methanol**	1 x 1 foot	150 (45.7)*	7
Methane	30 inch plume	100 (30.5)	3
JP-5**	1 x 1 foot	150 (45.7)*	2
JP-5**	2 x 2 feet	210 (64)*	4
JP-5**	2 x 2 feet	100 (30.5)	2
Office Paper 0.5 lb.	19" x 19" x 8"	100 (30.5)	4
Corrugated Panel	18" x 36"	100 (30.5)	8

* Outdoor test condition.

** Pre-burn from ignition.

*** Add 2 seconds for EQP model.

Medium Sensitivity

Fuel	Size	Distance feet (m)	Average Response Time (seconds)***
n-Heptane	1 x 1 foot	100 (30.5)	12
n-Heptane	1 x 1 foot	50 (15.2)	2
Diesel**	1 x 1 foot	70 (21.3)	4
Ethanol	1 x 1 foot	85 (25.9)	13
Methanol	1 x 1 foot	70 (21.3)	10
Methane	30 inch plume	65 (19.8)	3
Methane	30 inch plume	55 (16.8)	2
JP-5**	2 x 2 feet	100 (30.5)	3
Office Paper 0.5 lb.	19" x 19" x 8"	50 (15.2)	6
Corrugated Panel	18" x 36"	50 (15.2)	2

** Pre-burn from ignition.

*** Add 2 seconds for EQP model.

T-Low Sensitivity

Fuel	Size	Distance feet (m)	Average Response Time (seconds)***
n-Heptane	1 x 1 foot	50 (15.2)	7
Methanol	1 x 1 foot	20 (6.1)	5
Methane	32 inch plume	15 (4.6)	4

*** Add 2 seconds for EQP model.

Low Sensitivity

Fuel	Size	Distance feet (m)	Average Response Time (seconds)***
n-Heptane	1 x 1 foot	50 (15.2)	10
Methanol	1 x 1 foot	20 (6.1)	10
Methane	32 inch plume	15 (4.6)	9

*** Add 2 seconds for EQP model.

FM Approval and Performance Report – Continued

RESPONSE CHARACTERISTICS IN THE PRESENCE OF FALSE ALARM SOURCES

Very High Sensitivity

False Alarm Source	Distance feet (m)	Fire Source	Distance feet (m)	Average Response Time (seconds)***
Sunlight, direct, modulated, reflected	—	6-inch propane	6 (1.8)	< 10
Vibration	N/A	3-inch propane	10.5 (3.2)	< 10
Radio frequency interference	1 (0.3)	3-inch propane	12 (3.7)	< 10
Arc welding, #7014	40 (12.2)	1 x 1 foot n-Heptane	40 (12.2)	4
6 kw heater, modulated	80 (24.4)	1 x 1 foot n-Heptane	80 (24.4)	2
6 kw heater, unmodulated	10 (3)	1 x 1 foot n-Heptane	80 (24.4)	3
250 w vapor lamp, modulated	3 (0.9)	1 x 1 foot n-Heptane	80 (24.4)	2
300 w incandescent lamp, modulated	3 (0.9)	1 x 1 foot n-Heptane	80 (24.4)	7
500 w shielded quartz halogen lamp, modulated	8 (2.4)	1 x 1 foot n-Heptane	80 (24.4)	2
500 w unshielded quartz halogen lamp, modulated	8 (2.4)	1 x 1 foot n-Heptane	80 (24.4)	3
1500 w electric radiant heater, modulated	10 (3)	1 x 1 foot n-Heptane	80 (24.4)	5
Two 34 w fluorescent lamps, modulated	3 (0.9)	1 x 1 foot n-Heptane	80 (24.4)	3

*** Add 2 seconds for EQP model.

Medium Sensitivity

False Alarm Source	Distance feet (m)	Fire Source	Distance feet (m)	Average Response Time (seconds)***
Sunlight, direct, modulated, reflected	—	6-inch propane	6 (1.8)	< 4
Vibration*	N/A	N/A	N/A	N/A
Radio frequency interference	1 (0.3)	6-inch propane	6 (1.8)	< 1
Arc welding, #7014	10 (3)	1 x 1 foot n-Heptane	40 (12.2)	4
6 kw heater, modulated	60 (18.3)	1 x 1 foot n-Heptane	60 (18.3)	2
6 kw heater, unmodulated	10 (3)	1 x 1 foot n-Heptane	60 (18.3)	2
250 w vapor lamp, modulated	3 (0.9)	1 x 1 foot n-Heptane	60 (18.3)	1
300 w incandescent lamp, modulated	3 (0.9)	1 x 1 foot n-Heptane	60 (18.3)	1
500 w shielded quartz halogen lamp, modulated	8 (2.4)	1 x 1 foot n-Heptane	60 (18.3)	1
500 w unshielded quartz halogen lamp, modulated	8 (2.4)	1 x 1 foot n-Heptane	60 (18.3)	1
1500 w electric radiant heater, modulated	10 (3)	1 x 1 foot n-Heptane	60 (18.3)	6
Two 34 w fluorescent lamps, modulated	3 (0.9)	1 x 1 foot n-Heptane	60 (18.3)	2

* Fire was verified with very high sensitivity only.

*** Add 2 seconds for EQP model.

FM Approval and Performance Report – Continued

T-Low Sensitivity

False Alarm Source	Distance feet (m)	Fire Source	Distance feet (m)	Average Response Time (seconds)***
Sunlight, direct, unmodulated, reflected*	—	1 x 1 foot n-Heptane	35 (10.7)	< 6
Sunlight, direct, modulated, reflected*	—	1 x 1 foot n-Heptane	15 (4.6)	< 4
Arc welding, steady, #7014	5 (1.5)	1 x 1 foot n-Heptane	50 (15.2)	10
Arc welding, modulated, #7014	5 (1.5)	1 x 1 foot n-Heptane	30 (9.1)	3
70 w sodium vapor, unmodulated	3 (0.9)	1 x 1 foot n-Heptane	50 (15.2)	6
70 w sodium vapor, modulated	3 (0.9)	1 x 1 foot n-Heptane	50 (15.2)	7
250 w vapor lamp, unmodulated	3 (0.9)	1 x 1 foot n-Heptane	50 (15.2)	8
250 w vapor lamp, modulated	3 (0.9)	1 x 1 foot n-Heptane	50 (15.2)	6
300 w incandescent lamp, unmodulated	3 (0.9)	1 x 1 foot n-Heptane	50 (15.2)	7
300 w incandescent lamp, modulated	3 (0.9)	1 x 1 foot n-Heptane	50 (15.2)	8
500 w shielded quartz halogen lamp, unmodulated	3 (0.9)	1 x 1 foot n-Heptane	50 (15.2)	4
500 w shielded quartz halogen lamp, modulated	10 (3)	1 x 1 foot n-Heptane	50 (15.2)	5
1500 w electric radiant heater, unmodulated	3 (0.9)	1 x 1 foot n-Heptane	50 (15.2)	5
1500 w electric radiant heater, modulated	10 (3)	1 x 1 foot n-Heptane	30 (9.1)	7
Two 34 w fluorescent lamps, unmodulated	3 (0.9)	1 x 1 foot n-Heptane	50 (15.2)	5
Two 34 w fluorescent lamps, modulated	3 (0.9)	1 x 1 foot n-Heptane	50 (15.2)	4

* Outdoor test conditions.

*** Add 2 seconds for EQP model.

Low Sensitivity

False Alarm Source	Distance feet (m)	Fire Source	Distance feet (m)	Average Response Time (seconds)***
Sunlight, direct, unmodulated, reflected*	—	1 x 1 foot n-Heptane	35 (10.7)	< 13
Sunlight, direct, modulated, reflected*	—	1 x 1 foot n-Heptane	15 (4.6)	< 14
Arc welding, steady, #7014	5 (1.5)	1 x 1 foot n-Heptane	50 (15.2)	11
Arc welding, modulated, #7014	5 (1.5)	1 x 1 foot n-Heptane	30 (9.1)	10
70 w sodium vapor, modulated	3 (0.9)	1 x 1 foot n-Heptane	50 (15.2)	16
250 w vapor lamp, modulated	3 (0.9)	1 x 1 foot n-Heptane	50 (15.2)	18
300 w incandescent lamp, modulated	3 (0.9)	1 x 1 foot n-Heptane	50 (15.2)	18
500 w shielded quartz halogen lamp, unmodulated	3 (0.9)	1 x 1 foot n-Heptane	50 (15.2)	12
500 w shielded quartz halogen lamp, modulated	10 (3)	1 x 1 foot n-Heptane	50 (15.2)	11
1500 w electric radiant heater, unmodulated	3 (0.9)	1 x 1 foot n-Heptane	50 (15.2)	12
1500 w electric radiant heater, modulated	10 (3)	1 x 1 foot n-Heptane	30 (9.1)	11
Two 34 w fluorescent lamps, modulated	3 (0.9)	1 x 1 foot n-Heptane	50 (15.2)	14

* Outdoor test conditions.

*** Add 2 seconds for EQP model.

FM Approval and Performance Report – Continued

FALSE ALARM IMMUNITY

Very High Sensitivity

False Alarm Source	Distance feet (m)	Modulated Response	Unmodulated Response
Sunlight, direct, reflected	—	No alarm	No alarm
Vibration	N/A	No alarm	N/A
Radio frequency interference	1 (0.3)	No alarm (keyed)	No alarm (steady)
Arc welding	40 (12.2)	No alarm	No alarm
6 kw heater	3 (0.9)	No alarm	No alarm
250 w vapor lamp	3 (0.9)	No alarm	No alarm
300 w incandescent lamp	3 (0.9)	No alarm	No alarm
500 w unshielded quartz halogen lamp	8 (2.4)	No alarm	No alarm
500 w shielded quartz halogen lamp	8 (2.4)	No alarm	No alarm
1500 w electric radiant heater	3 (0.9)	No alarm	No alarm
Two 34 w fluorescent lamps	3 (0.9)	No alarm	No alarm

Medium Sensitivity

False Alarm Source	Distance feet (m)	Modulated Response	Unmodulated Response
Sunlight, direct, reflected	—	No alarm	No alarm
Vibration	N/A	No alarm	N/A
Radio frequency interference	1 (0.3)	No alarm (keyed)	No alarm (steady)
Arc welding	10 (3)	No alarm	No alarm
6 kw heater	3 (0.9)	No alarm	No alarm
250 w vapor lamp	3 (0.9)	No alarm	No alarm
300 w incandescent lamp	3 (0.9)	No alarm	No alarm
500 w unshielded quartz halogen lamp	8 (2.4)	No alarm	No alarm
500 w shielded quartz halogen lamp	3 (0.9)	No alarm	No alarm
1500 w electric radiant heater	3 (0.9)	No alarm	No alarm
Two 34 w fluorescent lamps	3 (0.9)	No alarm	No alarm

T-Low Sensitivity

False Alarm Source	Distance feet (m)	Modulated Response	Unmodulated Response
Sunlight, direct, reflected	—	No alarm	No alarm
Vibration	—	No alarm	No alarm
Arc welding	5 (1.5)	No alarm	No alarm
6 kw heater	3 (0.9)	No alarm	No alarm
70 w sodium vapor	3 (0.9)	No alarm	No alarm
250 w vapor lamp	3 (0.9)	No alarm	No alarm
300 w incandescent lamp	3 (0.9)	No alarm	No alarm
500 w shielded quartz halogen lamp	3 (0.9)	No alarm	No alarm
1500 w electric radiant heater	3 (0.9)	No alarm	No alarm
Two 34 w fluorescent lamps	3 (0.9)	No alarm	No alarm

Low Sensitivity

False Alarm Source	Distance feet (m)	Modulated Response	Unmodulated Response
Sunlight, direct, reflected	—	No alarm	No alarm
Vibration	—	No alarm	No alarm
Radio frequency interference	N/A	No alarm	N/A
Arc welding	5 (1.5)	No alarm	No alarm
6 kw heater	3 (0.9)	No alarm	No alarm
250 w vapor lamp	3 (0.9)	No alarm	No alarm
300 w incandescent lamp	3 (0.9)	No alarm	No alarm
500 w shielded quartz halogen lamp	3 (0.9)	No alarm	No alarm
1500 w electric radiant heater	3 (0.9)	No alarm	No alarm
Two 34 w fluorescent lamps	3 (0.9)	No alarm	No alarm

FM Approval and Performance Report – Continued

FIELD OF VIEW

Very High Sensitivity

Fuel	Size	Distance feet (m)	Horizontal (degrees)	Avg. Horiz. Response Time (seconds)***	Vertical (degrees)	Avg. Vert. Response Time (seconds)***
n-Heptane	1 x 1 foot	150* (45.7)	+45 -45	12 14	+45 -30	13 5
n-Heptane	1 x 1 foot	100 (30.5)	+45 -45	6 3	+45 -30	3 2
n-Heptane	6 in. x 6 in.	80 (24.4)	+45 -45	5 6	+45 -30	4 4
Isopropanol	6 in. x 6 in.	70 (21.3)	+45 -45	5 5	+45 -30	4 6
Diesel**	1 x 1 foot	100 (30.5)	+45 -45	2 3	+45 -30	4 3
Ethanol	1 x 1 foot	150 (45.7)	+45 -45	13 10	+45 -30	10 8
Methanol	6 in. x 6 in.	40 (12.2)	+45 -45	4 6	+45 -30	3 3
Methanol	1 x 1 foot	110 (33.5)	+45 -45	9 7	+45 -30	9 3
Methane	30 inch plume	100 (30.5)	+45 -45	7 3	+45 -30	2 2
JP-5**	1 x 1 foot	100 (30.5)	+45 -45	2 4	+45 -30	3 2
JP-5**	2 x 2 feet	180* (54.9)	+45 -45	2 5	+45 -30	3 2
JP-5**	2 x 2 feet	90 (27.4)	+45 -45	2 3	+45 -30	1 2
Office Paper 0.5 lb.	19" x 19" x 8"	80 (24.4)	+45 -45	4 2	+45 -30	2 1
Corrugated Panel	18" x 36"	80 (24.4)	+45 -45	1 1	+45 -30	3 2

* Outdoor test condition.

** Pre-burn from ignition.

*** Add 2 seconds for EQP model.

FM Approval and Performance Report – Continued

Medium Sensitivity

Fuel	Size	Distance feet (m)	Horizontal (degrees)	Avg. Horiz. Response Time (seconds)***	Vertical (degrees)	Avg. Vert. Response Time (seconds)***
n-Heptane	1 x 1 foot	75 (22.9)	+45 -45	9 6	+45 -30	10 7
n-Heptane	1 x 1 foot	50 (15.2)	+45 -45	4 3	+45 -30	3 3
Diesel**	1 x 1 foot	60 (18.3)	+45 -45	4 4	+45 -30	4 2
Ethanol	1 x 1 foot	60 (18.2)	+45 -45	12 9	+45 -30	12 9
Methanol	1 x 1 foot	50 (15.2)	+45 -45	9 3	+45 -30	9 1
Methane	32 inch plume	45 (13.7)	+45 -45	3 3	+45 -30	7 1
JP-5**	2 x 2 feet	90 (27.4)	+45 -45	4 2	+45 -30	2 2
Office Paper 0.5 lb.	19" x 19" x 8"	40 (12.2)	+45 -45	2 1	+45 -30	1 1
Corrugated Panel	18" x 36"	40 (12.2)	+45 -45	2 1	+45 -30	1 1

** Pre-burn from ignition.

*** Add 2 seconds for EQP model.

T-Low Sensitivity

Fuel	Size	Distance feet (m)	Horizontal (degrees)	Avg. Horiz. Response Time (seconds)***	Vertical (degrees)	Avg. Vert. Response Time (seconds)***
n-Heptane	1 x 1 foot	35 (10.7)	+45 -45	7 7	+45 -30	7 7
Methanol	1 x 1 foot	15 (4.6)	+45 -45	5 5	+45 -30	5 5
Methane	32 inch plume	15 (4.6)	+45 -45	4 4	+45 -30	4 4

*** Add 2 seconds for EQP model.

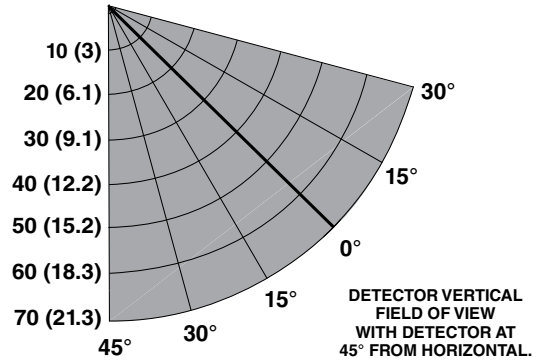
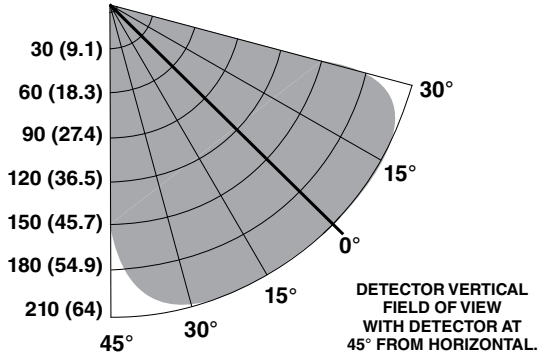
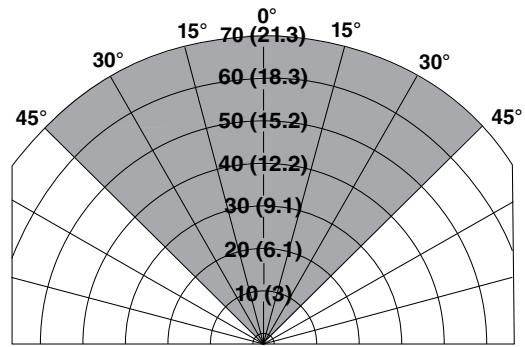
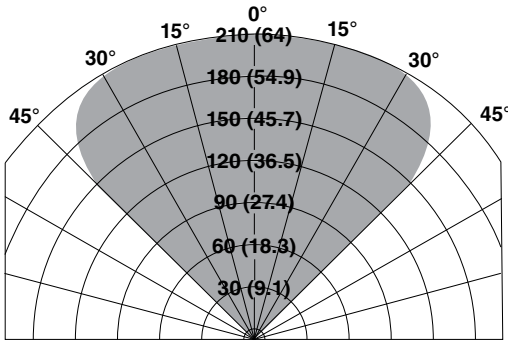
Low Sensitivity

Fuel	Size	Distance feet (m)	Horizontal (degrees)	Avg. Horiz. Response Time (seconds)***	Vertical (degrees)	Avg. Vert. Response Time (seconds)***
n-Heptane	1 x 1 foot	35 (10.7)	+45 -45	13 13	+45 -30	9 18
Methanol	1 x 1 foot	15 (4.6)	+45 -45	14 12	+45 -30	10 8
Methane	32 inch plume	15 (4.6)	+45 -45	10 11	+45 -30	8 10

*** Add 2 seconds for EQP model.

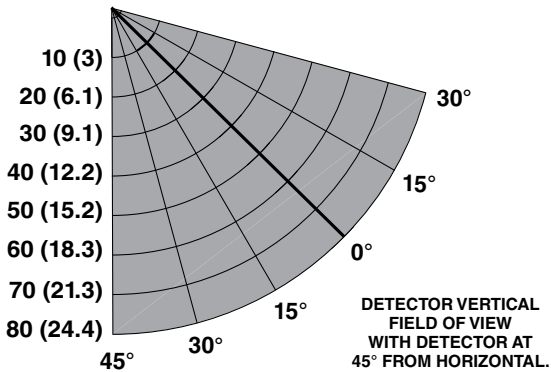
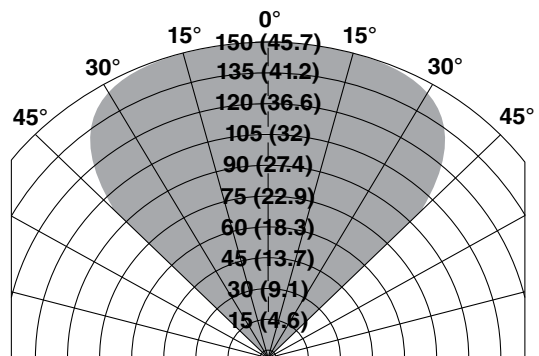
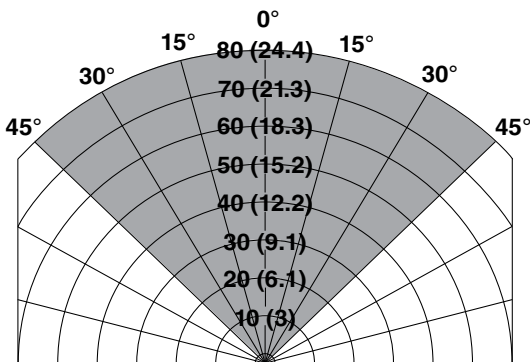
FM Approval and Performance Report – Continued

HIGH RESOLUTION FIELD OF VIEW



Field of View at Indicated Distance in Feet (m) for n-Heptane at Very High Sensitivity (1 x 1 foot)

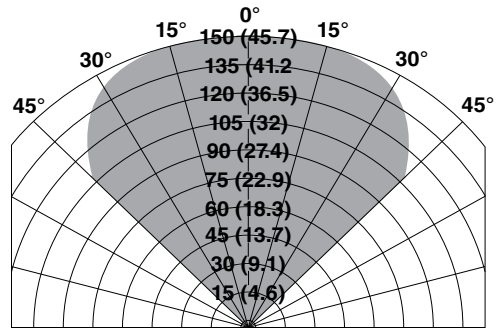
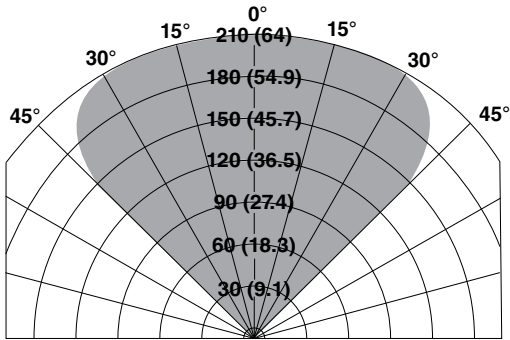
Field of View at Indicated Distance in Feet (m) for Isopropanol at Very High Sensitivity (6 in. x 6 in.)



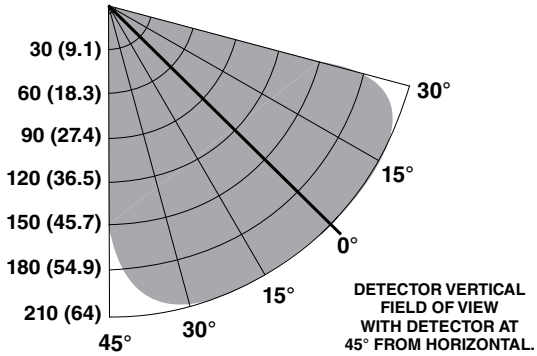
Field of View at Indicated Distance in Feet (m) for Diesel at Very High Sensitivity (1 x 1 foot)

Field of View at Indicated Distance in Feet (m) for n-Heptane at Very High Sensitivity (6 in. x 6 in.)

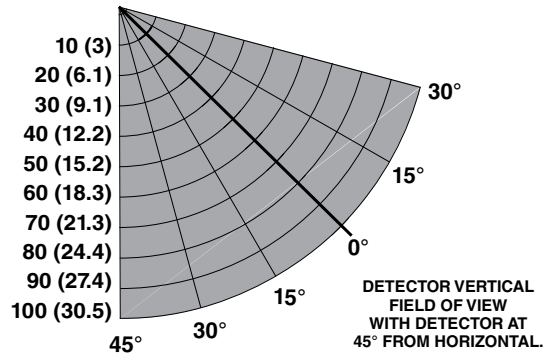
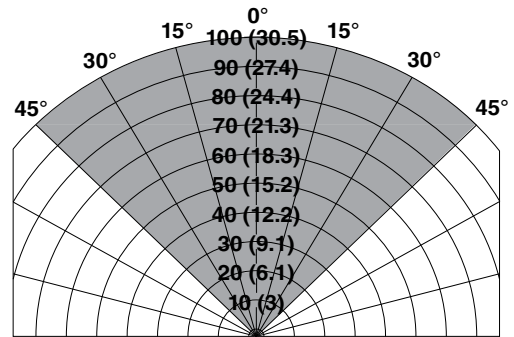
FM Approval and Performance Report – Continued



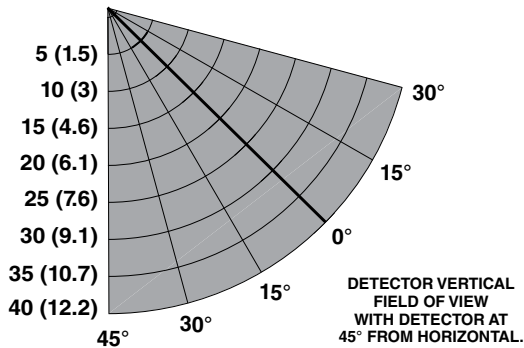
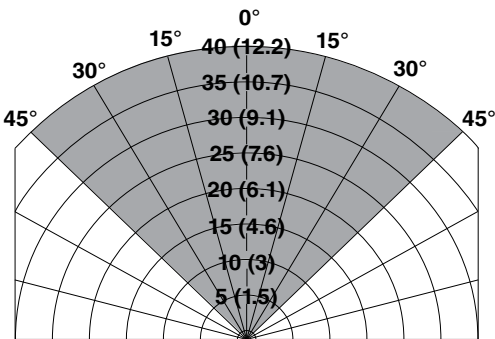
Field of View at Indicated Distance in Feet (m) for **Methanol** at **Very High** Sensitivity (1 x 1 foot)



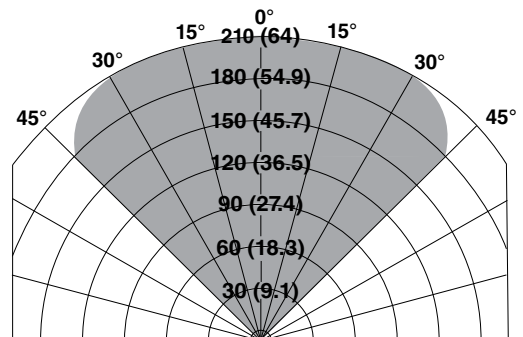
Field of View at Indicated Distance in Feet (m) for **Ethanol** at **Very High** Sensitivity (1 x 1 foot)



Field of View at Indicated Distance in Feet (m) for **Methane** at **Very High** Sensitivity (30 inch plume)

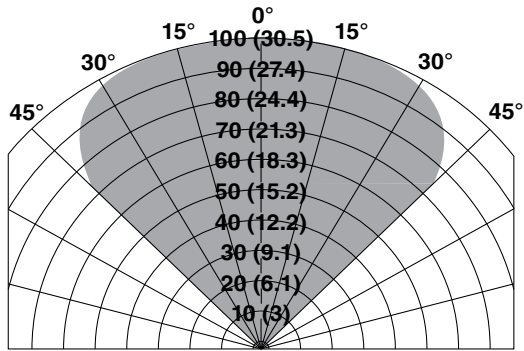


Field of View at Indicated Distance in Feet (m) for **Methanol** at **Very High** Sensitivity (6 in. x 6 in.)

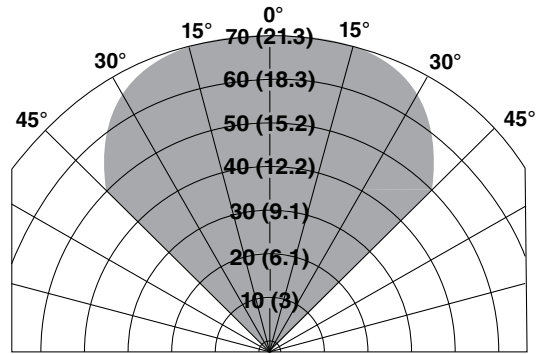


Field of View at Indicated Distance in Feet (m) for **JP-5** at **Very High** Sensitivity (2 x 2 feet)

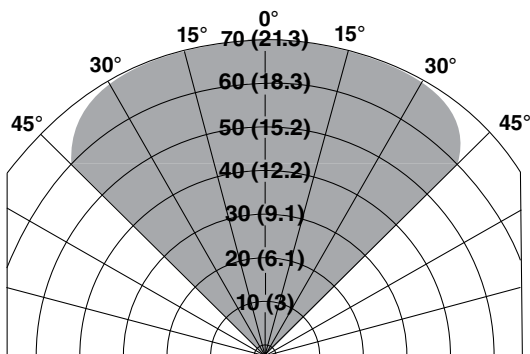
FM Approval and Performance Report – Continued



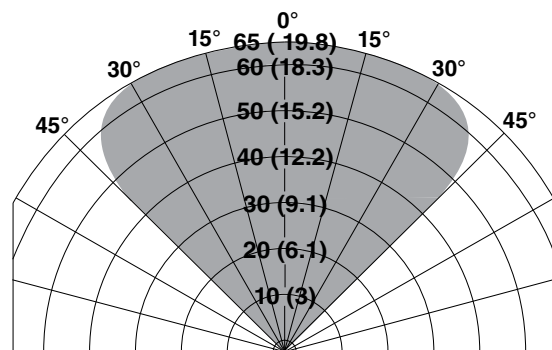
Field of View at Indicated Distance in Feet (m) for **n-Heptane** at **Medium** Sensitivity (1 x 1 foot)



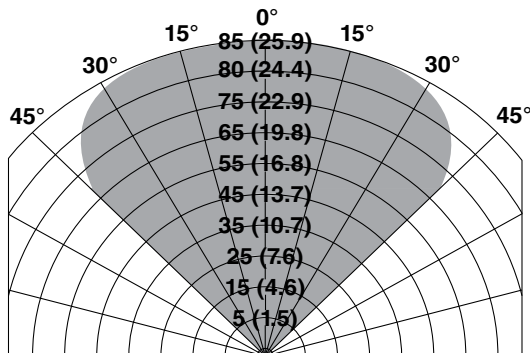
Field of View at Indicated Distance in Feet (m) for **Methanol** at **Medium** Sensitivity (1 x 1 foot)



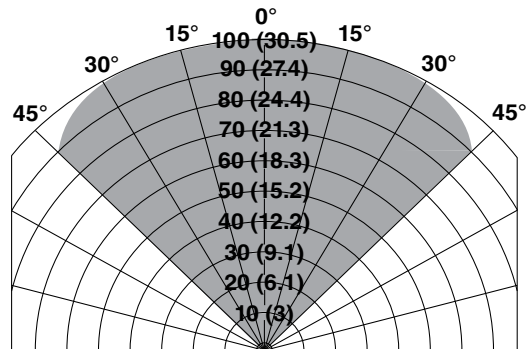
Field of View at Indicated Distance in Feet (m) for **Diesel** at **Medium** Sensitivity (1 x 1 foot)



Field of View at Indicated Distance in Feet (m) for **Methane** at **Medium** Sensitivity (30 inch plume)



Field of View at Indicated Distance in Feet (m) for **Ethanol** at **Medium** Sensitivity (1 x 1 foot)



Field of View at Indicated Distance in Feet (m) for **JP-5** at **Medium** Sensitivity (2 x 2 foot)

NOTE

FM Approvals minimum requirements are response distance measurements at 0° (on axis) and the limits of the field of view. These high resolution field of view diagrams show the measured response distances at all the indicated angles in the horizontal plane.

APPENDIX B

CSA APPROVAL

PRODUCTS

CLASS 4818 04 - SIGNAL APPLIANCES - Systems - For Hazardous Locations

Class I, Division 1, Groups B, C, and D (T4A); Class II, Division 1, Groups E, F, and G (T4A);

Class I, Division 2, Groups A, B, C, and D (T3C); Class II, Division 2, Groups F and G (T3C);

Class III; Enclosure NEMA/Type 4X;

Multispectrum IR Flame Detector/Controller X3301 Series, rated 18-30 Vdc, 4.6 Watts to 17 Watts.

Relay contacts rated 30 Vdc, 5 Amps.

NOTE

Hazardous location testing has been successfully completed on the Model X3301 series from an ambient temperature range of -55°C to +125°C; however, the detector label marking indicates -40°C to +75°C.

APPLICABLE REQUIREMENTS

CSA Std C22.2 No. 25-1966 – Enclosures for use in Class II Groups E, F & G Hazardous Locations.

CSA Std C22.2 No. 30-M1986 – Explosion-Proof Enclosures for use in Class I Hazardous Locations.

CAN/CSA C22.2 No. 94-M91 – Special Purpose Enclosures.

CSA Std C22.2 No. 142-M1987 – Process Control Equipment.

CSA Std C22.2 No. 213-M1987 – Nonincendive Electrical Equipment for use in Class I, Division 2 Hazardous Locations.

The following accessories are CSA approved for use with the X3301 Flame Detector:

Part Number	Description
102740-002	Magnet
007739-001	Magnet and Extension Pole
010857-001	Q1130A1001 Flange Mount Assembly
007290-001	Q9033B Stainless Steel Mounting Arm Assembly is for aluminum and stainless steel detectors
007290-002	Q9033A Aluminum Mounting Arm Assembly is for aluminum detectors only
011385-001	Q9033 Collar Attachment


APPENDIX C

ATEX / CE APPROVAL

EC-TYPE EXAMINATION CERTIFICATE

DEMKO 01 ATEX 130204X

Increased Safety Model

CE 0539  II 2 G
II 2 D

Ex d e IIC T6–T5 Gb


Ex tb IIIC T130°C

T6 (Tamb = –50°C to +60°C)

T5 (Tamb = –50°C to +75°C)

IP66/IP67.

Flameproof Model

CE 0539  II 2 G
II 2 D

Ex d IIC T6–T4 Gb

Ex tb IIIC T130°C

T6 (Tamb = –55°C to +60°C)

T5 (Tamb = –55°C to +75°C)

T4 (Tamb = –55°C to +125°C)

IP66/IP67.

Compliance with:

EN 60079-0: 2009

EN 60079-1: 2007

EN 60079-7: 2007

EN 60079-31: 2009

EN/IEC 60529: 2001.

INSTALLATION INSTRUCTIONS

The field wiring connections in the terminal compartment are ATEX certified and accepts wiring specifications from 14-24 AWG or 2.5-0.2 mm².

The Multispectrum infrared (IR) flame detector type X3301 shall be installed according to the instructions given by the manufacturer.

The cable entry devices shall be certified in type of explosion protection flameproof enclosure "d" for use with the terminal compartment in type of explosion protection flameproof enclosure "d", or in type of explosion protection increased safety "e" for use with the terminal compartment in type of explosion protection increased safety "e". They shall be IP66/IP67 rated, suitable for the conditions of use and correctly installed.

Unused entries shall be closed with suitable certified blanking elements.

The metal housing for the Multispectrum infrared (IR) flame detector type X3301 must be electrically connected to earth ground.

For ambient temperatures below –10°C and above +60°C use field wiring suitable for both minimum and maximum ambient temperature.

Special conditions for safe use:

The front window assembly contains a special cemented joint construction. In accordance with EN60079-1 clause 5.1.c, all inspections, repair and/or adjustments to this front window assembly shall be done by Detector Electronics Corporation only.

The EOL resistor can only be used within the flameproof terminal compartment.

EOL resistors must be ceramic, wirewound type, rated 5 watts minimum, with actual power dissipation not to exceed 2.5 watts.

The Multispectrum infrared (IR) flame detector type X3301 is to be installed in places where there is a low risk of mechanical damage.

NOTE

Operational performance verified from -40°C to $+75^{\circ}\text{C}$.

NOTE

An optional third party addressable module can only be used within the Ex d flameproof model unless the addressable module is component certified as Ex e for use within the Ex d e increased safety model.

NOTE

Refer to "EOL Resistors" section for installation details. All cable entry devices and blanking elements shall be certified to "E-generation" or "ATEX" standards, in type of explosion protection increased safety "e" or flameproof enclosure "d" (as applicable), suitable for the conditions of use and correctly installed. They shall maintain the degree of ingress protection IP66/IP67 for the apparatus. Unused conduit entries shall be closed with suitable blanking elements.

NOTE

For ATEX installations, the X3301 Flame Detector housing must be electrically connected to earth ground.

The following accessories are ATEX approved for use with the X3301 Flame Detector:

Part Number	Description
007290-001	Q9033B Stainless Steel Mounting Arm Assembly is for aluminum and stainless steel detectors
007290-002	Q9033A Aluminum Mounting Arm Assembly is for aluminum detectors only
011385-001	Q9033 Collar Attachment

APPENDIX D

IECEX APPROVAL

IECEX CERTIFICATE OF CONFORMITY

DEMKO

IECEX ULD 06.0017X

Ex d e IIC T6-T5 Gb

Ex tb IIIC T130°C

T6 (Tamb = -50°C to +60°C)

T5 (Tamb = -50°C to +75°C)

IP66/IP67.

or

Ex d IIC T6-T4 Gb

Ex tb IIIC T130°C

T6 (Tamb = -55°C to +60°C)

T5 (Tamb = -55°C to +75°C)

T4 (Tamb = -55°C to +125°C)

IP66/IP67.

Compliance with:

IEC 60079-0: 2007, Ed. 5

IEC 60079-1: 2007, Ed. 6

IEC 60079-7: 2006, Ed. 4

IEC 60079-31: 2008, Ed. 1

EN/IEC 60529: 2001.

INSTALLATION INSTRUCTIONS

The field wiring connections in the terminal compartment are suitable certified and accepts wiring specifications from 14-24 AWG or 2.5-0.2 mm².

The Multispectrum infrared (IR) flame detector type X3301 shall be installed according to the instructions given by the manufacturer.

The cable entry devices shall be certified in type of explosion protection flameproof enclosure "d" for use with the terminal compartment in type of explosion protection flameproof enclosure "d" or in type of explosion protection increased safety "e" for use with the terminal compartment in type of explosion protection increased safety "e". They shall be IP66/IP67 rated, suitable for the conditions of use and correctly installed.

Unused entries shall be closed with suitable certified blanking elements.

The metal housing for the Multispectrum infrared (IR) flame detector type X3301 must be electrically connected to earth ground.

For ambient temperatures below -10°C and above +60°C use field wiring suitable for both minimum and maximum ambient temperature.

Special conditions for safe use:

The front window assembly contains a special cemented joint construction. In accordance with IEC 60079-1 clause 5.1.c, all inspections, repair and/or adjustments to this front window assembly shall be done by Detector Electronics Corporation only.

The EOL resistor can only be used within the flameproof terminal compartment.

EOL resistors must be ceramic, wirewound type, rated 5 watts minimum, with actual power dissipation not to exceed 2.5 watts.

The Multispectrum infrared (IR) flame detector type X3301 is to be installed in places where there is a low risk of mechanical damage.

The following accessories are IECEx approved for use with the X3301 Flame Detector:

Part Number	Description
007290-001	Q9033B Stainless Steel Mounting Arm Assembly is for aluminum and stainless steel detectors
007290-002	Q9033A Aluminum Mounting Arm Assembly is for aluminum detectors only
011385-001	Q9033 Collar Attachment

APPENDIX E

EN54 APPROVALS

AGENCY	Conventional Output		LON Output	
	Certificate/Approval Number	Basis of Approval	Certificate/Approval Number	Basis of Approval
VdS – Constructive Product Directive	0786 – CPD – 20453	EN 54-10 + A1	—	—
VdS**	G 202136	VdS 2344 VdS 2504 EN 54-10 + A1	G 212019	VdS 2344 VdS 2504 EN 54-10 + A1 EN 54-17
	S 212002*	VdS 2344 EN 54-13	S 212002*	VdS 2344 EN 54-13
BRE – Constructive Product Directive	—	—	0832 – CPD – 1381	EN 54-10 + A1 EN 54-17
LPCB	973e/03	EN 54-10 + A1	973a/03	EN 54-10 + A1 EN 54-17

* Approved for use in conjunction with the EN54-13 compliant EQP System.

** Approval of Very High, Medium, and Low sensitivities, with T-Low sensitivity pending.

INSTRUCTIONS FOR THE APPLICATION OF THE APPROVAL COMPONENT/SYSTEM

The installation shall take into account, that the orientation arrow on the flame detector is directed upwards, as the view angle in this direction is <90°.

The IR-flame detector configured to High or Very High sensitivity corresponds to class 1.

The IR-flame detector configured to T-Low or Low sensitivity corresponds to class 2.

The following accessories are EN54-10 and EN54-17 approved for use with the X3301 Flame Detector:

Part Number	Description
102740-002	Magnet
007739-001	Magnet and Extension Pole
007290-001	Q9033B Stainless Steel Mounting Arm Assembly is for aluminum and stainless steel detectors
007290-002	Q9033A Aluminum Mounting Arm Assembly is for aluminum detectors only
011385-001	Q9033 Collar Attachment

APPENDIX F

OFFSHORE APPROVALS

USCG APPROVAL

Coast Guard Approval No. 161.002/49/0

The scope of this approval is for a fire detection system meeting 46 CFR 161.002, as part of the Eagle Quantum Premier System.

MARINE EQUIPMENT DIRECTIVE

DNV Certificate No. MED-B-5872.

Is found to comply with the requirements in the following Regulations / Standards:

Annex A.1, item No. A.1/3.5.1 and Annex B, Module B in the Directive. SOLAS 74 as amended, Regulation II-2/7 & X/3, 2000 HSC Code 7, FSS Code 9 and IMO MSC.1/Circ. 1242.

The equipment are found to comply with following location / application dependent requirements (for definition of each of the location classes, see below the table):

MODEL	TEMPERATURE	VIBRATION	EMC	ENCLOSURE
X3301	TEM-D	VIB-B	EMC-B	ENC-C

Definition of the location classes with reference to relevant standards:

Temperature

TEM-D Location (-25°C-70°C) (ref. IEC 60092-504 (2001) table 1 item 6-7)

Vibration

VIB-D For eq. on reciprocating machines etc. (ref IEC 60092-504 (2001) table 1 item 10)

EMC

EMC-B Bridge and open deck zone (ref. IEC 60092-504 (2001) table 1 item 19-20)

Enclosure

ENC-C Open deck (IP56) (ref. IEC 60092-201 table 5)

Conformity to Module D, E and F.

TYPE APPROVAL

DNV Certificate No. A-11022.

Subject Matter of the Approval

IR Flame Detector Type X3301 for use in Ships, High Speed & Light Craft, and Offshore Applications.

Application Location Classes:

Location classes for X3301 IR Flame Detector with Mounting Arm Q9033B / Q9033A (Shaded areas show Det-Tronics approved location classes)

TYPE	LOCATION WITHIN MAIN AREA	MAIN AREAS ON BOARD				
		Machinery spaces	Control room, Accommodation	Bridge	Pump room, Holds, Rooms with no heating	Open Deck
Temperature	Inside cubicles, desks, etc. with temperature rise of 5°C or more	B	B	B	D	D
	All other locations	A	A	A	C	D
Humidity	Locations where special precautions are taken to avoid condensation	A	A	A	A	A
	All other locations	B	B	B	B	B
Vibration	On machinery such as internal combustion engines, compressors, pumps, including piping on such machinery	B	—	—	B	B
	Masts	—	—	—	—	—
	All other locations	A	A	A	A	A
EMC (Electromagnetic compatibility)	All locations within specified main areas	A	A	B	A	B
Enclosure	Submerged application	D	—	—	D	D
	Below floor plates in engine room	C	—	—	—	—
	All other locations	B	A	A	B	C

TYPE APPROVAL

Lloyd's Register Certificate No. 09/00027.

Models Available: Relay output, relay 0-20 mA output, and EQP LON output versions.

The following accessories are offshore approved to the listed approvals, for use with the X3301 Flame Detector:

Part Number	Description
102740-002	Magnet
007739-001	Magnet and Extension Pole
007290-001	Q9033B Stainless Steel Mounting Arm Assembly is for aluminum and stainless steel detectors
007290-002	Q9033A Aluminum Mounting Arm Assembly is for aluminum detectors only
011385-001	Q9033 Collar Attachment

APPENDIX G

ADDITIONAL APPROVALS

SIL 2



IEC 61508

Certified SIL 2 Capable.

Applies to specific models – refer to the SIL 2 Certified X3301 Safety manual (95-8582) for details.

FRANCE



NF-SSI

AFNOR Identification No: LIR 007 A0.

www.marque-nf.com

RUSSIA



VNIIFTRI

CERTIFICATE OF CONFORMITY GOST R 51330.X-99

2ExdeIICT6/T5 IP66

T6 (Tamb = -50°C to +60°C)

T5 (Tamb = -50°C to +75°C).

– OR –

1ExdIICT6/T5/T4 IP66

T6 (Tamb = -55°C to +60°C)

T5 (Tamb = -55°C to +75°C)

T4 (Tamb = -55°C to +125°C).



VNIIPO

CERTIFICATE OF CONFORMITY TO TECHNICAL REGULATIONS, GOST R 53325-2009

BRAZIL



UL-BR 12.0093X

Ex d e IIC T6-T5 Gb IP66/IP67

Ex tb IIIC T130°C

T6 (Tamb = -50°C to +60°C)

T5 (Tamb = -50°C to +75°C).

– OR –

Ex d IIC T6-T4 Gb IP66/IP67

Ex tb IIIC T130°C

T6 (Tamb = -55°C to +60°C)

T5 (Tamb = -55°C to +75°C)

T4 (Tamb = -55°C to +125°C).



95-8527



X3301 Multispectrum
IR Flame Detector



PointWatch Eclipse®
IR Combustible Gas Detector



FlexVu® Universal Display
w/ GT3000 Toxic Gas Detector



Eagle Quantum Premier®
Safety System

Detector Electronics Corporation
6901 West 110th Street
Minneapolis, MN 55438 USA

T: 952.941.5665 or 800.765.3473
F: 952.829.8750

W: <http://www.det-tronics.com>
E: det-tronics@det-tronics.com

Instructions

95-8526

Infrared Hydrocarbon Gas Detector
PointWatch Eclipse®
Model PIRECL



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Infrared Hydrocarbon Gas Detector

PointWatch Eclipse®

Model PIRECL

IMPORTANT

Be sure to read and understand the entire instruction manual before installing or operating the gas detection system. This product is intended to provide early warning of the presence of a flammable or explosive gas mixture. Proper device installation, operation, and maintenance is required to ensure safe and effective operation. If this equipment is used in a manner not specified in this manual, safety protection may be impaired.



APPLICATION

The Pointwatch Eclipse® Model PIRECL is a diffusion-based, point-type infrared gas detector that provides continuous monitoring of combustible hydrocarbon gas concentrations in the range of 0 to 100% LFL.

Three basic configurations are available:

- 4-20 mA output with HART communication protocol and RS-485 MODBUS communications.
- 4-20 mA output with HART communication protocol and RS-485 MODBUS communications, with two alarm relays and one fault relay.
- Eagle Quantum Premier (EQP) compatible version (no analog or relay outputs).

All units are powered from 24 volts DC, and are furnished with an onboard "status indication" LED, an internal magnetic calibration switch and an external calibration line for use with the optional PIRTB remote calibration termination box.

The Pointwatch Eclipse is ideal for use in harsh outdoor environments and is certified for use in Class I, Division 1, and Zone 1 hazardous areas. It can be used as a stand-alone detector, or as part of a larger facility protection system using other Det-Tronics equipment such as the FlexVu® UD10 Universal Display Unit, the U9500H Infiniti Transmitter, the R8471H Controller, or the Eagle Quantum Premier Fire and Gas Detection/Releasing System.

OPERATION OVERVIEW

THEORY OF OPERATION

Flammable hydrocarbon gases diffuse through the weather baffle assembly into the internal measurement chamber, which is illuminated by an infrared (IR) source. As the IR passes through the gas within the chamber, certain IR wavelengths are absorbed by the gas, while other IR wavelengths are not. The amount of IR absorption is determined by the concentration of the hydrocarbon gas. A pair of optical detectors and associated electronics measure the absorption. The change in intensity of the absorbed light (active signal) is measured relative to the intensity of light at a non-absorbed wavelength (reference signal). See Figure 1. The microprocessor computes the gas concentration and converts the value into a 4 to 20 milliampere current output or digital process variable signal, which is then communicated to external control and annunciation systems.

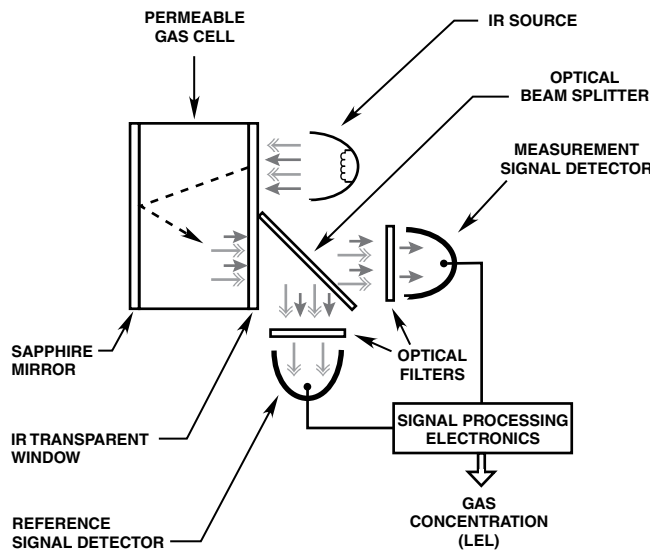


Figure 1—Measurement Scheme for Infrared Gas Detector

DETECTABLE GASES

Eclipse is capable of detecting many hydrocarbon gases and vapors. Refer to the Specifications section of this manual for details.

OUTPUTS

Standard

The standard version provides an isolated/non-isolated 4-20 mA current loop for connection to analog input devices.

Optional Relays

An optional relay output board providing two programmable alarm relay outputs and one fault relay output can be factory installed with the standard version. All relays are sealed and provide form C (NO/NC) contacts. The high and low alarm relay settings are programmable and can be set for latching or non-latching operation. The low alarm cannot be set above the high alarm threshold. Alarm configuration can be done with the HART or MODBUS interface. The onboard multicolor LED indicates a LOW alarm condition via a flashing red color, and a HIGH alarm condition via a steady red color. The Eclipse internal magnetic switch or HART Field Communicator can be used to reset latched alarms. A short-duration magnetic switch activation of 1 second will reset latched alarms. Holding the magnetic switch closed for 2 seconds will start the calibration sequence. The external calibration line will not reset latched alarm relays.

When the optional relay output board is specified, the PIRECL's approval rating is Ex d only.

NOTE

Refer to "Alarm Relays" in the Specifications section of this manual for important information regarding alarm relays.

EQP Version

The Eagle Quantum Premier model provides proprietary digital signals that are compatible with the EQ Premier network (LON) only. No analog 4-20 mA or RS-485 MODBUS signal outputs are provided. The optional onboard HART communication port is operational, but is not recommended for programming use. All programming of the EQP PIRECL detector should be accomplished using the S3 point configuration software. Refer to the EQP Appendix within this manual for additional information.

DATA LOGGING CAPABILITY

Non-volatile memory is provided to save the 10 most recent calibrations, alarm/fault events, and minimum/maximum operating temperature history. An hour meter (running operational hours since startup) is provided to record operating service time and to give an indication of the relative time between events. This information is accessible using HART, MODBUS communication, or EQP system software.

OPTIONAL THIRD PARTY ADDRESSABLE MODULES

The PIRECL is electrically compatible with third party addressable modules, provided the module fits within the PIRECL wiring compartment. Whenever a third party addressable module is installed, the PIRECL's Ex e rating and FM Approval are void, and only the Ex d rating is valid. Installation of a third party addressable module requires a specially labeled PIRECL model to ensure valid product approvals.

SPECIFICATIONS

INPUT VOLTAGE (All Models)—

24 Vdc nominal. Operating range is 18 to 32 Vdc.
Ripple cannot exceed 0.5 volts P-P.

POWER CONSUMPTION (All Models)—

Detector without Relays

4.0 watts nominal @ 24 Vdc
7.5 watts peak @ 24 Vdc
10 watts peak @ 32 Vdc.

Detector with Relays

5.5 watts nominal @ 24 Vdc
8.0 watts peak @ 24 Vdc
10.0 watts peak @ 32 Vdc.

TEMPERATURE RANGE—

Operating: -40°C to +75°C (-40°F to +167°F).
Storage: -55°C to +85°C (-67°F to +185°F).

HUMIDITY—

0 to 99% relative humidity (Det-Tronics verified).
5 to 95% relative humidity (FM/CSA/DEMKO verified).

GAS DETECTION RANGE—

0 to 100% LFL standard. Other ranges are configurable (down to 20% full scale).

DETECTABLE GASES—

Model PIRECL is provided with field-selectable settings for linear measurement of methane, propane, ethylene, and butane. Model PIRECL is performance certified for detection of methane, propane, ethylene, and butane, and is shipped from the factory calibrated and set for the customer's choice of one of these gases. Digital communication (such as HART) is required to confirm the current setting and change it if required. In addition to the gases listed above, the Eclipse is capable of detecting many other hydrocarbon gases and vapors, with settings provided for gases such as ethane and propylene. For detection of gases other than the four certified gases, performance characteristics / transfer curves are available. Please consult the factory for details.

DETECTOR CONFIGURATION OPTIONS—

A significant number of PIRECL configuration parameters are field programmable including gas type, measurement range, alarm setpoints, tag number, special notations, password protection, etc. Details are provided in the HART Communication Appendix. Three PIRECL field configuration programming methods are supported:

- HART Communication
- EQP System S3 Software
- RS-485 MODBUS Communication

THIRD PARTY ADDRESSABLE MODULE (Optional)—

Input Voltage: 30 Vdc.
Input Current: 30 mA.

SHORT CIRCUIT CURRENT

(Non-Relay Output Versions Only)—

Power Supply Short Circuit Current (Isc): 5.4 amperes*
Short Circuit Current on Fused Line: 3.1 amperes*
Power Supply Max Voltage: Um = 250V**

* For installations in accordance with Increased Safety wiring practices.

** For intrinsically safe HART communication port.

WARM-UP TIME (All Models)—

Device enters normal mode after two minutes upon cold power-up. One hour warm-up time is recommended for optimum performance. Signal output level during warm-up is programmable.

CURRENT OUTPUT (Standard Models Only)—

Linear 4-20 mA (current source/sink, isolated/non-isolated) rated at 600 ohms maximum loop resistance @ 24 Vdc operating voltage.

VISUAL STATUS INDICATOR (All Models)—

Tri-color LED:

Red = Low alarm, high alarm, or calibration.
See Table 1 for Details.

Green = Power on / OK

Yellow = Fault or warm-up.

RELAY OUTPUTS (Optional)—

(Available on Ex d approved models only, not available on Eagle Premier model).

ALARM RELAYS—

Low and High

Form C Type (NO/NC).

De-Energized during Normal mode, Energized on Alarm.

Contact Rating: 5 amperes at 30 Vdc.

Programmable for Latching or Non-Latching Operation.

Setpoint Range (both): 5-60% LFL.

Note: Low alarm range for EQP model is 5-40% LFL.

Factory Default Settings:

Low: 20% LFL – Non-latching

High: 50% LFL – Non-latching

Alarm relay programming can be accomplished using HART or MODBUS.

CAUTION

*When the PIRECL Gas Detector is used in conjunction with an appropriate certified Control Unit and configured for a non-latching high alarm, the control unit must **always** latch and require a deliberate manual action to clear a high gas alarm. When used as a stand alone device, the high alarm must always be programmed for latching operation.*

FAULT RELAY—

Form C Type (NO/NC). Energized during Normal mode, De-Energized on Fault or loss of power.
 Contact Rating: 5 amperes at 30 Vdc.
 Non-Latching Operation only — not programmable.

DIGITAL OUTPUT (Optional)—

Digital communication, transformer isolated (78.5 kbps).

CALIBRATION—

All units are factory set and calibrated to the customer's choice of methane, propane, ethylene, or butane.

Field programming and full calibration are typically required for detection of vapors other than the factory-calibrated gas. Refer to the "Calibration" section of this manual for details.

Routine calibration of the PIRECL after completion of initial commissioning is supported, but not absolutely required. Generally, an annual gas bump test or full calibration will ensure proper sensitivity and response.

NOTE

Frequent visual inspections of the PIRECL are recommended to confirm that there are no external impediments to proper detection capability.

Four methods of initiating Calibration are supported:

- On-Board magnetic reed switch
- HART communication
- Remote calibration line for remote switch
- MODBUS communication

RESPONSE TIME—

Refer to the appropriate Appendix for details.

VIBRATION—

PIRECL successfully passes Sinusoidal Vibration Testing in accordance with MIL-STD-810C, Method 514.2, Paragraph 4.5.1.3, Figure 514.2-7 Curve AW, and C22.2 No. 152-M1984, and also DET NORSKE VERITAS Certification Notes – No. 2.4 dated May 1995.

ACCURACY—

±3% LFL from 0 to 50% LFL, ±5% LFL from 51 to 100% LFL (at room ambient temperature, +23°C).

SELF-DIAGNOSTIC TEST—

Fail-Safe operation ensured by performing all critical tests once per second.

INGRESS PROTECTION—

IP66/IP67 (DEMKO Verified).

DETECTOR HOUSING MATERIAL—

316 stainless steel (CF8M).

CONDUIT ENTRY OPTIONS—

Two entries, 3/4 inch NPT or 25 mm.

HART COMMUNICATION PORT (optional)—

Intrinsically safe. For live maintenance, follow Control Drawing 007283-001 in Appendix J.

OPTICS PROTECTION—

The three-layer weather baffle assembly is UV-resistant, static-dissipating black Polythalamide plastic. The standard weather baffle version, recommended for most outdoor and indoor applications, includes an internal hydrophobic filter. The standard weather baffle includes a 3/16" (4.8mm) barb fitting for attaching a 3/16" I.D. hose during calibration.

Two replacement weather baffles with special calibration gas openings are available:

- 1/16" internally threaded calibration gas opening to enable the user to install a threaded compression fitting (not supplied) into the baffle for use with plastic or metal tubing (007529-xxx Direct Duct compatible)
- 7/16-20 externally threaded calibration gas opening for use with the PIRECL sample draw cup assembly (007378-001).

Heated optics minimize condensation to ensure reliable operation through temperature extremes.

WIRING—

Field wiring screw terminals are UL/CSA rated for up to 14 AWG wire, and are DIN/VDE rated for 2.5 mm² wire. Screw terminal required torque range is 3.5–4.4 in.-lbs. (0.4-0.5 N·m).

CERTIFICATION—

Refer to the appropriate Appendix for specific information.

DIMENSIONS—

See Figure 2.

SHIPPING WEIGHT (Approximate)—

10.5 pounds (4.8 kg).

WARRANTY—

Five year limited warranty from date of manufacture.

See Appendix I for details.

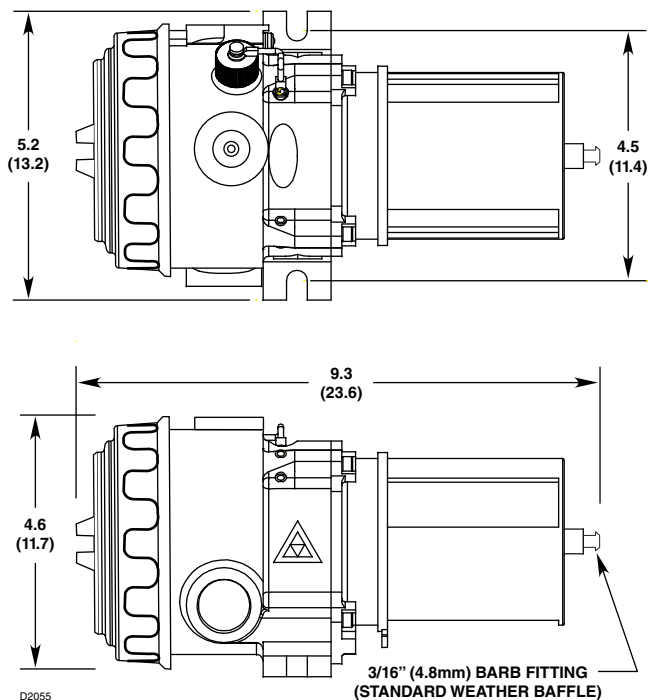


Figure 2—Dimensions of Eclipse Detector in Inches (Centimeters)

IMPORTANT SAFETY NOTES

CAUTION

The wiring procedures in this manual are intended to ensure proper functioning of the device under normal conditions. However, because of the many variations in wiring codes and regulations, total compliance to these ordinances cannot be guaranteed. Be certain that all wiring complies with the NEC as well as all local ordinances. If in doubt, consult the authority having jurisdiction before wiring the system. Installation must be done by a properly trained person.

CAUTION

This product has been tested and approved for use in hazardous areas. However, it must be properly installed and used only under the conditions specified within this manual and the specific approval certificates. Any device modification, improper installation, or use in a faulty or incomplete configuration will render warranty and product certifications invalid.

CAUTION

The detector contains no user serviceable components. Service or repair should never be attempted by the user. Device repair should be performed only by the manufacturer or trained service personnel.

LIABILITIES

The manufacturer's warranty for this product is void, and all liability for proper function of the detector is irrevocably transferred to the owner or operator in the event that the device is serviced or repaired by personnel not employed or authorized by Detector Electronics Corporation, or if the device is used in a manner not conforming to its intended use.

CAUTION

Observe precautions for handling electrostatic sensitive devices.

NOTE

The PointWatch Eclipse is intended for detection of hydrocarbon vapors only. The device will not detect hydrogen gas.

INSTALLATION

Before installing the Pointwatch Eclipse, define the following application details:

IDENTIFICATION OF FLAMMABLE VAPOR(S) TO BE DETECTED

It is necessary to always identify the flammable vapor(s) of interest at the job site in order to determine the proper calibration gas setting for Pointwatch Eclipse. In addition, the fire hazard properties of the vapor, such as vapor density, flashpoint, and vapor pressure should be identified and used to assist in selecting the optimum detector mounting location within the area.

The detector must be installed per local installation practices. For IEC/ATEX hazardous areas, it may be acceptable to utilize Ex e wiring practices with the Eclipse (non-relay versions).

IDENTIFICATION OF DETECTOR MOUNTING LOCATIONS

Identification of the most likely leak sources and leak accumulation areas is typically the first step in identifying the best detector mounting locations. In addition, identification of air current / wind patterns within the protected area is useful in predicting gas leak dispersion behavior. This information should be used to identify optimum sensor installation points.

If the vapor of interest is lighter than air, place the sensor above the potential gas leak. Place the sensor close to the floor for gases that are heavier than air. For heavy vapors, typically locate Pointwatch Eclipse at 2-4 cm above grade elevation. Note that air currents may cause a gas that is slightly heavier than air to rise under some conditions. Heated gases may also exhibit the same phenomenon.

The most effective number and placement of detectors varies depending on the conditions at the job site. The individual designing the installation must often rely on experience and common sense to determine the detector quantity and best locations to adequately protect the area. Note that it is typically advantageous to locate detectors where they are accessible for maintenance, and also where the Eclipse status indication LED can easily be seen. Locations near excessive heat / vibration sources should be avoided if possible.

Final suitability of possible gas detector locations should be verified by a job site survey. Gas detector area of coverage is a subjective evaluation, and may require long-term empirical data to confirm effectiveness. A typical rule of thumb is that one detector can cover a 900 square foot area.

However, this rule of thumb is subject to change depending upon specific application properties and requirements.

NOTE

For additional information on determining the quantity and placement of gas detectors in a specific application, refer to the article titled "The Use of Combustible Detectors in Protecting Facilities from Flammable Hazards" contained in the Instrumentation, Systems and Automation Society (ISA) Transaction, Volume 20, Number 2.

PHYSICAL INSTALLATION REQUIREMENTS

Pointwatch Eclipse is provided with built-in mounting feet that will accept 3/8 inch (M8) diameter mounting bolts. Always ensure that the mounting surface is vibration-free and can suitably support the total weight of the Pointwatch Eclipse without assistance from electrical cabling or conduit system.

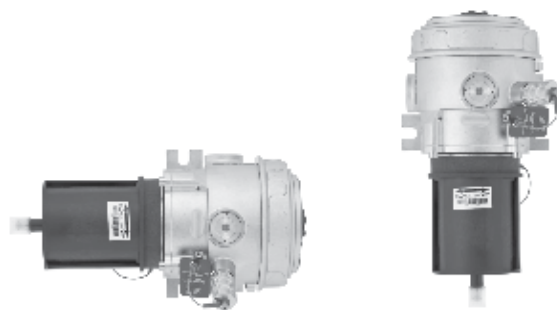
The detector must be installed per local installation practices. For IEC/ATEX hazardous areas, it may be acceptable to utilize Ex e wiring practices with the Eclipse.

Device Mounting Orientation

It is highly recommended that the Eclipse be installed in the horizontal position. The detector is not position-sensitive in terms of its ability to detect gas. However, the weather baffle assembly provides superior performance when the Eclipse is installed with the baffle in a horizontal position.

LED Visibility

Select a mounting orientation where the Pointwatch Eclipse status indication LED is visible to personnel within the area.



CORRECT

INCORRECT

Recommended Orientation of Eclipse Detector

Calibration Gas Port Cover

A protective cover for the calibration gas injection port is provided to ensure that contaminants are not accidentally introduced into the Eclipse optics. Ensure that this cover is properly installed over the port when calibration is not being performed.

NOTE

Failure to install the calibration gas port cover or the use of a damaged cover may result in nuisance faults and require cleaning the detector optics.

24 VDC POWER SUPPLY REQUIREMENTS

Calculate the total gas detection system power consumption rate in watts from cold start-up. Select a power supply with adequate capability for the calculated load. Ensure that the selected power supply provides regulated and filtered 24 Vdc output power for the entire system. If a back-up power system is required, a float-type battery charging system is recommended. If an existing source of 24 Vdc power is being utilized, verify that system requirements are met.

WIRING CABLE REQUIREMENTS

Always use proper cabling type and diameter for input power as well as output signal wiring. 14 to 18 AWG shielded stranded copper wire is recommended.

Always install a properly sized, master power fuse or breaker on the system power circuit.

NOTE

The use of shielded cable in conduit or shielded armored cable is required. In applications where the wiring is installed in conduit, dedicated conduit is recommended. Avoid low frequency, high voltage, and non-signaling conductors to prevent nuisance EMI problems.

CAUTION

The use of proper conduit installation techniques, breathers, glands, and seals is required to prevent water ingress and/or maintain the explosion-proof rating.

POWER WIRING SIZE AND MAXIMUM LENGTH

1. The Eclipse detector must receive 18 Vdc minimum to operate properly. 24 Vdc minimum is recommended.
2. Always determine voltage drops that will occur to ensure that 24 Vdc is delivered to the Eclipse.
3. Normally, nothing smaller than 18 AWG (0.75 mm²) is recommended by Det-Tronics for Eclipse power cabling.

Wire size requirements are dependent upon power supply voltage and wire length.

The maximum distance between the Eclipse detector and its power supply is determined by the maximum allowable voltage drop for the power wiring loop. If the voltage drop is exceeded, the device will not operate. To determine the maximum power loop voltage drop, subtract the minimum operating voltage for the device (18 Vdc) from the minimum output voltage of the power supply.

Maximum Power Loop
Voltage Drop =

Power Supply Voltage Minus Minimum Operating Voltage
--

To determine the actual maximum wire length:

1. Divide the maximum allowable voltage drop by the maximum current draw of the Eclipse (0.31 A),
2. Divide by the resistance of the wire (ohms/foot value available in wire manufacturer's specification data sheet),
3. Divide by 2.

Maximum Wire Length =

Maximum Voltage Drop ÷ Maximum Current ÷ Wire Resistance in Ohms/ Foot ÷ 2

For example: Consider an installation using 18 AWG wiring with a power supply providing 24 Vdc.

Power supply voltage = 24 Vdc,
Eclipse minimum operating voltage = 18 Vdc

$$24 - 18 = 6 \text{ Vdc}$$

Maximum Voltage Drop = 6
Maximum Current = 0.31 A
Wire Resistance in Ohms/Foot = 0.006523

$$6 \div 0.31 \div 0.006523 \div 2 = 1484 \text{ feet}$$

NOTE

For FM/CSA/ATEX Certified systems using HART communication, the maximum wiring distance is 2000 feet.

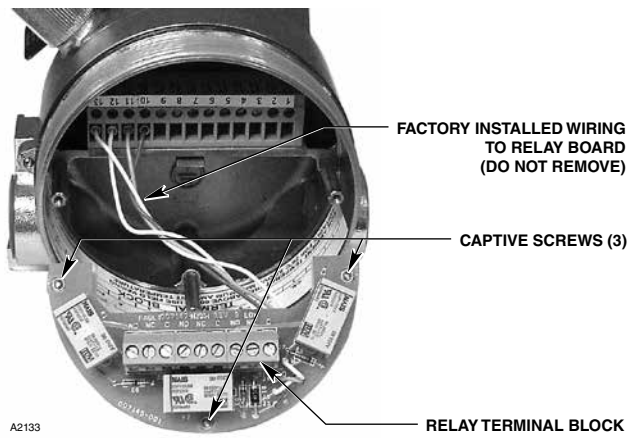


Figure 3—Eclipse Wiring Termination Compartment with Optional Relay Board Removed

OPTIONAL RELAYS

Optional relay contacts are “dry”, meaning that the installer must provide the voltage to the common terminal of the relay output.

AC voltage should not be switched directly using the Eclipse relays. The use of an external relay is required if AC voltage must be switched by the Eclipse relays.

In order to change alarm relay settings from the factory default settings, it is recommended to utilize a HART Field Communicator. Contact the factory for further assistance.

NOTE

Refer to “Alarm Relays” in the Specifications section of this manual for important information regarding alarm relays.

The relay board must temporarily be removed from the Eclipse termination compartment to connect the relay output field wiring cables. After the relay wiring is connected, re-install the relay board using the three captive screws. Refer to Figure 3.

WIRING PROCEDURE

Ensure that all cables are terminated properly. Pointwatch Eclipse screw terminal torque range is 3.5–4.4 in.-lbs. (0.4–0.5 N·m).

Conductor insulation should be stripped off with a bare conductor length of 0.2 inch (5 mm) minimum and 0.7 inch (18 mm) maximum.

Cable shield, if used, should be properly terminated. If not terminated, clip the shield wire off short and insulate it within the detector housing to prevent the shield wire from accidentally contacting the detector housing or any other wire.

Figure 4 shows the wiring terminal strip located inside the detector’s integral junction box.

Figure 5 shows the wiring terminal configuration for the standard Eclipse without relays.

Figure 6 shows the wiring terminal configuration for the standard Eclipse with relays.

Figures 7 through 10 show the 4-20 mA output of the Eclipse detector in various wiring schemes.

Figure 11 shows a standard Eclipse wired to a FlexVu UD10 Universal Display Unit.

Figure 12 shows a standard Eclipse wired to a Model U9500H Infiniti Transmitter.

Figure 13 shows a standard Eclipse wired to a Model R8471H Controller.

Figure 14 shows the wiring terminal configuration for the Eagle Quantum Premier Eclipse.

Figure 15 shows the Eclipse wired for benchtop testing/programming using HART protocol.

NOTE

The Eclipse housing must be electrically connected to earth ground. A dedicated earth ground lug is provided for this purpose.

REMOTE CALIBRATION WIRING

If it is desired to initiate calibration using the remote calibrate line, the use of the Det-Tronics Model PIRTB Termination Box is highly recommended for optimum ease of installation and calibration. The PIRTB module includes a magnetic reed switch, indicating LED, and wiring terminal block. Refer to “Remote Calibration Option” in the “Description” section of this manual for details.

Figure 16 shows the location of the wiring terminals, reed switch and LED inside the calibration termination box. See Figures 17 and 18 for wiring details.

WARNING

Do not attempt to physically connect or touch the calibration lead wire to DCV common in the field to begin calibration. This practice is often less than precise, and may result in a spark or other undesirable results. For optimum ease of installation and calibration, always utilize a Det-Tronics junction box with magnetic reed-switch, indicating LED, and termination block (Model PIRTB).

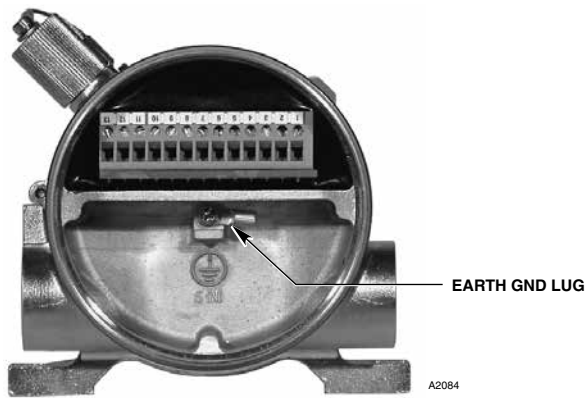


Figure 4—Terminal Strip Located Inside Wiring Compartment

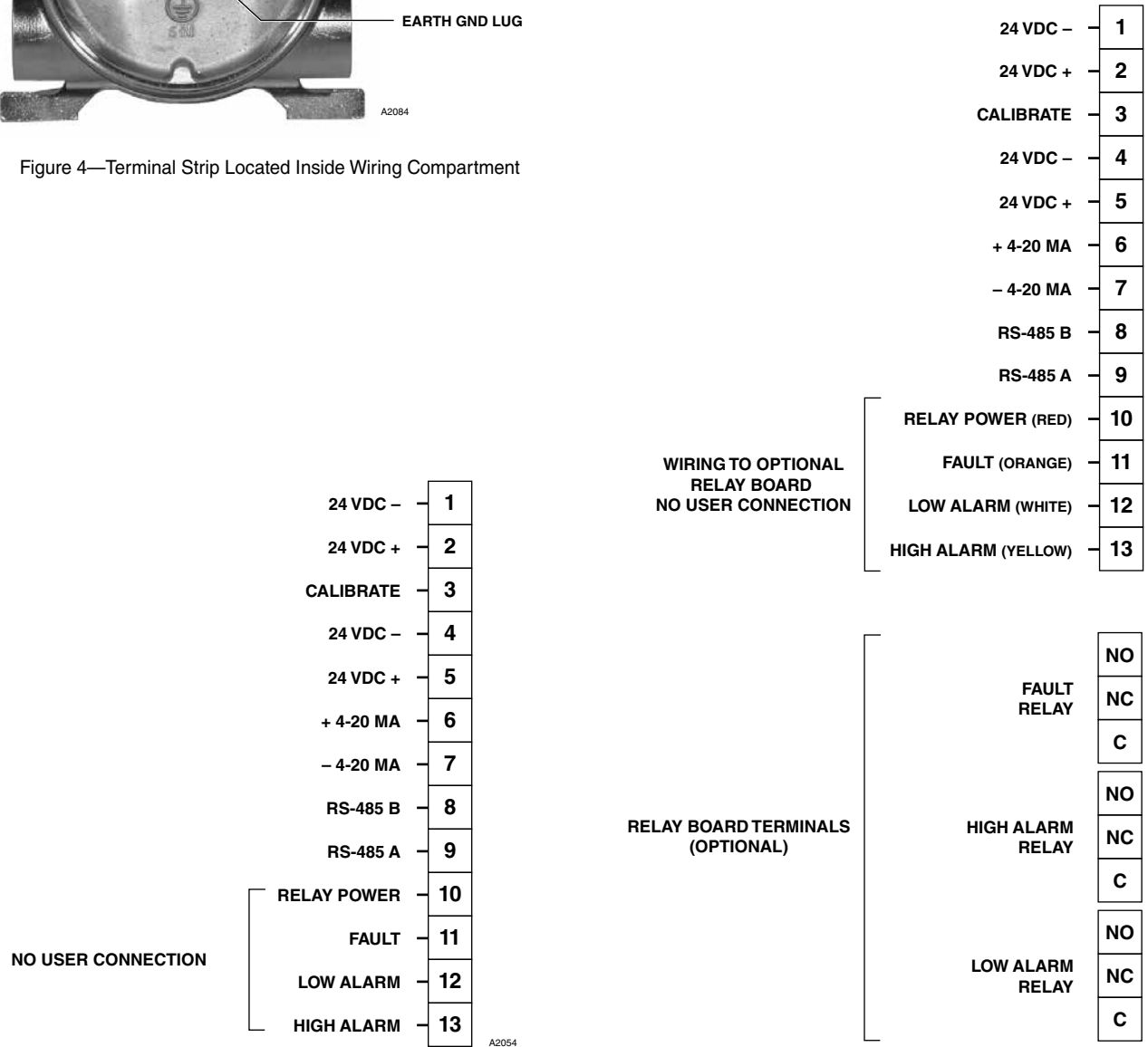
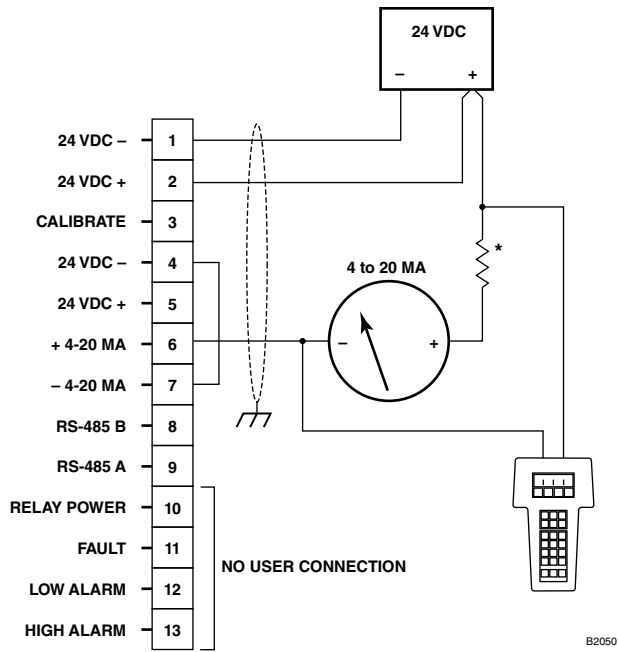


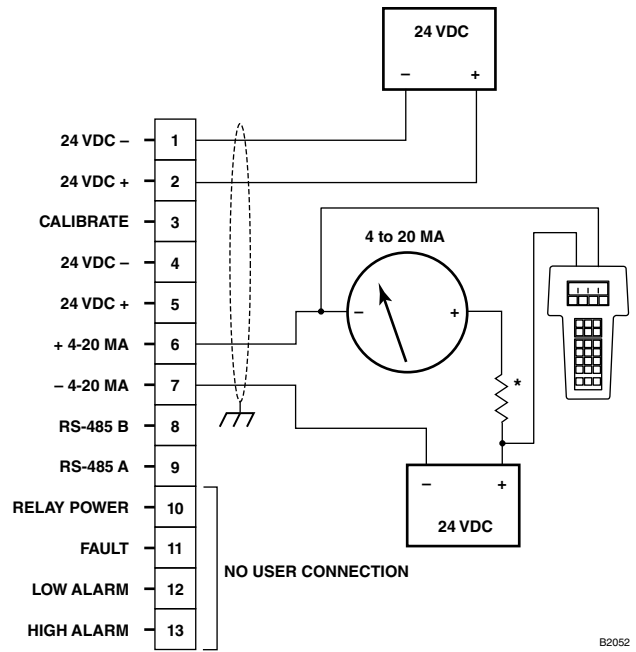
Figure 5—Wiring Terminal Identification for Standard Eclipse Without Relays

Figure 6—Wiring Terminal Identification for Standard Eclipse with Relays



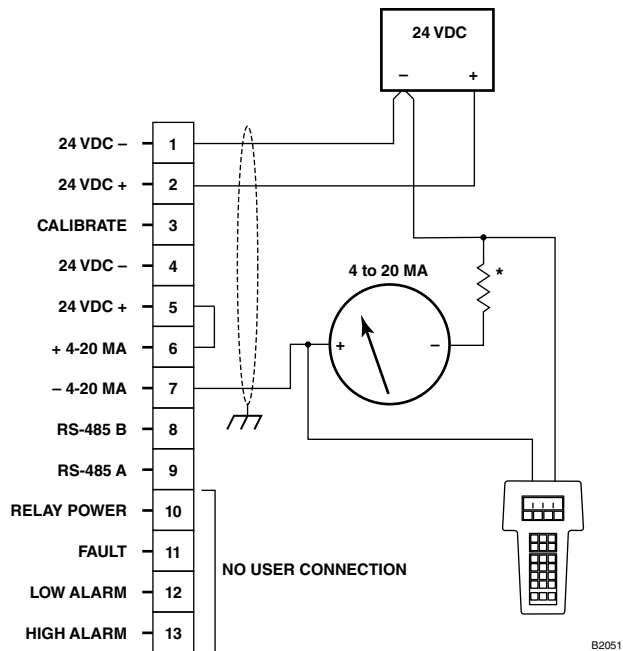
*TOTAL LOOP RESISTANCE = 250 OHMS MINIMUM, 600 OHMS MAXIMUM.
DO NOT INSTALL RESISTOR WITHIN PIRECL ENCLOSURE IN EEx e APPLICATIONS.

Figure 7—Eclipse Detector Wired for Non-Isolated 4-20 mA Current Output (Sinking)



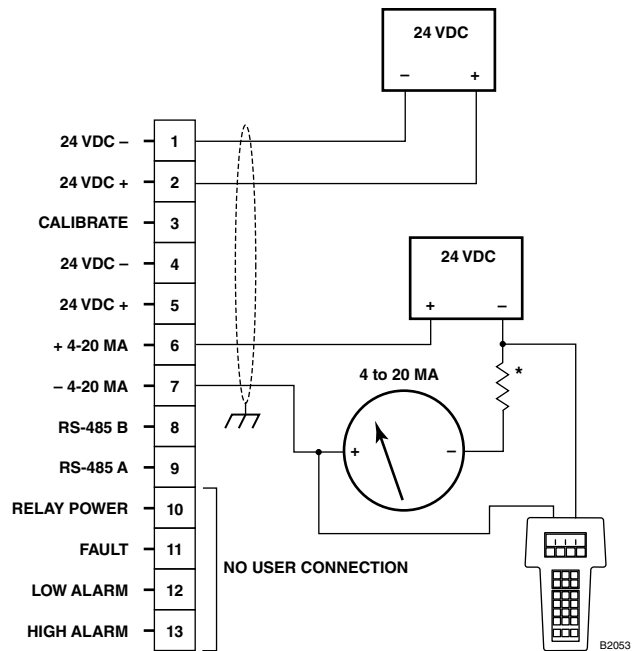
*TOTAL LOOP RESISTANCE = 250 OHMS MINIMUM, 600 OHMS MAXIMUM.
DO NOT INSTALL RESISTOR WITHIN PIRECL ENCLOSURE IN EEx e APPLICATIONS.

Figure 9—Eclipse Detector Wired for Isolated 4-20 mA Current Output (Sinking)



*TOTAL LOOP RESISTANCE = 250 OHMS MINIMUM, 600 OHMS MAXIMUM.
DO NOT INSTALL RESISTOR WITHIN PIRECL ENCLOSURE IN EEx e APPLICATIONS.

Figure 8—Eclipse Detector Wired for Non-Isolated 4-20 mA Current Output (Sourcing)



*TOTAL LOOP RESISTANCE = 250 OHMS MINIMUM, 600 OHMS MAXIMUM.
DO NOT INSTALL RESISTOR WITHIN PIRECL ENCLOSURE IN EEx e APPLICATIONS.

Figure 10—Eclipse Detector Wired for Isolated 4-20 mA Current Output (Sourcing)

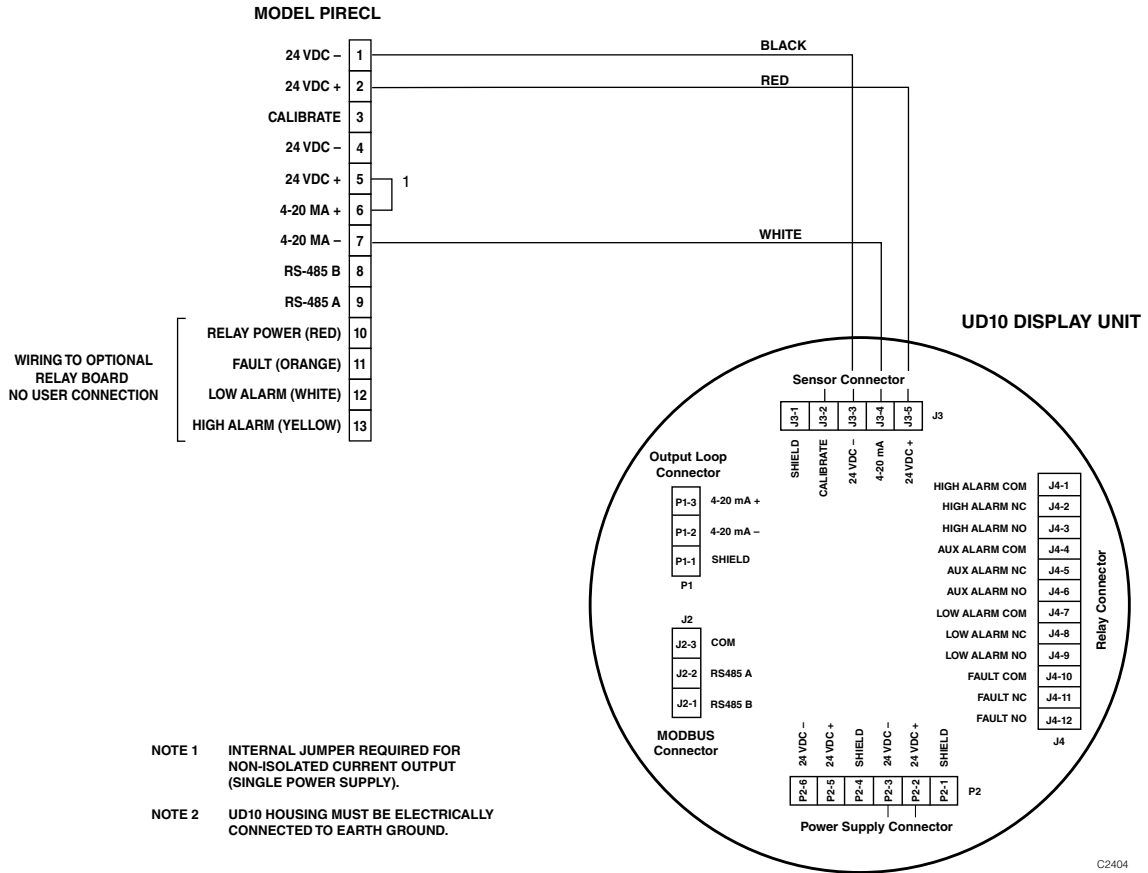
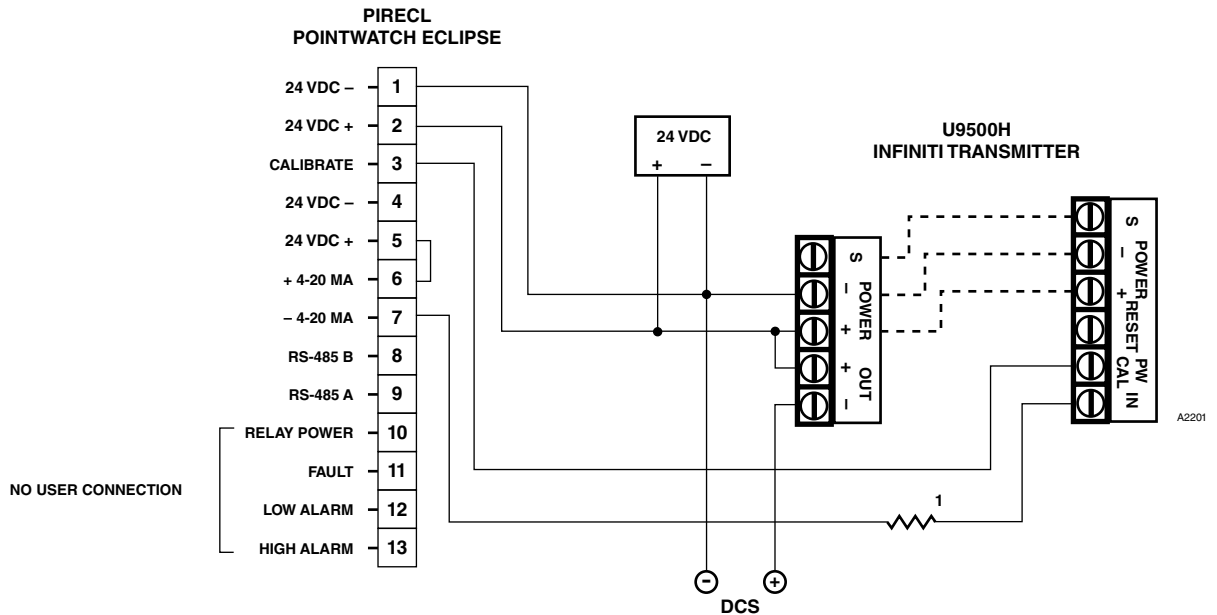


Figure 11—Standard Eclipse Wired to a Model UD10 Universal Display Unit



NOTES: 1 250 OHM RESISTOR REQUIRED IF USING HART PORT COMMUNICATIONS.

2 PIRECL ECLIPSE MUST BE PROGRAMMED TO PIR9400 FAULT MODE FOR PROPER STATUS IDENTIFICATION AT THE U9500H TRANSMITTER.

Figure 12—Standard Eclipse Wired to a Model U9500H Infiniti Transmitter

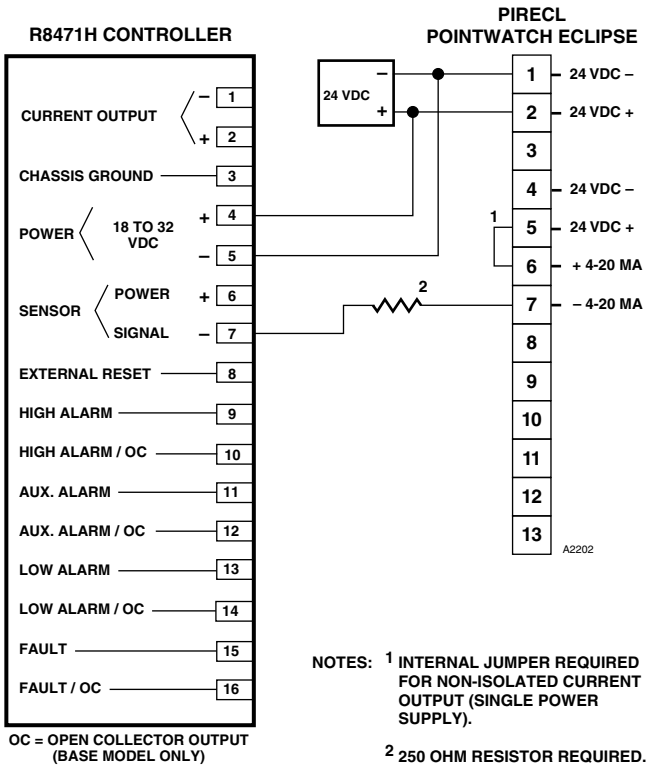


Figure 13—Standard Eclipse Wired to a Model R8471H Controller

Figure 14—Wiring Terminal Identification for Eagle Quantum Premier Eclipse

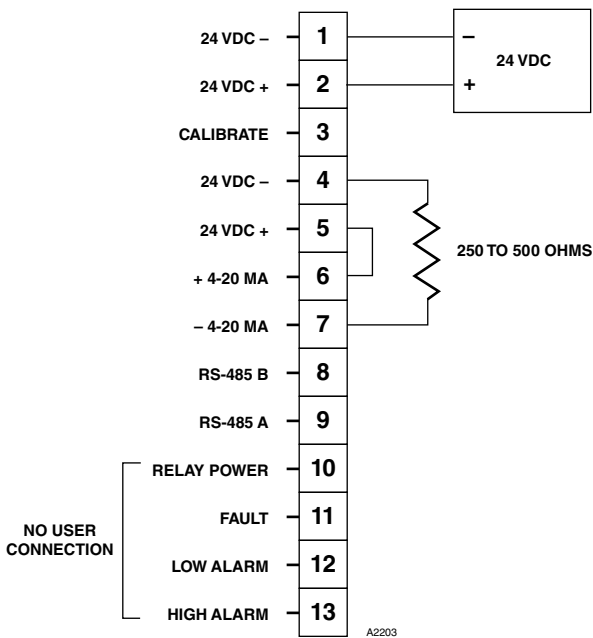


Figure 15—Wiring the Model PIRECL for Benchtop Testing/Programming Using HART Protocol

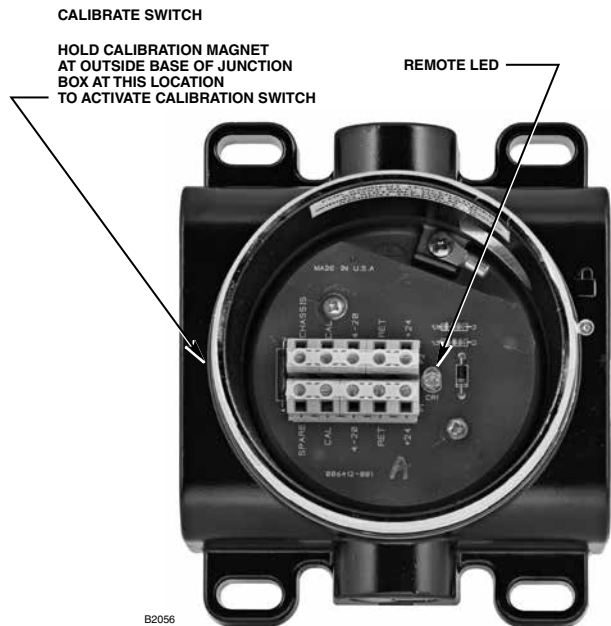


Figure 16—Remote Calibration Switch and LED in Optional Det-Tronics PIRTB Termination Box

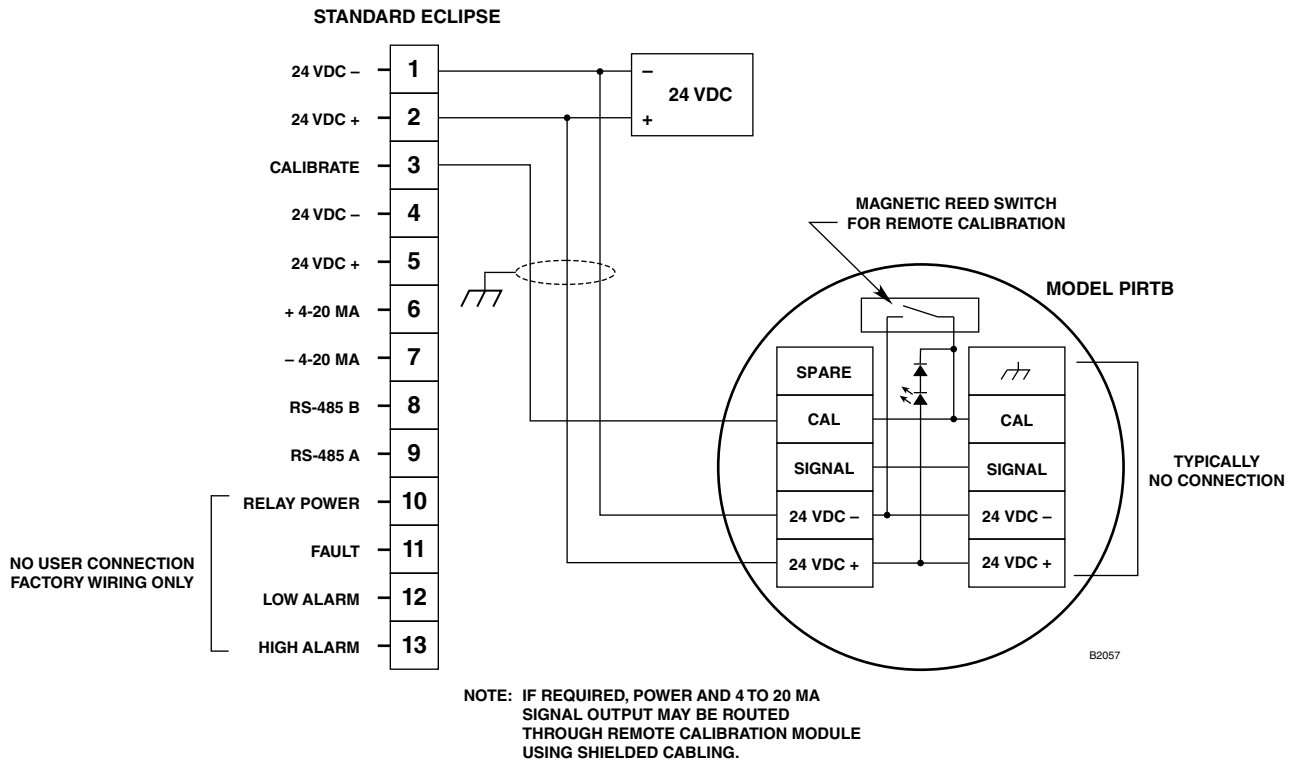


Figure 17—Remote Calibration Module Wired to Standard PointWatch Eclipse

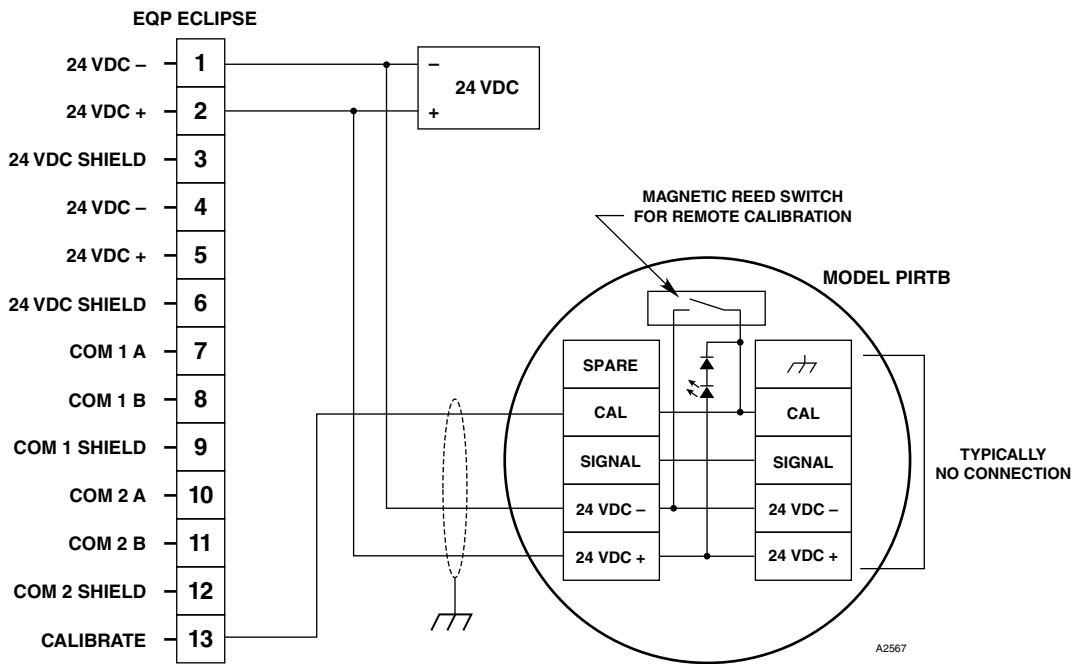


Figure 18—Remote Calibration Module Wired to Eagle Quantum Premier Eclipse

DESCRIPTION

INTERNAL MAGNETIC SWITCH

An internal magnetic switch is provided for resetting latched alarms and initiating calibration. See Figure 19 for switch location. Momentary switch activation will reset alarms, while holding the switch closed for 2 seconds or longer will start the calibration sequence. The switch can also be used to enter "live" calibration mode or terminate the calibration sequence (see "Calibration" section).

HART COMMUNICATION

An optional intrinsically safe HART communication port provides a non-intrusive means for connecting the HART Communicator to the Eclipse. Refer to Figure 20.

Alternatively, the HART communicator can be connected across a 250 ohm resistor in the 4-20 mA loop.

NOTE

All Eclipse gas detectors (except EQP models) are furnished with HART capability. However, a 250 ohm resistor must be present within the 4-20 mA loop for HART communication to work. In many cases, this resistor is already present in the control panel. For a bench test or a situation where the 4-20 mA loop is not active, this resistor must still be installed for HART communication to function properly (see Figure 15).

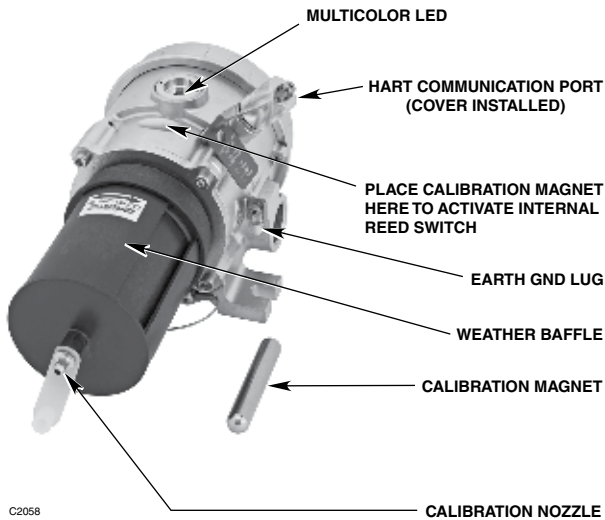


Figure 19—PointWatch Eclipse

If a PIRTB Remote Calibration Termination Box is utilized, the HART Communicator can be connected at the PIRTB. Note that this connection requires removal of the PIRTB cover.

Connect the HART Communicator, then turn it on by pressing the ON/OFF key. The communicator will indicate when the connection is made. If the connection is not made, the communicator will indicate that no device was found. Refer to the HART Appendix in this manual for complete information.

WARNING

For Division applications, do not open cover when explosive gas atmosphere may be present.

Refer to Appendix F in this manual for complete information regarding HART communication with Eclipse.

I.S. HART PORT NOT PROVIDED ON THIS MODEL



HART COMMUNICATOR CONNECTED TO I.S. HART PORT



Figure 20—Eclipse Models with and without IS HART Port

Table 1—LED Status Indication

LED	Device Status
Green	Normal operation.
Red	Blinking indicates Low Alarm. On steady indicates High Alarm.
Yellow	Fault condition or warmup.

MULTICOLOR LED

An onboard multi-color LED is provided for indicating faults, alarms, and calibration status. See Table 1. LED operation for fault status is non-latching. LED operation for alarms is configurable for latching/non-latching.

WEATHER BAFFLE ASSEMBLY

The black weather baffle is provided to prevent debris and water from entering the optics, while allowing gases and vapors to enter readily. An O-ring is provided on the main Eclipse body to ensure a proper seal with the weather baffle. Two weather baffle configurations are available — one with an internal hydrophobic filter and one without the internal hydrophobic filter.

The weather baffle version with hydrophobic filter is recommended for most outdoor and indoor applications, especially wet and/or dirty applications. When compared to the weather baffle version without the hydrophobic filter, it provides optimum protection against airborne water and dirt, with minimal reduction in speed of gas alarm response.

The weather baffle assembly is not field-serviceable, but is easily replaceable. To remove the plastic weather baffle from the Eclipse body, rotate it one quarter turn counter-clockwise and pull.

The weather baffle is furnished with a calibration gas nozzle for direct injection of gas to the sensor, allowing the operator to apply gas to the detector without going through the weather baffle.

NOTE

Always cover the calibration gas nozzle with the cap during normal operation, and ensure that the cap is not damaged.

CLOCK

An hour meter is provided to give a relative indication of time for historical logs. The meter is zeroed at the time of manufacture and only increments while power is applied. HART or MODBUS communication is required to view the running hours.

HISTORY LOGS

All history logs are saved in non-volatile memory and retained through power cycles. HART or MODBUS communication is required to view the history logs.

Event Log (Alarms and Faults)

An event log saves the ten most recent alarms and a selected group of faults with an hour meter time stamp. HART or MODBUS communication is required to view the log. Types of logged events include:

- Low Alarms
- High Alarms
- Optics Fault
- Warm-up
- Calibration Fault

Calibration Log

A log of the ten most recent calibrations with time stamp is saved. HART or MODBUS communication is required to view the log. Types of calibration records include:

- Zero Only Calibration
- Complete Calibration
- Failed Calibration

Min/Max Temperature History

Ambient minimum and maximum exposed temperature measurements are stored in non-volatile memory, and are accessible via HART or MODBUS communication. The measurements are time tagged with respect to total hours of powered operation. The temperature log may be reset, in which case all min/max exposed temperature logs are cleared.

REMOTE CALIBRATION OPTION

In most applications, it is recommended to install the Pointwatch Eclipse where it will contact the vapor of interest as quickly as possible. Unfortunately, the best location for early warning can often result in accessibility problems for the operator when calibration is required. In these applications, the Model PIRTB Termination Box is highly recommended to provide the ability to calibrate the Pointwatch Eclipse from a remote location.

The PIRTB consists of a termination/circuit board, housed within an explosion-proof junction box. The circuit board contains a magnetic reed switch for initiating calibration, an indicating LED to signal the operator when to apply and remove the calibration gas, and a wiring terminal block. The junction box cover is furnished with a small viewing window that enables calibration to be performed without hazardous area de-classification. The PIRTB may be installed up to 100 feet away from the Eclipse. Refer to Figure 21 for remote calibration configuration options.

NOTE

The remote calibration switch is intended for initiating calibration only. Resetting latching alarm outputs using the remote calibration switch cannot be accomplished without entering the Calibration mode.

The following recommendations are provided to enhance operator ease and convenience of remote calibration configurations:

1. Install the Eclipse in such a manner that the onboard LED is visible whenever possible. This will aid in checking device status "at a glance."
2. The Eclipse is provided with a calibration gas nozzle on the weather baffle, which allows the use of permanently attached calibration gas delivery tubing (either polyethylene or stainless steel). The tubing is typically routed in parallel with the remote calibration cabling to the same location as the PIRTB termination box. This arrangement enables a technician to initiate calibration and deliver the calibration gas to the Eclipse from a single location.
3. When permanently installed calibration gas tubing is utilized, always install a shut-off valve at the open end to prevent unwanted vapors or debris from entering the tubing.

4. Always purge the permanent tubing with clean, dry compressed air prior to and immediately after calibration to ensure that residual combustible gases are cleared. Always close the shutoff valve after post-calibration purging is complete. This will ensure that all hydrocarbon vapors are eliminated from the Eclipse optics.
5. Note that permanently installed calibration gas tubing will increase the calibration gas consumption rate as a function of total tubing length.

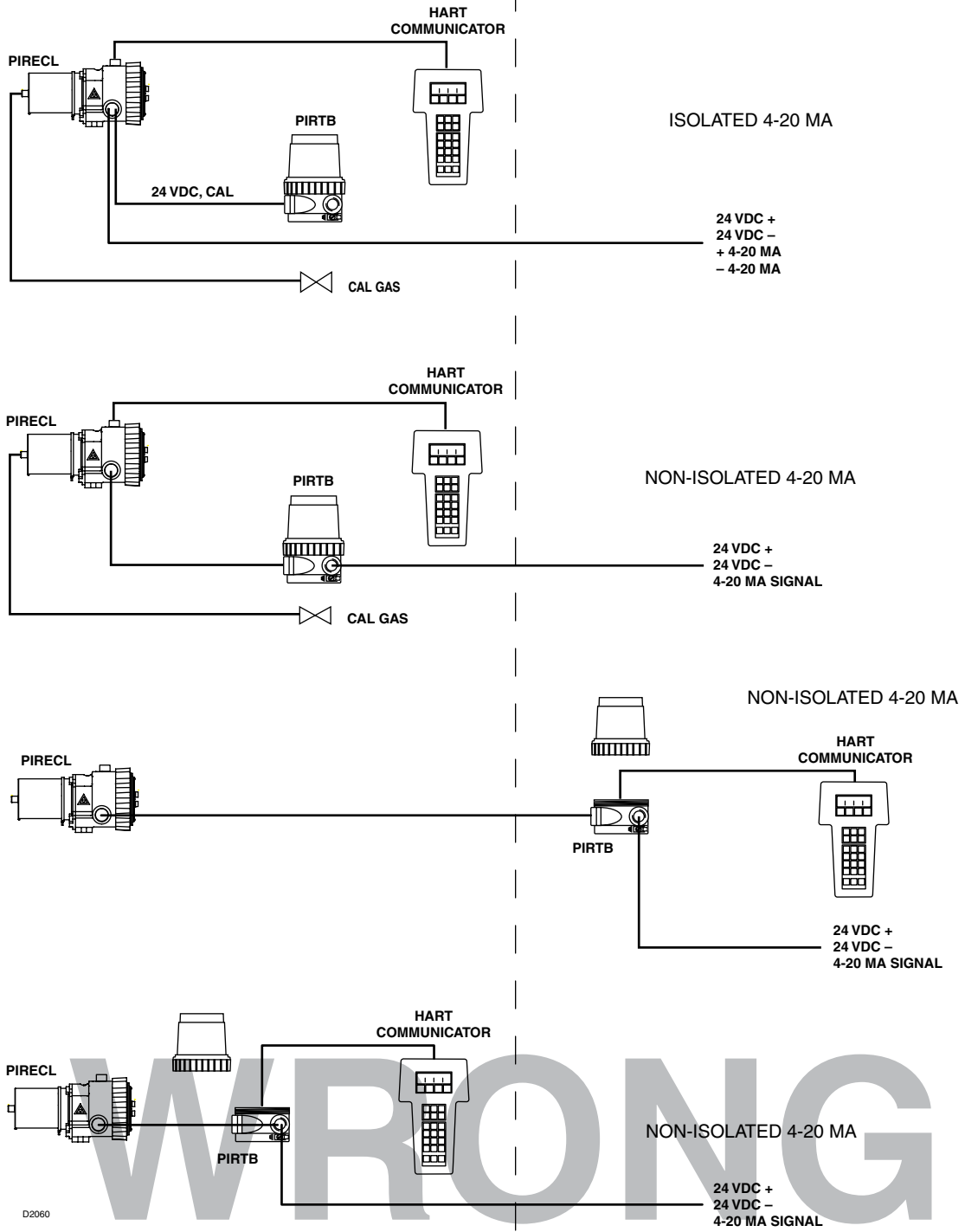
Other methods of remote Eclipse calibration include utilizing HART or MODBUS communications. Refer to the HART and MODBUS appendices for details.

SPECIAL APPLICATIONS

The standard Pointwatch Eclipse is intended for open area combustible gas detection applications. However, special detector configurations are available for applications such as duct-mounting and sample extraction. Contact Detector Electronics Corporation for information on these special device configurations.

HAZARDOUS LOCATION

NON-HAZARDOUS LOCATION



NOTE: THE TOTAL WIRING DISTANCE FROM THE HART COMMUNICATOR THROUGH THE POINTWATCH ECLIPSE TO THE SIGNAL RECEIVER MUST NOT EXCEED 2000 FEET (610 METERS).

Figure 21—Remote Calibration Configuration Options

OPERATION

FACTORY DEFAULT SETTINGS

The Pointwatch Eclipse is shipped from the factory pre-calibrated and set for the customer's choice of 0-100% LFL methane, propane, ethylene, or butane. Detection of gases other than the factory default gas will require changing the gas setting and performing field calibration of the device. HART or MODBUS communication is required to change the factory default settings. Refer to the HART Communications Appendix within this document for additional guidance.

OPERATING MODES

The Eclipse has three operating modes: warm-up, normal, and calibrate.

Warm-up

Warm-up mode is entered upon application of 24 Vdc operating power. During warm-up, the 4-20 mA current loop output will indicate warm-up, the indicating LED is yellow, and the alarm outputs are disabled. The warm-up mode lasts nominally two (2) minutes after power-up.

Normal

After warm-up mode is completed, the device automatically enters the Normal mode, and all analog and alarm outputs are enabled.

Calibrate

Calibration of the Eclipse is normally not required; however, the user has the option to verify proper calibration or to perform calibration procedures if necessary. Guidelines for when to perform a calibration or a response test are listed in Table 2. The user has the choice of three methods to place the device into the Calibrate mode. Refer to the "Calibration" section in this manual for details.

Table 2—Calibration or Response Test

Function	Calibration	Response Test
Startup		X
Gas selection changed	X	
Non-standard gas (using linearization other than methane)	X	
Replace any part	X	
Constant zero offset	X	
Periodic Functional Testing (at least once a year)		X

4-20 MA CURRENT LOOP OUTPUT

Eclipse provides an isolated, linear current loop output that is proportional to the detected gas level. Fault and calibration status are also indicated by this output.

The factory default for full-scale 100% LFL output is 20 mA. Other full scale values (from 20 to 100% LFL) can be selected using HART or MODBUS communication. HART and MODBUS interfaces also have the ability to calibrate the 4 mA and 20 mA levels.

When the default setting is selected, the LFL percentage for a given current reading can be calculated using the formula:

$$\% \text{ LFL} = (X - 4) \div 0.16 \quad X = \text{Current reading in milliamperes}$$

Example: Device reads 12 mA.

$$12 - 4 = 8$$

$$8 \div 0.16 = 50$$

50% LFL is indicated.

Normally, the current loop output is proportional to the selected standard gas type only.

FAULT INDICATION

There are three modes of signaling faults using the 4-20 mA analog signal output:

- PIR9400 (Factory default setting, used for retrofit applications of the PIR9400 detector)
- Eclipse
- User Defined

Fault signaling mode can be selected using the HART or MODBUS interface. Table 3 shows the current levels for each fault mode.

PIR9400 Fault Mode

This mode is provided for compatibility with existing Det-Tronics PointWatch gas detectors. The fault and calibration levels are identical to existing PIR9400 units, which makes the Eclipse compatible with the U9500 Infiniti Transmitter. As with the PIR9400 detector, live and suppressed “signal during calibration” modes are available.

Eclipse Fault Mode

Eclipse mode follows conventional fault signaling practice. The current loop output indicates the presence of a fault, but does not attempt to identify a specific fault with a specific current output value. Identification of a specific fault type is done through the HART Communicator or MODBUS.

User Defined Fault Mode

This mode is intended for users who wish to program unique current levels for faults and calibration signals. User defined current levels can be set from 0.0 to 24.0 mA. and can be programmed from HART or MODBUS interfaces. Four unique current levels are available: warm-up, general fault, calibration, and blocked optics.

Table 3—Output Levels of 4-20 mA Current Loop and Corresponding Status Indications

Condition	PIR9400 Fault Mode	Eclipse Fault Mode	User Defined Fault Mode
Gas Level (-10% to 102.2% Full scale)	2.4 to 20.5	2.4 to 20.5	2.4 to 20.5
Warm-up	0.00	1.00	Warm-up
Reference Sensor Saturated	0.20	1.00	General Fault
Active Sensor Saturated	0.40	1.00	General Fault
Calibration line active on power-up	0.60	1.00	General Fault
Low 24 volts	0.80	1.00	General Fault
Low 12 volts	1.20	1.00	General Fault
Low 5 volts	1.20	1.00	General Fault
Dirty Optics	1.00	2.00	Blocked Optics
Calibration Fault	1.60	1.00	General Fault
Calibration complete	1.80	1.00	Calibration
Span calibration, apply gas	2.00	1.00	Calibration
Zero calibration in progress	2.20	1.00	Calibration
Negative signal output fault	2.40	1.00	General Fault
Flash CRC	1.20	1.00	General Fault
Ram Error	1.20	1.00	General Fault
EEPROM Error	1.20	1.00	General Fault
IR Source Failure	1.20	1.00	General Fault

STARTUP

When the Eclipse is installed and wired as described in the "Installation" section, it is ready for commissioning. If the application requires that specific changes be made to the factory settings, HART, MODBUS or EQP communication will be required. Refer to the appropriate Appendix for details.

NOTE

Ensure that controller alarm outputs are inhibited for a minimum of 10 seconds after system power-up to prevent unwanted output actuation.

NOTE

The safety function (gas input-to-actuation/notification) must always be verified upon completion of installation and/or modification.

PIRECL STARTUP/COMMISSIONING CHECKLISTS

Electrical Checklist

- All 24 Vdc power conductors are properly sized and are properly terminated.
- The 24 Vdc power supply provides sufficient load capacity for all gas detectors.
- Using a DC voltmeter, 24 Vdc has been measured at the detector.
- All signal output conductors are properly terminated, and the jumper wire is installed if a non-isolated signal output is desired.
- All relay contact output signal conductors are properly terminated if applicable.
- All screw terminals have been tightened and all wires pull-tested to confirm proper termination has been accomplished.

Mechanical Checklist

- PIRECL detector is mounted to a solid surface not prone to high vibration, shock, traumatic impact or other undesirable condition.
- PIRECL detector is installed in proper orientation (horizontal).
- PIRECL detector is installed to achieve weatherproof status, e.g. conduit seals or cable glands have been properly installed. If there is an unused conduit entry, this entry has been sealed with a weathertight plug.
- PIRECL detector threaded covers are tightened to engage all O-rings.
- The hex head set screw is tightened to secure the cover and prevent access to the wiring compartment without the use of a tool.

Gas Detection and Measurement Checklist

- Vapor(s) to be detected have been identified, and appropriate calibration gas setting for the PIRECL has been confirmed.
- Area(s) of coverage have been identified, and optimum detector locations for installation are documented.
- Detector installation location is suitable for intended purpose, e.g. no obvious impediments to contact with the gas or vapor of interest exist or are likely to exist.
- Proper calibration gas(es) are available to perform proof of response test or calibration during commissioning.
- HART communicator or similar field communicator is available if field programming is expected or required.
- Calibration magnet is available to initiate quick calibration or reset.

CALIBRATION

CALIBRATION OVERVIEW

Although routine calibration of the Pointwatch Eclipse is normally not required, the device supports non-intrusive field calibration capability. Two (2) calibration procedure options are provided:

1. **Normal Calibration** is a two-step process consisting of clean air (zero) condition and mid-scale (span) adjustment. Calibration gas must be applied by the operator to enable span adjustment. Normal calibration is required whenever the gas type setting has been changed from the factory setting (methane, propane, ethylene, or butane). Purge the Eclipse optics with clean, dry air prior to calibration initiation to ensure that an accurate zero (clean air) condition is present.

The following Normal Calibration guidelines always apply:

- A. The Eclipse is factory set for detection of methane, propane, ethylene, or butane. If the gas setting is changed (using HART, MODBUS or EQP communication), the Eclipse **must** be re-calibrated (normally with the matching gas type).
 - B. The calibration gas type normally should match the selected gas setting for the Eclipse. Different calibration gas types are selectable using HART, MODBUS or EQP communication.
 - C. The recommended calibration gas concentration is 50% LFL, although other calibration concentrations may be utilized if previously defined in the Eclipse using HART, MODBUS or EQP communication.
2. **Zero Only Calibration** is a one-step process consisting of clean air (zero) condition adjustment only, which is performed automatically by the device. This procedure adjusts the "clean air" signal output only, and is normally used if the 4 milliamperes signal level has drifted. The cause of drift is typically due to the presence of background gas during calibration. Purge the Eclipse optics with clean, dry compressed air prior to calibration initiation to ensure an accurate zero (clean air) condition is present.

ADDITIONAL CALIBRATION NOTES

IMPORTANT

Always ensure that the correct gas type is used for calibration. (2.5 LPM flow rate is recommended.)

NOTE

It is highly recommended that the detector has been operating for at least two hours before calibrating.

NOTE

Always ensure that the Eclipse optics are totally free of all hydrocarbons before initiating calibration. This may require purging of the Eclipse with pure air prior to initiating calibration.

NOTE

Under very windy conditions, it may not be possible to successfully calibrate the Eclipse. This situation is easily corrected by using the Eclipse Calibration Bag (P/N 006682-002), available from Det-Tronics.

NOTE

Always place the protective cap back on the calibration nozzle after completion of span calibration.

CALIBRATION INITIATION

Eclipse calibration may be initiated by any of the following means:

- The onboard magnetic calibration switch
- The magnetic calibration switch in the remote termination box
- HART communication.

Calibration using Magnetic Switch

1. Onboard Switch and LED

The Pointwatch Eclipse provides an onboard magnetic calibration/reset switch for non-intrusive calibration capability. The magnetic switch is located on the device bulkhead. See Figure 19 for switch location. An onboard tri-color LED is also provided to signal the operator when to apply and remove calibration gas.

2. Remote Switch and Indicating LED

A special Remote Termination Box (Model PIRTB) is available for initiating calibration from a remote location. The PIRTB provides an internal magnetic switch and indicating LED (LED is on/off only, not tri-color). The PIRTB is provided with a clear window on the cover, enabling non-intrusive calibration capability.

Either magnetic switch must be actuated for 2 seconds using a calibration magnet to initiate Eclipse calibration. Upon initiation, the Eclipse automatically performs the zero calibration adjustment, and then signals the operator when it is time to apply calibration gas. Upon completion of the span adjustment, the Eclipse returns to normal mode after the calibration gas has cleared. The indicating LED (either onboard LED or PIRTB LED, if used) provides visual signals to the operator regarding the proper time to apply and remove the calibration gas.

For Zero Only Calibration, the operator must re-actuate the magnetic switch upon LED signal to apply calibration gas. This action instructs the Eclipse to utilize the previous span setting, and return to normal mode without requiring application of calibration gas.

Digital Communication Calibration

HART, MODBUS or EQP communication may be utilized to initiate Eclipse calibration. Refer to the appropriate Appendix for details.

DETAILED CALIBRATION PROCEDURE USING MAGNETIC SWITCH

Refer to Tables 4 and 5 for a quick summary of the standard calibration sequence.

1. Apply magnet for 2 seconds minimum to initiate calibration.
 - A. The onboard LED turns to steady red.
 - B. The LED within the PIRTB (if used) turns on.
 - C. The Eclipse current output decreases from 4 mA to 1 mA when the default Eclipse calibration routine is used.
2. When Zero Calibration is complete:
 - A. The onboard LED changes from steady red to flashing red.
 - B. The LED within the PIRTB (if used) begins flashing.
 - C. The Eclipse current output does not change from the 1 mA level when the default Eclipse calibration routine is used.
 - D. The operator should now apply the appropriate calibration gas to the Eclipse if conducting Normal Calibration.
 - E. If conducting Zero Only Calibration, the operator should re-apply the magnet to the switch. This will conclude the Zero Only calibration sequence.
3. When Span Calibration is complete:
 - A. The onboard LED changes from flashing red to "off".
 - B. The operator should now close the valve and remove the calibration gas from the Eclipse.

NOTE

It is normal for the Eclipse LED to go off or turn blank (no color displayed) until the calibration gas is cleared from the optics chamber. Remove the weather baffle if necessary to clear residual gas.

- A. The LED within the PIRTB (if used) changes to steady on.
- D. The Eclipse current output does not change from the 1 mA level when the default Eclipse calibration routine is used.

Table 4—Quick Reference Guide for Normal Calibration Procedure Using Magnetic Switch

Description	Indicating LED (on-board/PIRTB)	Current Output (default setting)	Operator Action
Normal-ready to calibrate	steady green/off	4 mA	Purge with clean air if required
Initiate Calibration	steady red/on-steady	1 mA	Apply Magnet for 2 seconds min.
Zero Calibration complete	flashing red/on-flashing	1 mA	Apply Calibration Gas to device
Span Calibration in progress	flashing red/on-flashing	1 mA	Continue cal gas flow
Span Calibration complete	off/on-steady	1 mA	Remove Calibration Gas
Output Returns to Normal	steady green/off	4 mA	Calibration Completed
Normal Operation	steady green/off	4 mA	None

Table 5—Quick Reference Guide for Zero Only Calibration Procedure Using Magnetic Switch

Description	Indicating LED (on-board/PIRTB)	Current Output (default setting)	Operator Action
Normal-ready to calibrate	steady green/off	4 mA	Purge with clean air if required
Initiate Calibration	steady red/on-steady	1 mA	Apply Magnet for 2 seconds min.
Zero Calibration complete	flashing red/on-flashing	1 mA	Re-initiate magnetic switch to terminate calibration
Return to Normal Mode	steady green/off	4 mA	Zero Calibration Completed

4. Return to Normal is complete when:
 - A. The onboard LED changes from “off” to steady green.
 - B. The LED within the PIRTB (if used) turns off.
 - C. The Eclipse current output returns to 4 mA after detected calibration gas level drops below 5% LFL or the calibration abort signal is provided.

CALIBRATION ABORT

Calibration can be aborted at any time after zero calibration is completed. This is done by activating the onboard or PIRTB magnetic switch, or by a command from the HART, MODBUS or EQP interface. If calibration is terminated, the new zero point is retained, and a zero calibration code is saved in the calibration history buffer. The unit will immediately return to normal operation.

TIME OUT

If calibration is not completed within 10 minutes, a calibration-failed fault is generated, and the unit returns to normal operation using the previous calibration values.

NOTE

Under normal conditions, span calibration is typically completed in 3 minutes or less.

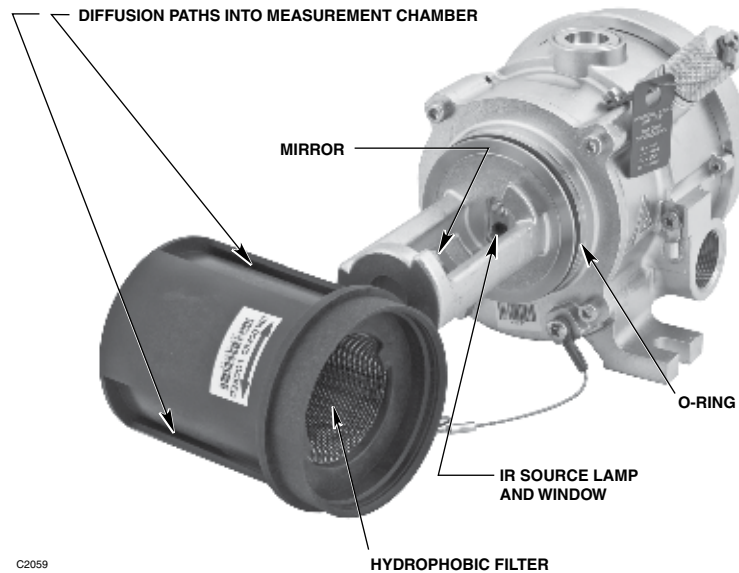


Figure 22—PointWatch Eclipse with Baffle Removed

MAINTENANCE

NOTE

Refer to the Model PIRECL Safety Manual (number 95-8630) for specific requirements and recommendations applicable to the proper installation, operation, and maintenance of all SIL-Certified PIRECL IR gas detectors.

ROUTINE INSPECTION

The PointWatch Eclipse detector should be inspected periodically to ensure that external obstructions such as plastic bags, mud, snow, or other materials do not block the weather baffle, thereby impairing the performance of the device. In addition, the weather baffle assembly should be removed and inspected to ensure that the diffusion paths into the measurement chamber are clear. See Figure 22.

WEATHER BAFFLE CLEANING

Remove the weather baffle assembly and clean with a soft brush and soap and water. Rinse and allow to dry.

Replace the weather baffle if damaged or if fouling of the baffle vents is evident.

NOTE

Solvents may damage the weather baffle assembly. If contamination is not removed using soap and water, then replacement of the baffle may be required.

OPTICS CLEANING

Cleaning of the Eclipse optical surfaces is normally required only if an optical fault is indicated.

Thoroughly douse the mirror and window using a liberal amount of isopropyl alcohol to clear away contaminant particles. Repeat the alcohol flush to remove any remaining contaminants. Allow the assembly to air-dry in a dust-free location.

O-RING

Periodically the O-ring should be inspected for breaks, cracks and dryness. To test the ring, remove it from the enclosure and stretch it slightly. If cracks are visible, it should be replaced. If it feels dry, a thin coating of lubricant should be applied. See “Spare Parts” section for recommended lubricant. When re-installing the ring, be sure that it is properly seated in the groove.

PROTECTIVE CAPS AND COVERS

The calibration nozzle cap must always be installed, except while performing calibration. Also ensure that the HART Communication Port cover and the wiring compartment cover are installed and fully engaged.

TROUBLESHOOTING

A Fault status is indicated by a yellow LED and also by the 4-20 mA output. Refer to Table 6 to identify the fault type using the 4-20 mA output. (The operator must know which fault signaling mode has been programmed.) Refer to Table 7 for assistance in correcting malfunctions with the PointWatch Eclipse Detector.

DEVICE REPAIR AND RETURN

The Pointwatch Eclipse IR Hydrocarbon Gas Detector is not designed to be repaired in the field. If a problem should develop, first carefully check for proper wiring, programming and calibration. If it is determined that the problem is caused by an electronics failure, the device must be returned to the factory for repair.

Prior to returning devices or components, contact the nearest local Detector Electronics office so that a Service Order number can be assigned. A written statement describing the malfunction must accompany the returned device or component to expedite finding the cause of the failure.

Return all equipment transportation prepaid to the factory in Minneapolis.

Table 6—Using the 4-20 mA Output Level to Identify a Fault Condition

Condition	PIR9400 Fault Mode	Eclipse Fault Mode	User Defined Fault Mode
Gas Level (-10% to 120% Full scale)	2.4 to 20.5	2.4 to 20.5	2.4 to 20.5
Warm-up	0.00	1.00	Warm-up
Reference Sensor Saturated	0.20	1.00	General Fault
Active Sensor Saturated	0.40	1.00	General Fault
Calibration line active on power-up	0.60	1.00	General Fault
Low 24 volts	0.80	1.00	General Fault
Low 12 volts	1.20	1.00	General Fault
Low 5 volts	1.20	1.00	General Fault
Dirty Optics	1.00	2.00	Blocked Optics
Calibration Fault	1.60	1.00	General Fault
Calibration complete	1.80	1.00	Calibration
Span calibration, apply gas	2.00	1.00	Calibration
Zero calibration in progress	2.20	1.00	Calibration
Negative signal output fault	2.40	1.00	General Fault
Flash CRC	1.20	1.00	General Fault
Ram Error	1.20	1.00	General Fault
EEPROM Error	1.20	1.00	General Fault
IR Source Failure	1.20	1.00	General Fault

Table 7—Troubleshooting Guide

Fault Condition	Corrective Action
Low 24 volts	24 vdc operating voltage is out of range. Verify proper wiring to the detector and correct voltage output from the power source. Power supply faults are self-clearing when the condition is corrected. If the fault does not clear, consult the factory.
Dirty Optics	Perform cleaning procedure, then recalibrate as required. (Refer to "Maintenance" for details.)
Calibration Fault	If the calibration process is allowed to time-out, the fault is set and can only be reset with a successful calibration. Check the gas bottle to ensure that there is enough gas to complete the calibration. Are conditions too windy for a successful calibration? If so, use a PointWatch Eclipse Calibration Bag (P/N 006682-002). Always calibrate with a Det-Tronics calibration kit for Eclipse with correct regulator. Be sure that the calibration gas being used matches the configured setting. If the fault is still present, perform cleaning procedure, then recalibrate.
Negative Signal Output	This fault is indicated when the signal output drops below -3% LFL. Normally detection capability is not compromised in this condition. The device was probably zero calibrated with background gas present. If the condition persists, purge with clean air and repeat the zero calibration.
Calibration line active at start-up	The only way to clear this fault is to correct the wiring and reapply power. Be sure that the calibration line is not shorted and that the calibration switch is open. If the fault does not clear, consult the factory.
Other Faults	Consult the factory.

ORDERING INFORMATION

POINTWATCH ECLIPSE DETECTOR

When ordering, please refer to the PIRECL Model Matrix.

CALIBRATION EQUIPMENT

Pointwatch Eclipse calibration kits consist of a sturdy carrying case containing two 3.6 cubic foot (103 liter) cylinders of specified gas, a regulator and pressure indicator, three feet of tubing, barbed nozzle for direct application to the device, and a calibration wind shield to contain the gas in high wind applications.

Methane, 50% LFL, 2.5% by volume	006468-001
Ethylene, 50% LFL, 1.35% by volume	006468-003
Propane, 50% LFL, 1.1% by volume	006468-004
Butane, 50% LFL, 0.8% by volume	006468-006
PointWatch Eclipse Regulator	162552-002
Eclipse Calibration Bag	006682-002

Other calibration gases are available. Consult the factory for specific information.

SPARE PARTS

Weather Baffle with Inlet Nozzle, with Hydrophobic Filter	007165-002
Weather Baffle with Inlet Nozzle, without Hydrophobic Filter	007165-001
Weather Baffle w 1/16" NPT cal gas inlet, with Hydrophobic Filter	007165-004
Weather Baffle w 1/16" NPT cal gas inlet, without Hydrophobic Filter	007165-003
Calibration Port Cover	009192-001
Calibration Magnet	102740-002
Silicone Free Grease	005003-001
O-Ring, 3.75" i.d., for wiring compartment cover	107427-040
O-Ring, 3.25" i.d., for front flange (internal)	107427-053
O-Ring, 2.44" i.d., for weather baffle	107427-052

ASSISTANCE

For assistance in ordering a system to meet the needs of a specific application, contact:

Detector Electronics Corporation
 6901 West 110th Street
 Minneapolis, Minnesota 55438 USA
 Operator: (952) 941-5665 or (800) 765-FIRE
 Customer Service: (952) 946-6491
 Fax: (952) 829-8750
 Web site: www.det-tronics.com
 E-mail: det-tronics@det-tronics.com

PIRECL MODEL MATRIX

MODEL	DESCRIPTION																
PIRECL	Point Infrared Eclipse Gas Detector																
	<table border="1"> <thead> <tr> <th>TYPE</th> <th>THREAD TYPE</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>3/4" NPT</td> </tr> <tr> <td>B</td> <td>M25</td> </tr> </tbody> </table>	TYPE	THREAD TYPE	A	3/4" NPT	B	M25										
TYPE	THREAD TYPE																
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B	M25																
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2	Division/Zone Ex d																

*Type "Approvals" can use one or more letters.

**Detectors are always Class I, Div. 1.

APPENDIX A

FM APPROVAL DESCRIPTION

The following items, functions and options describe the FM approval.

APPROVAL

PointWatch Eclipse® Infrared Hydrocarbon Gas Detector, Model PIRECL Series.

Explosion-proof for Class I, Division 1, Groups B, C, & D (T4) Hazardous (Classified) Locations per FM 3615, With intrinsically safe output for HART communication in accordance with control drawing 007283-001. Non-incendive for Class I, Division 2, Groups A, B, C & D (T3C) Hazardous (Classified) Locations per FM 3611. Tamb = -40°C to +75°C. Acidic atmospheres excluded. Conduit seal not required.

Performance verified for 0 to 100% LFL Methane-in-air atmospheres per FM 6310/6320 and ANSI 12.13.01.
Performance verified for 0 to 100% LFL Propane-in-air atmospheres per FM 6310/6320 and ANSI 12.13.01.
Performance verified for 0 to 100% LFL Ethylene-in-air atmospheres per FM 6310/6320 and ANSI 12.13.01.
Performance verified for 0 to 100% LFL Butane-in-air atmospheres per FM 6310/6320 and ANSI 12.13.01.

NOTES

Approval of the Model PIRECL does not include or imply approval of the apparatus to which the detector may be connected and which processes the electronic signal for eventual end use. In order to maintain an approved system, the apparatus to which the detector is connected must also be approved.

This Approval does not include or imply Approval of the communications protocol or functions provided by the software of this instrument or the communications apparatus or software connected to this instrument.

RESPONSE TIME (Average* in Seconds, with Weather Protection Baffle Installed, and 100% LFL Applied)—

Gas	Baffle	T50	T60	T90
Methane	Without Hydrophobic Filter	4.5	4.9	6.8
	With Hydrophobic Filter	4.7	5.0	7.6
Propane	Without Hydrophobic Filter	5.2	5.6	7.5
	With Hydrophobic Filter	5.3	5.6	8.1
Ethylene	Without Hydrophobic Filter	4.9	5.5	6.6
	With Hydrophobic Filter	4.2	4.5	10.1
Butane	Without Hydrophobic Filter	5.1	5.4	7.6
	With Hydrophobic Filter	5.8	6.1	8.9

* Average of three consecutive trials, with the minimum and maximum response times no greater than ± 2 seconds from the average indicated response time.

NOTE: Add 2 seconds to response time for EQP compatible models.

ACCURACY—

±3% LFL from 0 to 50% LFL, ±5% LFL from 51 to 100% LFL
(at room ambient temperature, +23°C).

NOTE

Product operates properly with 5 watt walkie talkie keyed at 1 meter.

OTHER GASES

The Pointwatch Eclipse® is provided with field-selectable “standard gas” signal processing program settings for linear measurement of methane, propane, ethylene, and butane gases. This means that the Eclipse is capable of providing an analog signal output that is directly proportional to the % LFL concentration for these gases, provided the proper gas setting has been selected, and the Eclipse has been calibrated with the proper calibration gas type. The Eclipse is performance certified for detection of methane, propane, ethylene, or butane, and is shipped from the factory calibrated and set for the customer's choice of one of these gases. Digital communication (such as HART) is required to confirm the current setting and change it if required. In addition to the gases listed above, the Eclipse is capable of detecting and measuring many other hydrocarbon gases and vapors, with settings provided for gases such as ethane and propylene. For detection of other commonly encountered gases where specific gas settings are not provided, one of the standard settings will usually suffice. Please consult the factory for details.

APPROVED ACCESSORIES

Part Number	DESCRIPTION
007355-001	Q900A Duct Mount Kit, Standard
009931-001	Q900C Duct Mount Kit, Marine
007525-003	Direct Duct Mount Kit, Stainless Steel, Vertical
007525-004	Direct Duct Mount Kit, Aluminum, Vertical
007525-005	Direct Duct Mount Kit, Stainless Steel, Horizontal
007525-006	Direct Duct Mount Kit, Aluminum, Horizontal
007529-XXX	Direct Duct Assembly w/PIRECL, Kit – This part number consists of several combinations of approved PIRECL detectors and Direct Duct Assemblies (007525-003-006).
006468-006	Gas Calibration Kit, 50% Butane
006468-003	Gas Calibration Kit, 50% Ethylene
006468-014	Gas Calibration Kit, 50% Methane (2.2% Vol.)
006468-914	Gas Calibration Kit, 50% Methane (Russian Certified, 2.2% Vol.)
006468-001	Gas Calibration Kit, 50% Methane (2.5% Vol.)
006468-906	Gas Calibration Kit, 50% Methane (Russian Certified, 2.5% Vol.)
006468-004	Gas Calibration Kit, 50% Propane (1.1% Vol.)
006468-015	Gas Calibration Kit, 50% Propane (0.85% Vol.)
006468-915	Gas Calibration Kit, 50% Propane (Russian Certified)
102740-002	Calibration Magnet
103922-001	475 HART Field Communicator
103922-002	475 HART & Foundation Fieldbus Field Communicator

NOTE

Refer to the appropriate instruction manual for complete information regarding the following devices:

Q900A - 95-8537

Q900C - 95-8640

Direct Duct Mount Kits - 95-8557

APPENDIX B

CSA APPROVAL DESCRIPTION

The following items, functions and options describe the CSA approval.

APPROVAL

PointWatch Eclipse® Infrared Hydrocarbon Gas Detector, Model PIRECL Series.

Explosion-proof for Class I, Division 1, Groups B, C, & D (T4) Hazardous (Classified) Locations per C22.2 #30, With intrinsically safe output for HART communication in accordance with control drawing 007283-001. Non-incendive for Class I, Division 2, Groups A, B, C & D (T3C) Hazardous (Classified) Locations per C22.2 #213. Tamb = -40°C to +75°C. Acidic atmospheres excluded. Conduit seal not required.

Performance verified for 0 to 100% LFL Methane-in-air atmospheres per C22.2 #152.
Performance verified for 0 to 100% LFL Propane-in-air atmospheres per C22.2 #152.
Performance verified for 0 to 100% LFL Ethylene-in-air atmospheres per C22.2 #152.
Performance verified for 0 to 100% LFL Butane-in-air atmospheres per C22.2 #152.

NOTES

Approval of the Model PIRECL does not include or imply approval of the apparatus to which the detector may be connected and which processes the electronic signal for eventual end use. In order to maintain an approved system, the apparatus to which the detector is connected must also be approved.

This Approval does not include or imply Approval of the communications protocol or functions provided by the software of this instrument or the communications apparatus or software connected to this instrument.

RESPONSE TIME (Average* in Seconds, with Weather Protection Baffle Installed, and 100% LFL Applied)—

Gas	Baffle	T50	T60	T90
Methane	Without Hydrophobic Filter	4.5	4.9	6.8
	With Hydrophobic Filter	4.7	5.0	7.6
Propane	Without Hydrophobic Filter	5.2	5.6	7.5
	With Hydrophobic Filter	5.3	5.6	8.1
Ethylene	Without Hydrophobic Filter	4.9	5.5	6.6
	With Hydrophobic Filter	4.2	4.5	10.1
Butane	Without Hydrophobic Filter	5.1	5.4	7.6
	With Hydrophobic Filter	5.8	6.1	8.9

* Average of three consecutive trials, with the minimum and maximum response times no greater than ± 2 seconds from the average indicated response time.

NOTE: Add 2 seconds to response time for EQP compatible models.

ACCURACY—

±3% LFL from 0 to 50% LFL, ±5% LFL from 51 to 100% LFL
(at room ambient temperature, +23°C).

OTHER GASES

The Pointwatch Eclipse® is provided with field-selectable “standard gas” signal processing program settings for linear measurement of methane, propane, ethylene, and butane gases. This means that the Eclipse is capable of providing an analog signal output that is directly proportional to the % LFL concentration for these gases, provided the proper gas setting has been selected, and the Eclipse has been calibrated with the proper calibration gas type. The Eclipse is performance certified for detection of methane, propane, ethylene, or butane, and is shipped from the factory calibrated and set for the customer's choice of one of these gases. Digital communication (such as HART) is required to confirm the current setting and change it if required. In addition to the gases listed above, the Eclipse is capable of detecting and measuring many other hydrocarbon gases and vapors, with settings provided for gases such as ethane and propylene. For detection of other commonly encountered gases where specific gas settings are not provided, one of the standard settings will usually suffice. Please consult the factory for details.

APPENDIX C

ATEX APPROVAL DESCRIPTION

The following items, functions and options describe the ATEX approval.

APPROVAL

PointWatch Eclipse® Infrared Hydrocarbon Gas Detector, Model PIRECL Series.

CE 0539 II 2 G
Ex de IIC T4-T5 Gb
-- OR --

Ex de [ib] IIC T4-T5 Gb
(with HART communication port)
DEMKO 01 ATEX 129485X.
(Performance verified to Methane, Propane, Ethylene, and Butane in accordance with EN 60079-29-1).
T5 (Tamb -50°C to +40°C)
T4 (Tamb -50°C to +75°C)
IP66/IP67.

-- OR --

CE 0539 II 2 G
Ex d IIC T4-T5 Gb
-- OR --

Ex d [ib] IIC T4-T5 Gb
(with HART communication port)
DEMKO 01 ATEX 129485X.
(Performance verified to Methane, Propane, Ethylene, and Butane in accordance with EN 60079-29-1).
T5 (Tamb -55°C to +40°C)
T4 (Tamb -55°C to +75°C)
IP66/IP67.

HART Communication Port:

$U_0 = 4.0V$ $C_0 = 20\mu F$

$I_0 = 100mA$ $L_0 = 500\mu H$

Performance testing to EN60079-29-1:

The measuring function of the Infrared Gas Detector model PIRECL for explosion protection, according to Annex II clause 1.5.5, 1.5.6 and 1.5.7 of the Directive 94/9/EC is, for methane, propane, ethylene, and butane, covered in this EC-Type Examination Certificate in the following configurations:

1. PIRECL Infrared Gas Detector (LON Model) tested in combination with the EQP System Controller Model EQ3XXX.
2. PIRECL Infrared Gas Detector tested in combination with the Model PIRTB, Termination Box.
3. PIRECL Infrared Gas Detector tested as a stand-alone gas detector.

ATEX Special Conditions for Safe Use ('X'):

- The Infrared Gas Detector model PIRECL shall be installed in places where there is a low risk of mechanical damage.
- The field wiring terminal connections are certified for a single wire in size from 0.2 to 2.5 mm², (or two conductors with same cross section 0.2 to 0.75 mm²).The screws must be tightened down with a torque 0.4 to 0.5 Nm.
- The metal housing of the model PIRECL Infrared Hydrocarbon Gas Detector must be electrically connected to earth ground.
- The intrinsically safe output on the HART Communicator Port is internally connected to earth ground.
- The Infrared Gas Detector model PIRECL has an ambient temperature rating for performance of –55°C to +75 °C.
- Alarm output latching requirement: High alarm outputs must be configured as latching, either as part of the alarm operation of the gas detector itself (in stand-alone applications), or as a function of the “high alarm” indication within the controller that is directly connected to the gas detector (for remote applications).

Additional Safety Notes:

- The following warning is on the product: Warning: Do not open when an explosive gas atmosphere may be present. For ambient temperature above 60°C use field wiring suitable for maximum ambient temperature. For temperature below –10°C use suitable field wiring for the lowest temperature.
- The ambient temperature range is limited to –55°C to +75°C (for Ex d version) or –50°C to +75°C (for Ex de version).
- Cable, bushings and the conduit entries shall be of a type already certified according to relevant ATEX standard, so the protection principle employed will not be impaired.
- Unused conduit entries shall be closed using stop plugs certified for the conditions of use (IP66/IP67 minimum). The stop plugs should be removable only with the aid of a tool.
- The terminal compartment for Eclipse without relays is designed for either an increased safety “e” termination or a flameproof “d” termination of the supply cable. If a flameproof connection is chosen, then an ATEX certified cable entry device certified to EN60079 must be used. The Eclipse with relays requires Ex d cable entry devices only.
- Shielded cable is required.

EN Standards:

EN 50270: 2006
EN 50271: 2002
EN 60079-0: 2009
EN 60079-1: 2007
EN 60079-7: 2007
EN 60079-11: 2007
EN 60079-29-1: 2007
EN 60529: 1991+ A1 2000
EN 61000-6-4 (Emissions)
EN 61000-6-2 (Immunity)

CE: Conforms to:

Low Voltage Directive: 2006/95/EC,
EMC Directive: 2004/108/EC,
ATEX Directive: 94/9/EC.

RESPONSE TIME (Average* in Seconds, with Weather Protection Baffle Installed, and 100% LFL Applied)—

Gas	Baffle	T50	T60	T90
Methane	Without Hydrophobic Filter	3.7	4.0	6.4
	With Hydrophobic Filter	4.4	4.8	8.2
Propane	Without Hydrophobic Filter	5.2	5.6	7.5
	With Hydrophobic Filter	5.2	5.6	8.1
Ethylene	Without Hydrophobic Filter	4.9	5.2	6.6
	With Hydrophobic Filter	4.2	4.5	10.0
Butane	Without Hydrophobic Filter	5.1	5.4	7.6
	With Hydrophobic Filter	5.8	6.1	8.9

* Average of three consecutive trials, with the minimum and maximum response times no greater than ± 2 seconds from the average indicated response time.

NOTE: Add 2 seconds to response time for EQP compatible models.

ACCURACY—

$\pm 3\%$ LFL from 0 to 50% LFL, $\pm 5\%$ LFL from 51 to 100% LFL
(at room ambient temperature, +23°C).

OTHER GASES

The Pointwatch Eclipse® is provided with field-selectable “standard gas” signal processing program settings for linear measurement of methane, propane, ethylene, and butane gases. This means that the Eclipse is capable of providing an analog signal output that is directly proportional to the % LFL concentration for these gases, provided the proper gas setting has been selected, and the Eclipse has been calibrated with the proper calibration gas type. The Eclipse is performance certified for detection of methane, propane, ethylene, or butane, and is shipped from the factory calibrated and set for the customer’s choice of one of these gases. Digital communication (such as HART) is required to confirm the current setting and change it if required. In addition to the gases listed above, the Eclipse is capable of detecting and measuring many other hydrocarbon gases and vapors, with settings provided for gases such as ethane and propylene. For detection of other commonly encountered gases where specific gas settings are not provided, one of the standard settings will usually suffice. Please consult the factory for details.

APPENDIX D

IECEX APPROVAL DESCRIPTION

The following items, functions and options describe the IECEx approval.

APPROVAL

PointWatch Eclipse® Infrared Hydrocarbon Gas Detector, Model PIRECL Series.

IECEX ULD 04.0002X

Ex de IIC T4-T5 Gb

-- OR --

Ex de [ib] IIC T4-T5 Gb

(with HART communication port)

T5 (Tamb -50°C to +40°C)

T4 (Tamb -50°C to +75°C)

IP66/IP67.

-- OR --

IECEX ULD 04.0002X

Ex d IIC T4-T5 Gb

-- OR --

Ex d [ib] IIC T4-T5 Gb

(with HART communication port)

T5 (Tamb -55°C to +40°C)

T4 (Tamb -55°C to +75°C)

IP66/IP67.

HART Communication Port:

$U_0 = 4.0V$ $C_0 = 20\mu F$

$I_0 = 100mA$ $L_0 = 500\mu H$

IEC Conditions of Certification:

- The field wiring terminal connections are certified for a single wire in size from 0.2 to 2.5 mm², (or two conductors with same cross section 0.2 to 0.75 mm²). The screws must be tightened down with a torque 0.4 to 0.5 Nm.
- The metal housing of the Model PIRECL Gas Detector must be electrically connected to earth ground.
- The gas detector shall be protected against any impact greater than 4 joules.
- The intrinsically safe output on the HART Communicator Port is internally connected to frame.
- The power supply for the detector has to be a Safety Isolating transformer according to e.g. IEC61558. The rating of the power supply line fuse shall be less than 3.1 A.
- When connecting to a circuit using up to 1% of C_0 or L_0 , then the C or L is limited to the C_0 and L_0 listed above. If either the C or L is above 1% of C_0 or L_0 , then C or L are each limited to 50% of the C_0 or L_0 listed above.
- Um is restricted to 250 V, prospective short circuit current < 1500 A.

IEC Standards:

IEC 60079-0: 2007

IEC 60079-1: 2007-04

IEC 60079-11: 2006

IEC 60079-7: 2006-07

IEC 60529, 2.1 Edition with Corr. 1

(2003-01 + 2 (2007-10))

WARNING

Always ensure that the detector/junction box hazardous (classified) location ratings are applicable for the intended use.

APPENDIX E

OTHER APPROVALS

The following items, functions and options describe various other approvals applicable to the Model PIRECL.

SIL APPROVAL

IEC 61508
Certified SIL 2 Capable.

For specific information regarding SIL models, refer to the Safety Reference Manual, form 95-8630.

DNV

Type Approval Certificate No. A-11023.

Subject Matter of the Approval

Model PIRECL IR Hydrocarbon Gas Detector and PIRTB Termination Box are found to comply with Det Norske Veritas' Rules for Classification of Ships and Det Norske Veritas' Offshore Standards.

Application/Limitation

Location Classes					
MODEL	TEMPERATURE	HUMIDITY	VIBRATION	EMC	ENCLOSURE
PIRECL	D	B	B	B	C

Relevant tests according to "Standard for Certification No. 2.4".

MED

Certificate No. MED-B-5866.

Model PIRECL IR Hydrocarbon Gas Detector and PIRTB Termination Box are found to comply with the requirements in the following Regulations/Standards:
Annex A.1, item No. A.1/3.54 and Annex B, Module B in the Directive. SOLAS 74 as amended, Regulation II-2/4 & V1/3 and FSS Code 15.

The equipment is found to comply with the following location/application dependent requirements (for definition of each of the location classes, see the table below):

MODEL	TEMPERATURE	VIBRATION	EMC	ENCLOSURE
PIRECL	TEM-D	VIB-B	EMC-B	ENC-C

Definition of the location classes with reference to relevant standards:

Temperature

TEM-D Location (-25°C to +70°C) (ref. IEC 60092-504 (2001) table 1 item 6-7)

Vibration

VIB-D For eq. on reciprocating machines etc. (ref. IEC 60092-504 (2001) table 1 item 10)

EMC

EMC-B Bridge and open deck zone (ref. IEC 60092-504 (2001) table 1 item 19-20)

Enclosure

ENC-C Open deck (IP56) (ref. IEC 60092-201 table 5).

INMETRO

CEPEL 02.0078X

Ex d [ib] IIC T4-T5 Gb IP66/67

T5 (T_{amb} -55°C to +40°C)

T4 (T_{amb} -55°C to +75°C)

—OR—

Ex d e [ib] IIC T4-T5 Gb IP66/67

T5 (T_{amb} -50°C to +40°C)

T4 (T_{amb} -50°C to +75°C)

Note: All cable entry devices or blanking elements shall be Brazil certified in the type of explosion protection, flameproof enclosure 'd', suitable for the conditions of use and correctly installed, with an ingress protection rating of IP66/IP67.

A screw or cover lock is provided for a secondary means of fastening the cover.

APPENDIX F

HART COMMUNICATION

Digital communication with the Pointwatch Eclipse is necessary to monitor internal status and to modify the factory settings. This appendix provides guidance on establishing HART communication, and describes the communication menu structure when using the Eclipse with the HART Handheld Communicator.

ESTABLISHING LOCAL HART COMMUNICATION WITH POINTWATCH ECLIPSE

The HART Handheld Communicator can be connected to the 4-20 mA circuit as shown in the wiring diagrams provided in the Installation section of this manual. If the Eclipse is equipped with an I.S. HART communication port on the side of the detector, unscrew the protective cap and connect the HART Communicator test probes to the two terminals inside the port (non-polarized).

Press the "on" key to switch on the HART Handheld Communicator. The Online menu is the first menu to appear when the Communicator is properly connected to the Eclipse. This menu is structured to provide important information about the connected device. The HART protocol incorporates a concept called the "Device Description Language" (DDL) that enables HART instrument manufacturers to define and document their product in a consistent format. This format is readable by handheld communicators, PC's and other process interface devices that support DDL.

NOTES

Proper analog signal output termination and minimum loop resistance must be completed in all cases to enable HART communication. Failure to provide proper analog signal output loop resistance will preclude all HART communication.

It is possible to establish HART Communication with the PIRECL in Generic HART communication mode. In this mode, HART communication with the PIRECL detector will be established, but the Communicator will not recognize the PIRECL as a gas detector. Generic HART communication will not provide access to the PIRECL DDL menu and important set-up, diagnostics or operation functions, including gas type selection.

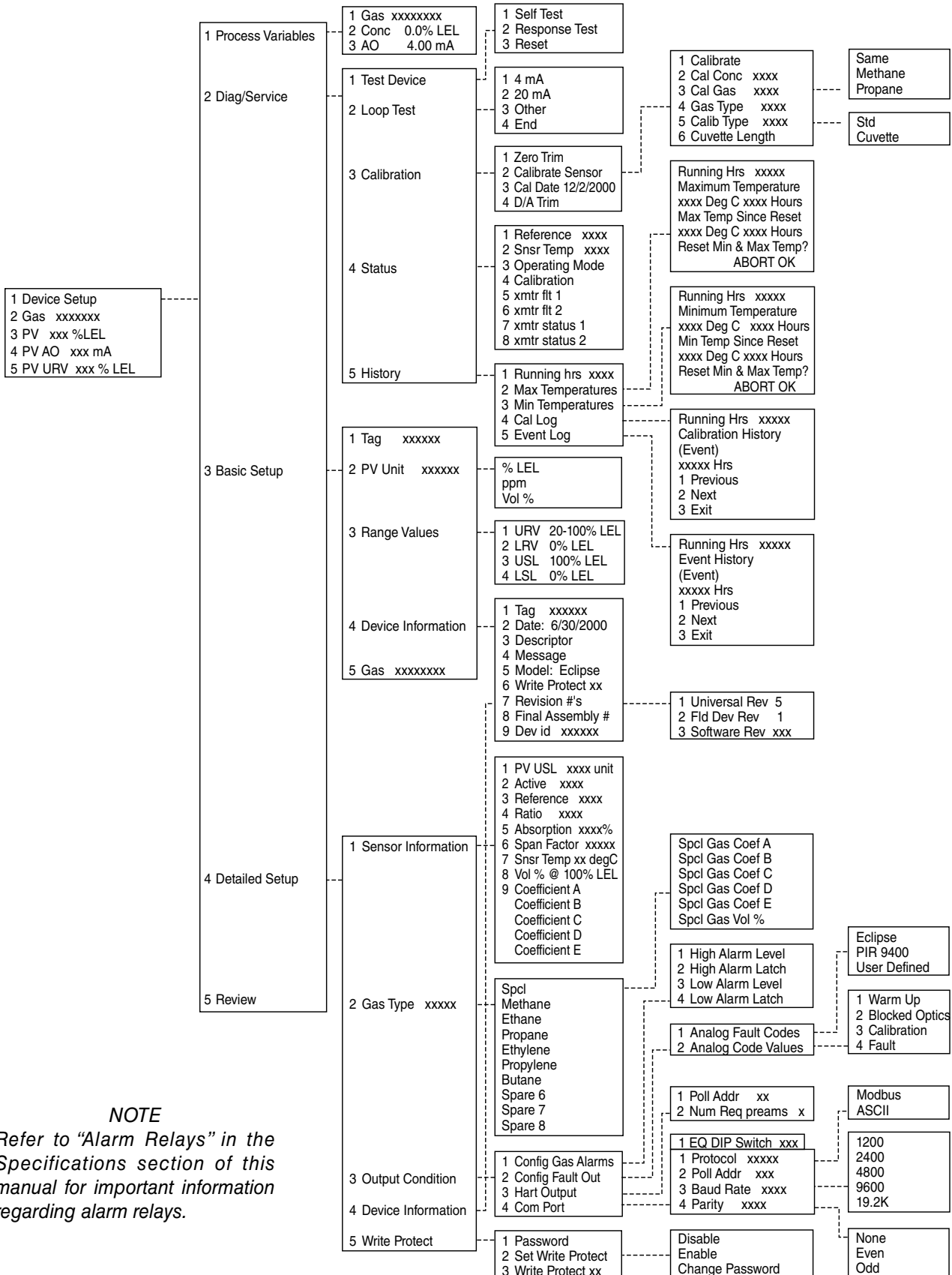
PROCEDURE TO DETERMINE IF ECLIPSE DDL IS PRESENT IN YOUR COMMUNICATOR

1. From the Main menu, select the Offline menu.
2. From the Offline menu, select New Configurations to access the list of device descriptions programmed into your HART Communicator. The Manufacturer menu displays a list of each manufacturer with available DDLs.
3. Select a manufacturer, and the display will show the list of available device types.
4. If you cannot find the Eclipse device on your Communicator, the specific DDL is not programmed into the Memory Module. Your HART Communicator will require a DDL upgrade in order to access all Eclipse DDL functions.

The HART Communication Foundation (www.hartcomm.org) manages the HCF Approved DDL Library and programming sites for HCF Approved field communicators. A complete listing of the DD Library is available for download and provides manufacturer and device type file identification.

ECLIPSE HART MENU STRUCTURE

This section displays the menu trees for the Pointwatch Eclipse. The Menu tree shows the primary commands and options available when using menu selections.



NOTE

Refer to "Alarm Relays" in the Specifications section of this manual for important information regarding alarm relays.

CONNECTIONS AND HARDWARE

The HART Communicator can interface with the Eclipse from the onboard I.S. communication port, from the control room, or any wiring termination point in the analog output signal loop. To communicate, connect the HART communicator in parallel with the Eclipse analog signal or load resistor. The connections are non-polarized.

NOTE

The HART Communicator needs a minimum of 250 ohms resistance in the loop to function properly. The HART Communicator does not measure loop resistance. Any external ohmmeter is required.

COMMONLY USED HART COMMANDS

The most commonly used HART commands for the PIRECL are:

1. Performing basic setup functions such as:
 - Assigning a tag number to the detector
 - Assigning unit of measure (%LEL, PPM, % Vol)
2. Performing detailed setup functions such as:
 - Assigning a special gas type
 - Configuring Gas Alarm Levels (Low & High threshold)
 - Configuring Fault Codes (analog signal output levels during various fault conditions)
 - Configuration of HART and MODBUS communication protocols
 - Write-protecting the HART programming, or assigning a password to protect the setup.
3. Performing Diagnostic and Service functions such as:
 - Reset Alarms or Faults
 - Performing a signal loop output test
 - Performing a Calibration
 - Monitoring detector history/data logs

It is important for the user to understand how to correctly operate the HART Field Communicator, and how to navigate through the various programming options and either select or de-select the desired parameters. This document does NOT cover this fundamental information on the HART Field Communicator. Please refer to the Field Communicator instruction manual for specific guidance on how to operate the communicator.

TYPICAL SETUP OF A PIRECL

After HART communication has been established with the PIRECL, the following operational parameters are generally verified:

1. Inspect the Root menu to confirm that the gas type selected is proper for the gas hazard to be detected. The PIRECL is shipped from the factory calibrated and set for detection of methane, propane, ethylene, or butane. If a different gas type is desired, then change the setting using the detailed setup programming option, and perform a field calibration using the same gas type as is selected. Refer to the Calibration section of this manual.
2. Inspect the Gas Alarm level thresholds and Fault output signals using the Detailed setup option, and modify these settings if required.
3. Enter a device Tag number and/or descriptor for future traceability and guidance.

While these three operations are typical, these steps may not be satisfactory for your application.

The following data provides basic guidance on HART menu navigation. Refer to the HART Field Communicator manual for additional guidance.

ONLINE MENU

When HART communication is established with the PIRECL, the first menu displayed is the Root menu:

To select any of the 5 menu options shown, highlight the desired option using the up/down arrow key, and then press the "right arrow" key.

1 Device Setup
2 Gas xxxxx
3 PV xxx %LEL
4 PV AO xxx mA
5 PV URV xxx %LEL

1 Device Setup

Press to access the Device Setup menu from the Online menu. The Device Setup menu accesses every configurable parameter of the connected device. Refer to the Device Setup SubMenu for more information.

2 Gas

This shows gas type selected for detection.

3 PV (Primary Variable)

This shows the gas concentration being detected in %LEL.

4 PV AO (Analog Output)

This shows the Analog output level in selected units, typically milliamperes.

5 PV URV (Upper Range Value)

Select URV to view the upper range value and related engineering units.

DEVICE SETUP SUBMENU

The Device Setup menu accesses every configurable parameter of the connected device. The first accessible setup parameters include:

1 Process Variables

Selecting this menu item will list all process variables and their values.

These process variables are continuously updated, and include:

Gas xxxxx (gas type being detected).

Conc 0.0 % (concentration of gas in % full scale).

AO 4.00 mA (analog output of device).

2 Diag/Service Menu

Selecting this menu offers device and loop tests, calibration, and status/history options.

Refer to the Diag/Service Submenu for more information.

3 Basic Setup

This menu provides quick access to a number of configurable parameters including tag, unit, range values, device information, and gas type. Refer to the Basic Setup Submenu for additional information.

The options available in the Basic Setup menu are the most fundamental tasks that can be performed with a given device. These tasks are a subset of the options available under the Detailed Setup menu.

4 Detailed Setup

Press to access the Detailed setup menu.

This menu provides access to:

- 1 Sensor information
- 2 Gas Type
- 3 Output Condition
- 4 Device information
- 5 Write protect

Refer to the Detailed Setup Submenu for additional information.

5 Review

Press to access the Review menu. This menu lists all of the parameters stored in the connected device, including information about the measuring element, signal condition, and output. It also includes stored information about the connected device such as tag, materials of construction, and device software revision.

- | |
|---------------------|
| 1 Process Variables |
| 2 Diag/Service |
| 3 Basic Setup |
| 4 Detailed Setup |
| 5 Review |

DIAGNOSTICS/SERVICE MENU

The specific diagnostic and/or service functions available are:

1 Test Device

- 1 Self-test. Internal tests are performed and any problems are reported in xmtr flt 1 and xmtr flt 2.
- 2 Response Test. The analog output is held at 4 mA to prevent the alarm relays from activating when gas is applied. Gas response is indicated by the PV.
- 3 Reset. Latched relay outputs are reset.

2 Loop Test

This test allows the operator to manually set the analog signal output to a selected constant value.

3 Calibration

This menu option initiates the calibration routine and is used to set device calibration preferences.

Calibration Submenus include:

- 1 Zero Trim. The current sensor input is used as the new zero reference.
- 2 Calibrate Sensor. This is the command used to calibrate the Eclipse Detector. Submenus include:
 - 1 Calibrate. Zero and span calibrations are performed.
 - 2 Cal Concentration. The output will be set to this value when gas is applied during calibration.
 - 3 Cal Gas
 - 4 Gas Type. Submenu includes optional gases:
 - Methane
 - Propane
 - 5 Calibration Type. Submenu includes options:
 - Standard
 - Cuvette
 - 6 Cuvette Length (in millimeters)
- 3 Calibration Date (CalDate). Shows date of last calibration
- 4 D/A trim (internal use only).

4 Status

This menu option shows extensive status information about the detector. Data available includes:

- 1 Reference xxxx (output value of the reference sensor).
- 2 Snr temp xxxx (temperature of the sensor that is making the process measurement).
- 3 Operating mode (calibration, normal, reset)
- 4 Calibration
- 5 xmtr flt 1. Xmtr flt and xmtr status provide status information relating to failures, warnings and status of processes.
- 6 xmtr flt 2
- 7 xmtr status 1
- 8 xmtr status 2

1 Test Device

2 Loop Test

3 Calibration

4 Status

5 History

5 History

This menu option shows extensive historical information about the detector. Data available includes:

- 1 Running hrs xxxx (the number of hours the unit has been powered).
- 2 Max temperatures (the maximum temperatures recorded in the device).
See max temperature submenu below.
- 3 Min temperatures (the minimum temperatures recorded in the device).
See min temperature submenu below.
- 4 Cal log (data regarding stored calibrations). The most recent calibration is shown first.
Calibrations are recorded as zero only cal, cal OK (zero and span were successfully completed), and cal failed. See cal log submenu below.
- 5 Event log (data regarding stored events). The most recent event is shown first.
Recorded events include blocked optics, warm-up, zero drift, low alarms and high alarms.
See event log submenu below.

Max Temperature Submenu:

Running hrs xxxx
Maximum Temperature
xxxx degC xxxx hours
Max temp since reset
xxxx degC xxxx hours
Reset min&max temp?
ABORT OK

Min Temperature Submenu:

Running hrs xxxx
Minimum Temperature
xxxx degC xxxx hours
Min temp since reset
xxxx degC xxxx hours
Reset min&max temp?
ABORT OK

Cal Log Submenu:

Running hrs xxxx
Calibration history
(Event)
xxxxx Hrs
1 Previous
2 Next
3 Exit

Event Log Submenu:

Running hrs xxxx
Event history
(Event)
xxxx Hrs
1 Previous
2 Next
3 Exit

BASIC SETUP SUBMENU

The tag number identifies a specific device. Changing units affects the engineering units that are displayed. Re-ranging changes the analog output scaling.

1 Tag

Press to access the Tag number menu. Enter the device tag number as desired.

2 PV Unit

Press to access PV Unit submenu. Select %LEL for standard combustible applications.

- % LEL
- ppm
- Vol %

3 Range Values

Press to access Range Values submenu.

- 1 URV 20-100% LEL (upper range value).
- 2 LRV 0% LEL (lower range value).
- 3 USL 100% LEL (upper sensor limit).
- 4 LSL 0% LEL (lower sensor limit).

4 Device Information

Press to access device information submenu:

- 1 Tag xxxx
- 2 Date 6/30/2000
- 3 Descriptor (text associated with the field device that can be used by the operator in any way).
- 4 Message (text associated with the field device that can be used by the operator in any way).
- 5 Model: Eclipse
- 6 Write protect xx. This indicates whether variables can be written to the device, or whether commands that cause actions to be performed in the device can or cannot occur.
- 7 Revision #'s. See Revision #'s submenu below.
- 8 Final asmbly num
- 9 Dev id xxxx (a number is used to identify a unique field device).

Revision # submenu

offers selection options for:

- 1 Universal rev
- 2 Fld dev rev
- 3 Software rev xx

5 Gas

Type of gas being detected.

1 Tag
2 PV Unit xxxxx
3 Range Values
4 Device Information
5 Gas xxxxxx

DETAILED SETUP MENU

1 Sensor Information

This menu provides detailed information on the internal detector operations. Submenu options include:

- 1 PV USL xxxx. The upper sensor limit value defines the maximum usable value for the upper range of the sensor.
- 2 Active xxxx (output value of the active sensor).
- 3 Reference xxxx (output value of the reference sensor).
- 4 Ratio xxxx (the ratio of the active sensor over the reference sensor).
- 5 Absorption xxxx % (the gas absorption expressed in percent).
- 6 Span Factor xxxx (the number used in calibrating this specific device).
- 7 Snsr temp xx degC (the temperature of the sensor that is making the process measurement).
- 8 Vol % @ 100%LEL (the % volume of gas equal to 100% LEL).
- 9 Coefficient A
Coefficient B
Coefficient C
Coefficient D
Coefficient E

2 Gas Type

Select the gas to be detected here. Submenu options include:

- Spcl
 - Spcl Gas Coef A
 - Spcl Gas Coef B
 - Spcl Gas Coef C
 - Spcl Gas Coef D
 - Spcl Gas Coef E
 - Spcl Gas Vol %
- Methane
- Ethane
- Propane
- Ethylene
- Propylene
- Butane
- Spare 6
- Spare 7
- Spare 8

- | |
|----------------------|
| 1 Sensor Information |
| 2 Gas Type xxxxx |
| 3 Output Condition |
| 4 Device Information |
| 5 Write Protect |

3 Output Condition

Select and configure the output signal options for the Eclipse detector. Submenu options:

1 Config Gas Alarms. Submenu options include:

- 1 High Alarm Level. The high alarm level cannot be set higher than 60% LEL or lower than the low alarm level.
- 2 High Alarm Latch
- 3 Low Alarm Level. The low alarm level cannot be set lower than 5% LEL or higher than the high alarm level.
- 4 Low Alarm Latch

NOTE

Refer to "Alarm Relays" in the Specifications section of this manual for important information regarding alarm relays.

2 Config fault out. Submenu options include:

1 Analog fault codes. This programs the analog output used to indicate faults. Submenu options include:

- Eclipse
- PIR 9400
- User defined

2 Analog code values. Submenu options include:

- 1 Warm up
- 2 Blocked Optics
- 3 Calibration
- 4 Fault

3 Hart output. Submenu options include:

- 1 Poll addr xx (address used by the host to identify a field device).
- 2 Num req preams x (Number of Request Preambles).

4 Com Port. Submenu options include:

1 EQ DIP switch xxx (used with Eagle Quantum systems only).

1 Protocol xxxx (protocol for RS-485 communications). Submenu options:

- Modbus
- ASCII

2 Poll addr xxx (polling address for RS-485 communications).

3 Baud Rate xxxx (baud rate for RS-485 communications). Submenu options include:

- 1200
- 2400
- 4800
- 9600
- 19.2k

4 Parity xxxx (parity for RS-485 communications). Submenu options include:

- None
- Even
- Odd

4 Device Information

Press to access device information submenu:

- 1 Tag xxxx
- 2 Date 6/30/2000
- 3 Descriptor (text associated with the field device that can be used by the operator in any way).
- 4 Message (text associated with the field device that can be used by the operator in any way).
- 5 Model: Eclipse
- 6 Write protect xx. This indicates whether variables can be written to the device, or whether commands that cause actions to be performed in the device can or cannot occur.
- 7 Revision #'s. See Revision #'s submenu below.
- 8 Final assembly num
- 9 Dev id xxxx (a number used to identify a unique field device).

Revision # submenu

offers selection options for:

- 1 Universal rev
- 2 Fld dev rev
- 3 Software rev xx

5 Write Protect

Enable/disable password and write protection capability. Submenu options include:

- 1 Password. A password is required to enable writing to the device.
- 2 Set Write Protect
 - Disable
 - Enable
 - Change Password
- 3 Write Protect xx. This indicates whether variables can be written to the field device or whether commands that cause actions to be performed in the device can or cannot occur.

APPENDIX G

MODBUS COMMUNICATION

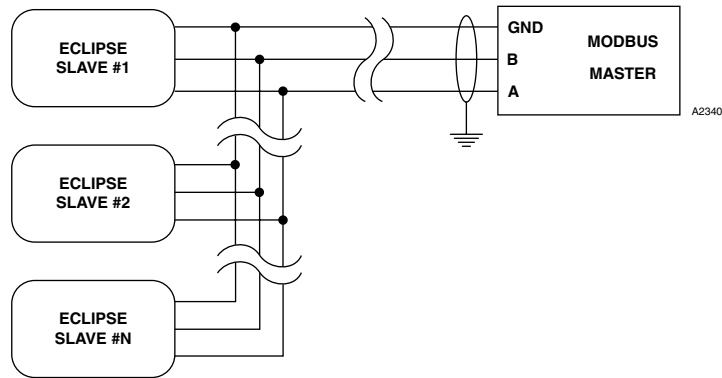
OVERVIEW

This appendix outlines the communication protocol and related memory structures that define the interface between PointWatch Eclipse Gas Detector and a system MODBUS Master. The system MODBUS Master is defined as any device capable of reading and writing to the holding register area of a MODBUS slave device. This includes proprietary software, HMI systems such as Wonderware and The FIX, PLCs and DCSs.

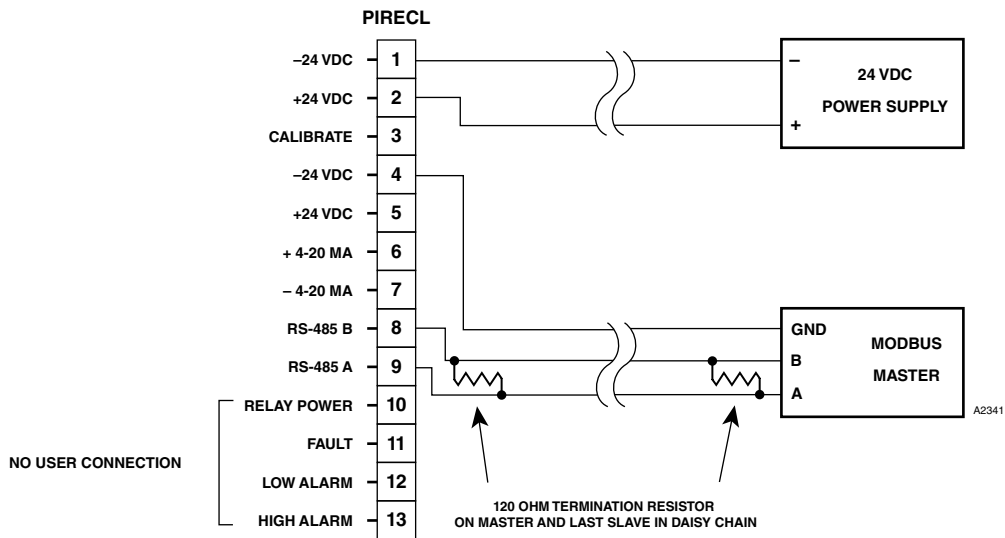
The Eclipse will respond as a slave device to a MODBUS Master, allowing the master to control data flow. A MODBUS memory map is defined, which divides memory into functional blocks consisting of: factory constants, configuration information, real time status, control and device defined information. Each block is then subdivided into individual variables that may be simple integers or floating point numbers.

WIRING

Typical RS-485/Modbus communication architecture is indicated in the diagram below. Eclipse units act as slave devices to a Modbus Master. Multiple Eclipse units are daisy-chained for RS-485 communication. If long cable runs are used, 120 Ohm end-of-line termination resistors may be required.



Individual Eclipse units are wired as shown below. Note the inclusion of the end-of-line termination resistor.



For more information, refer to the EIA RS-485-A standard.

HARDWARE LAYER

RS-485 is used for the hardware interface layer. The output drivers are capable of driving at least 32 devices. The device RS-485 output is tri-stated until a command address matches the programmed address. Default serial settings are MODBUS protocol, address 1, 9600 baud, 1 stop bit, and no parity.

MODBUS FUNCTION CODES

Supported Modbus Functions	
Function Number	Definition
3	Read holding registers
6	Preset single registers
16	Preset multiple registers

MEMORY MAP

Description	Starting Address	Ending Address	Size in Words	Access	Memory Type
Factory Constants	40001	40100	100	Read/Write at Factory	Flash/EEPROM
Device Configuration	40101	40200	100	Read/Write	EEPROM
Status Information	40201	40300	100	Read Only	Ram
Control Words	40301	40400	100	Write Only	Pseudo RAM
Event Logs	40401	40430	30	Read Only	EEPROM
Calibration Logs	40431	40460	30	Read Only	EEPROM
Raw Signal Buffer	40500	40979	480	Read Only	Ram

ECLIPSE MEMORY MAP

Factory Constants

This area holds values determined at the time of manufacture. Device type and firmware version is determined when the program is compiled and can't be changed. The serial number and manufacture date is written as part of the manufacturing process.

Eclipse Factory Constants		
Description	Address	Value
Device Type	40001	3 (Eclipse)
Firmware Version	40003	00.00..99.99
Serial Number	40004	Unsigned Long LSW
	40005	Unsigned Long MSW
Year (Manufacture Date)	40006	1999
Month	40007	1..12
Day	40008	1..31
Reserved	40009 to 40010	

Device Configuration: (Read/Write)

This area of memory holds field adjustable parameters for the device. The Hart configuration changed bit will be set on writes to this area.

Eclipse Device Configuration		
Description	Address	Value
Modbus Polling Address	40101	1..247
Baud Rate Code	40102	See Codes
Parity Code	40103	See Codes
Gas Type	40104	See Codes
Calibration Gas Type	40105	See Codes
Calibration Method	40106	See Codes
Calibration Cuvette Length (1.0 to 150.0 mm)	40107	Float LSW
	40108	Float MSW
Analog Fault Code	40109	See Codes
4 to 20 Range (20 to 100% LEL)	40110	Float LSW
	40111	Float MSW
Cal Gas Concentration (20 to 100% LEL)	40112	Float LSW
	40113	Float MSW
Warmup Fault Level (0.0 to 24.0 mA)	40114	Float LSW
	40115	Float MSW
Blocked Optics Fault Level (0.0 to 24.0 mA)	40116	Float LSW
	40117	Float MSW
Calibration Current Level (0.0 to 24.0 mA)	40118	Float LSW
	40119	Float MSW
General Fault Current Level (0.0 to 24.0 mA)	40120	Float LSW
	40121	Float MSW
Volume at LEL (Special Gas Type)	40122	Float LSW
	40123	Float MSW
Gas Coefficient a (Special Gas Type)	40124	Float LSW
	40125	Float MSW
Gas Coefficient b (Special Gas Type)	40126	Float LSW
	40127	Float MSW
Gas Coefficient c (Special Gas Type)	40128	Float LSW
	40129	Float MSW
Gas Coefficient d (Special Gas Type)	40130	Float LSW
	40131	Float MSW
Gas Coefficient e (Special Gas Type)	40132	Float LSW
	40133	Float MSW
Low Alarm Level (5 to 60% LEL)	40134	Float LSW
	40135	Float MSW
High Alarm Level (5 to 60% LEL)	40136	Float LSW
	40137	Float MSW
Low Alarm Latch	40138	See Codes
High Alarm Latch	40139	See Codes
Reserved	40140	

NOTE
Refer to "Alarm Relays" in the Specifications section of this manual for important information regarding alarm relays.

Device Status (Read only)

This area of memory holds real time status information.

Eclipse Status Information		
Description	Address	Value
General Status Bits	40201	Bit Values (See below)
Fault Status Bits	40202	Bit Values (See below)
Gas Level in LEL	40203	Float LSW
	40204	Float MSW
Calibration Step	40205	See Codes
Active Sensor Signal	40206	Float LSW
	40207	Float MSW
Reference Sensor Signal	40208	Float LSW
	40209	Float MSW
Sensor Ratio	40210	Float LSW
	40211	Float MSW
Sensor Absorption	40212	Float LSW
	40213	Float MSW
Temperature (°C)	40214	Float LSW
	40215	Float MSW
Hour Meter	40216	Unsigned Long LSW
	40217	Unsigned Long MSW
Max Temperature	40218	Float LSW
	40219	Float MSW
Max Temp Hour	40220	Unsigned Long LSW
	40221	Unsigned Long MSW
Max Temp (Since Reset)	40222	Float LSW
	40223	Float MSW
Max Temp Hour (Since Reset)	40224	Unsigned Long LSW
	40225	Unsigned Long MSW
Ram Error Code	40226	Unsigned Integer
Volume at LEL (Current Gas Type)	40227	Float LSW
	40228	Float MSW
Gas Coefficient a (Current Gas Type)	40229	Float LSW
	40230	Float MSW
Gas Coefficient b (Current Gas Type)	40231	Float LSW
	40232	Float MSW
Gas Coefficient c (Current Gas Type)	40233	Float LSW
	40234	Float MSW
Gas Coefficient d (Current Gas Type)	40235	Float LSW
	40236	Float MSW
Gas Coefficient e (Current Gas Type)	40237	Float LSW
	40238	Float MSW

Eclipse Status Information (continued)		
Description	Address	Value
Min Temperature	40239	Float LSW
	40240	Float MSW
Min Temp Hour	40241	Unsigned Long LSW
	40242	Unsigned Long MSW
Min Temp (Since Reset)	40243	Float LSW
	40244	Float MSW
Min Temp Hour (Since Reset)	40245	Unsigned Long LSW
	40246	Unsigned Long MSW
Fixed 4 to 20 mA Value	40247	Float LSW
	40248	Float MSW
Reserved	40249	
Reserved	40250	
Reserved	40251	
Reserved	40252	
Zero Ratio	40253	Float LSW
	40254	Float MSW
Span Factor	40255	Float LSW
	40256	Float MSW
5 Volt Power Supply Value (As read by ADC)	40257	Float LSW
	40258	Float MSW
12 Volt Power Supply Value (As read by ADC)	40259	Float LSW
	40260	Float MSW
24 Volt Power Supply Value (As read by ADC)	40261	Float LSW
	40262	Float MSW

General Status Bits

These bits are used to signal the current operating mode of the device.

Name	Bit	Description
Device Fault (any fault)	0	Set for all fault conditions
Calibration Active	1	Set during calibration
Warm up Mode	2	Set during warm-up
Low Alarm Active	3	Set while alarm is active
High Alarm Active	4	Set while alarm is active
Output Current Fixed	5	Set when output current is fixed
Modbus Write Protect	6	0 = Locked 1 = Unlocked
Calibration Input Active	7	True while the cal line is active
Magnetic Switch Active	8	True while the onboard magnetic switch is active
Hart Initiated Self Test	9	True when self test is initiated from the Hart interface
Reserved	10	
Response Test Active	11	True during the gas response test.
Manual Self Test Active	12	True during manual self test

Fault Status Word

These bits are used to signal the active faults of the device.

Name	Bit
Calibration Fault	0
Dirty Optics	1
Open Lamp	2
Cal Active at start	3
EE Error 1	4
EE Error 2	5
Ref ADC Saturated	6
Active ADC Saturated	7
Bad 24 volts	8
Bad 12 volts	9
Bad 5 volts	10
Zero Drift	11
Flash CRC Error	12
Ram Error	13

Control Words

Setting values in this area of memory initiates action in the device. For example, it may start a calibration sequence. The device automatically clears command word bits after the function is performed.

Eclipse Control Words		
Description	Address	Value
Command Word 1	40301	See below
Command Word 2 (Reserved)	40302	
Reserved	40303 to 40306	

Command Word 1

Description	Bit
Start Calibration	0
Abort Calibration	1
Warm up Mode	2
Low Alarm Active	3
High Alarm Active	4
Output Current Fixed	5
Modbus Write Protect	6
Calibration Input Active	7
Magnetic Switch Active	8
Hart Initiated Self Test	9
Reserved	10
Response Test Active	11
Manual Self Test Active	12
End Response Test	13
Reserved	14
Start Manual Self Test	15

Event Logs

Fault and calibration logs are held in this area of memory.

Eclipse Event Logs			
Description	Address	Value	Notes
Event Hour	40401	Unsigned Long LSW	1 of 10 logs
	40402	Unsigned Long MSW	
Event ID 1	40403	See Codes	
Event Hour	40428	Unsigned Long LSW	Last of 10
	40429	Unsigned Long MSW	
Event ID 10	40430	See Codes	
Event Hour	40431	Unsigned Long LSW	1 of 10 logs
	40432	Unsigned Long MSW	
Calibration Event ID 1	40433	See Codes	
Event Hour	40458	Unsigned Long LSW	Last of 10
	40459	Unsigned Long MSW	
Calibration Event ID 10	40460	See Codes	

VALUE CODES

Baud Rate Code

Description	Code
1200	0
2400	1
4800	2
9600 (Default)	3
19200	4

Parity Code

Description	Code
None (Default)	0
Even	1
Odd	2

Gas Type

Description	Code
Methane	0
Ethane	1
Propane	2
Ethylene	3
Propylene	4
Butane	5
Reserved	6
Reserved	7
Reserved	8
Special	9

Calibration Gas Type

Description	Code
Same as Measured	0
Methane	1
Propane	2

Calibration Method

Description	Code
Standard	0
Cuvette	1

Analog Fault Code

Description	Code
Eclipse	0
PIR 9400	1
User Defined	2

Calibration Step

Description	Code
Waiting to Start	0
Waiting for Zero	1
Waiting for Signal	2
Waiting for Gas	3
Waiting for Span	4
Waiting for End	5
Calibration Terminated	6
Calibration Complete	7

Alarm Latch Configuration

NOTE

Refer to "Alarm Relays" in the Specifications section of this manual for important information regarding alarm relays.

Description	Code
Non-Latching	0
Latching	1

Event Log ID Codes

Description	Code
Empty	0
Blocked Beam	1
Warm-up	2
Zero Drift	3
Low Alarm	4
High Alarm	5

Calibration Log ID Codes

Description	Code
Empty	0
Zero Cal	1
Zero and Span	2
Failed Cal	3

ASCII PROTOCOL

The RS485 serial port can be configured for ASCII protocol, which is intended for applications that don't require custom software on the host side. Off the shelf terminal emulation software can be used to receive messages from the device. Percent LEL and sensor readings are sent once per second and user prompt messages are sent during the calibration process to guide the user at each step. Default serial settings are 9600 baud, 1 stop bit, and no parity. Protocol and serial parameters should be selected with the HART handheld communicator.

APPENDIX H

EAGLE QUANTUM PREMIER COMPATIBLE ECLIPSE

INSTALLATION AND WIRING

The Eagle Quantum Premier (EQP) version of the Model PIRECL PointWatch Eclipse uses the identical installation procedure, device location guidelines, and power supply requirements as described in the “Installation” section of this manual. Refer to the EQP version wiring diagram for specific wiring termination guidance.

An important difference in EQP applications is that LON network cabling will be routed both in and out from the the EQP Eclipse enclosure, so this requirement should be anticipated and planned for during EQP Eclipse installation.

Table H-1—LON Maximum Cable Lengths

LON Cable (Manufacturer and Part No.)*	Maximum Length**	
	Feet	Meters
Belden 8719	6,500	2,000
Belden 8471	6,500	2,000
FSI 0050-000006-00-NPLFP	6,500	2,000
Technor BFOU	4,900	1,500
Level IV, 22 AWG	4,500	1,370

Note: *Use the same type of cable in each wiring segment between network extenders.

**Maximum wire lengths represent the linear wire distance of LON communications wiring between network extenders.

The maximum wire lengths given in Table C-1 are based upon the cable’s physical and electrical characteristics.

IMPORTANT

Det-Tronics recommends the use of shielded cable (required by ATEX) to prevent external electromagnetic interference from affecting field devices.

IMPORTANT

For best fault isolation performance, the maximum LON wiring length should not exceed 1600 feet (500 meters).

IMPORTANT

Be sure that selected cable meets all job specifications. The use of other cable types can degrade system operation. If necessary, consult factory for further suggested cable types.

CONFIGURATION AND OPERATION

Configuration of the EQP Eclipse is accomplished using Det-Tronics Safety System Software (S3) that is running on the EQP Operator Interface Station (OIS).

ONBOARD HART PORT

The on-board HART port is functional on the EQP Eclipse, however, it should **not** be used for device configuration purposes. All EQP device configuration should be performed using the S3 program.

MULTI-COLORED LED

Operation of the status indicating LED is identical to all other PIRECL versions.

REMOTE CALIBRATION OPTION

Operation of the remote calibration option is identical to all other PIRECL versions.

ANALOG OUTPUT

A 4-20 mA analog current output is not available with EQP PIRECL.

RS-485 COMMUNICATION

RS-485 communication is not available with EQP PIRECL.

CALIBRATION ROUTINE

The calibration procedure for the EQP PIRECL (normal and zero calibration) is identical to all other PIRECL versions.

NOTE

For complete information regarding installation, configuration or operation of the Eagle Quantum Premier system, refer to form 95-8533 (Eagle Quantum Premier hardware manual) or form 95-8560 (Safety System Software manual).

ECLIPSE OPERATION WITH EAGLE QUANTUM PREMIER

Table H-2—Typical Update Rate for PIRECL in an EQP System

Field Device	Transmit time to Controller (sec)
PIRECL	
Gas Alarms	Immediate
Gas Level	1
Device Fault	1

Table H-3—PIRECL Fixed Alarm Logic (Thresholds Programmed Using S3 Configuration Software)

Field Device	Fire Alarm	High Gas Alarm	Low Gas Alarm	Trouble	Supervisory
PIRECL (Point IR Eclipse)					
High Alarm		X			
Low Alarm			X		

Table H-4—PIRECL Faults and Fixed Logic System Outputs

Field Device VFD Faults	Trouble LED	Trouble Relay
Calibration Fault	X	X
Dirty Optics	X	X

SETTING NETWORK ADDRESSES

Overview of Network Addresses

Each PIRECL IR gas detector on the EQP LON must be assigned a unique address. Addresses 1 to 4 are reserved for the EQP controller. Valid addresses for field devices including PIRECL gas detectors are from 5 to 250.

IMPORTANT

If the address is set to zero or an address above 250, the system will ignore the switch setting and the device.

The LON address is programmed by setting rocker switches on an 8 switch “DIP Switch” located within the PIRECL housing. The address number is binary encoded with each switch having a specific binary value with switch 1 being the LSB (Least Significant Bit). (See Figure C-1.) The device’s LON address is equal to the added value of all closed rocker switches. All “Open” switches are ignored.

Example: for node No. 5, close rocker switches 1 and 3 (binary values 1 + 4); for node No. 25, close rocker switches 1, 4 and 5 (binary values 1 + 8 + 16).

NOTE

For convenience in setting LON address switches, a “Rocker Switch Table” is included in the EQP System manual (form 95-8533).

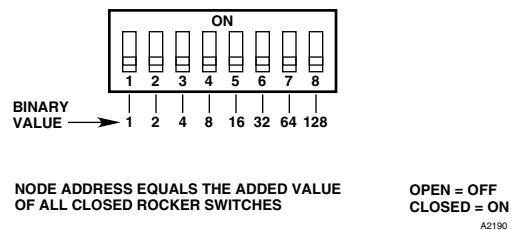


Figure H-1—PIRECL Address Switches

Do not assign duplicated addresses. Duplicated addresses are not automatically detected. Modules given the same address will use the number given and report to the controller using that address. The status word will show the latest update, which could be from any of the reporting modules using that address.

After setting address switches, record the address number and device type on the "Address Identification Chart" (form 95-8487). Post the chart in a convenient location near the Controller for future reference.

IMPORTANT

*The PIRECL sets the LON address only when power is applied to the device. Therefore, it is important to set the switches **before** applying power. If an address is ever changed, system power must be cycled before the new address will take effect.*

PIRECL Address Switches

Address switches for PIRECL are located within the device enclosure. Refer to Figure C-2 for switch location.

WARNING

Disassembly of the PIRECL housing and removal of the front electronics module from the bulkhead is required to gain access to the network address switches. Power should be removed from the detector before disassembly. If disassembly is performed in a hazardous areas, the area must be de-classified before starting disassembly.

WARNING

Disassembly of the PIRECL detector should only be performed with proper electrostatic discharge grounding protection. A controlled lab or shop setting is recommended for device programming.

The PIRECL detector contains semiconductor devices that are sensitive to electrostatic discharge (ESD). Damage caused by electrostatic discharge can be virtually eliminated if the equipment is handled only in a static safeguarded work area and protective measures against static electricity discharge are employed during the disassembly process. Since a static safeguarded work area is usually impractical in most field installations, handle the device by the housing, taking care not to touch electronic components or terminals. Use a wrist grounding strap or similar method at all times to control accidental ESD when disassembling, programming, or reassembling the PIRECL gas detector.

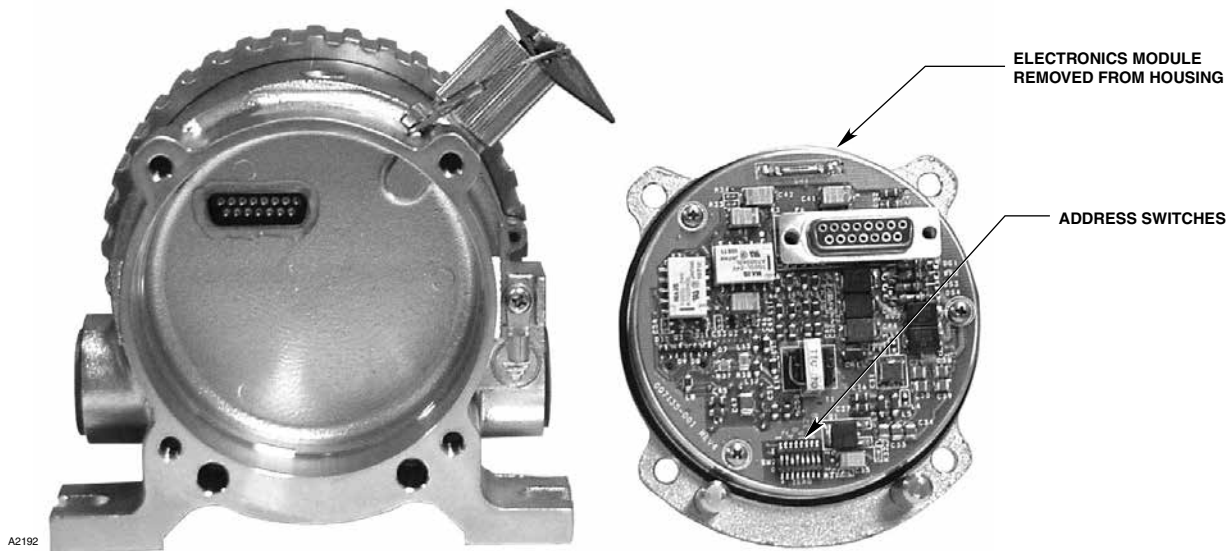


Figure H-2—Location of PIRECL Address Switches

Switch Access Procedure

NOTE

It is strongly recommended to document all PIRECL gas detector network addresses as well as the addresses of all other LON devices on the Address Identification Chart before disassembling and programming the PIRECL gas detectors.

Removal of four stainless steel flange bolts and the front electronics module of the PIRECL IR gas detector from the bulkhead is required in order to gain access to the network address DIP switch. Tools required for this procedure include a 4mm hex wrench and a torque wrench capable of accurately measuring 40 inch-pounds.

1. Remove 24 Vdc power from the PIRECL detector. Remove the weather baffle from the detector.
2. Remove the four stainless steel flange bolts using a 4mm hex wrench. Take care to properly support the electronics module as the last flange bolt is removed.
3. Carefully remove the electronics module by extracting it straight out from the bulkhead.
4. Set the network address switches.
5. Ensure that the module O-ring is intact and undamaged.
6. Reinstall the electronics module by inserting it straight into the bulkhead.

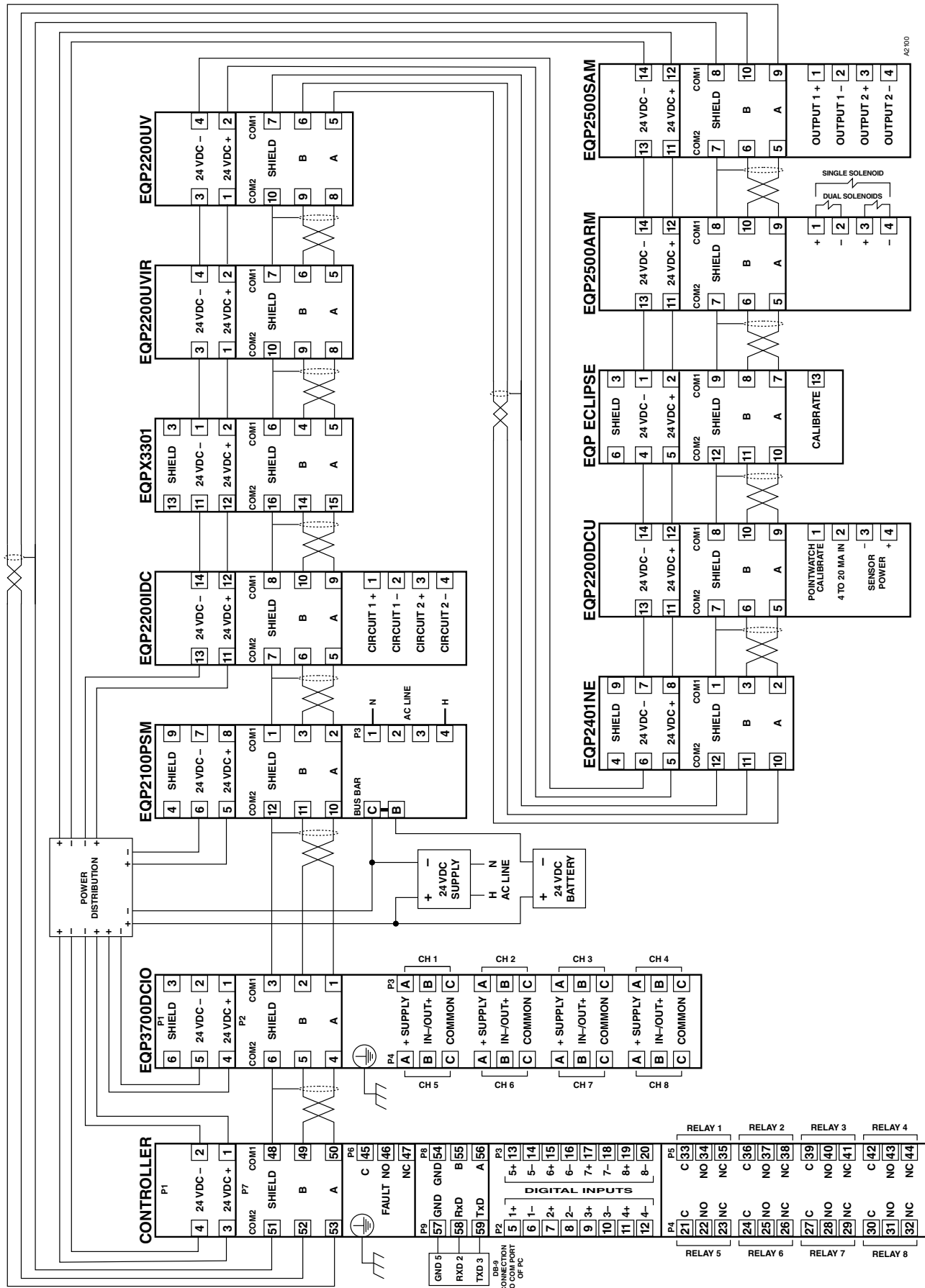
NOTE

Take care to properly align the module's electrical connector with the bulkhead connector before attempting to fully insert the module. Failure to do so may result in damage to the module and/or bulkhead.

7. Insert and tighten the four flange bolts in an opposing consecutive order in two stages — first partially tighten all four bolts equally, and then fully tighten each bolt in an opposing order to 40 inch-pounds (4.5 Nm) of torque. (Bolts are M6 per ISO 965 with M5 head, SST with a yield stress of 448 N/mm² (65,000 PSI) minimum.)
8. Apply power after all network addresses have been programmed and all field enclosures are properly installed.

TYPICAL APPLICATIONS

Figure C-3 is a simplified drawing of a typical EQP system. This system includes an EQP Controller, DCIO and various LON field devices.



A3100

Figure H-3—A Typical System

APPENDIX I

WARRANTY

Detector Electronics Corporation products are manufactured from high quality components and the completed device is rigorously inspected and tested before shipment; however, any electronic device is subject to failure beyond the control of the manufacturer. To ensure system reliability, it is important for the user to maintain the system as recommended by the instruction manuals and to determine the frequency of functional checking of the system required for each specific installation. The more frequent the checking, the greater the system reliability. For the highest reliability, a completely redundant system is necessary. The manufacturer warrants the PointWatch Eclipse against defective parts and workmanship, and will replace or repair equipment returned to the manufacturer for these reasons within five years after purchase date. See manufacturer's Standard Terms and Conditions on the invoice for complete details. Please note that no other warranties, written or implied, will be honored by the manufacturer.

CAUTION

The detector contains no user serviceable components. Service or repair should never be attempted by the user. The manufacturer's warranty for this product is void, and all liability for proper function of the detector is irrevocably transferred to the owner or operator in the event that the device is serviced or repaired by personnel not employed or authorized by Detector Electronics Corporation, or if the device is used in a manner not conforming to its intended use.

APPENDIX J

CONTROL DRAWING

THE MODEL PIRECL INFRARED HYDROCARBON GAS DETECTORS PROVIDE AN FM APPROVED AND CSA CERTIFIED INTRINSICALLY SAFE OUTPUT FOR CONNECTION WITH THE HART COMMUNICATOR WHEN INSTALLED PER THE NATIONAL ELECTRICAL CODE (NEC), NFPA 70, ARTICLES 501 & 504 OR CANADIAN ELECTRICAL CODE, C22.1, SECTION 18 & APPENDIX F.

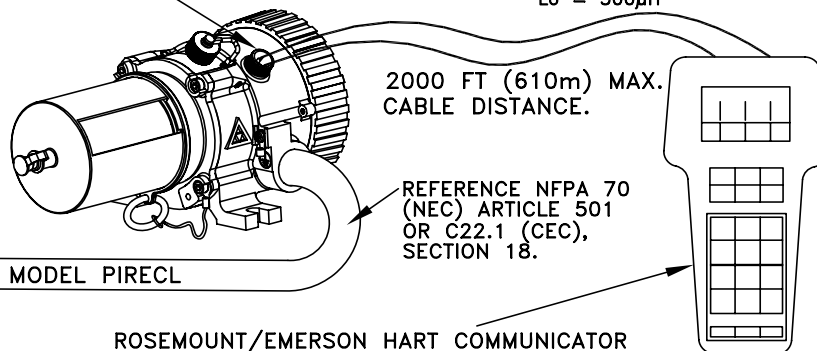
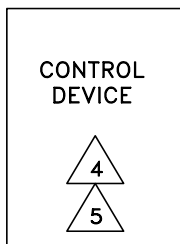
NOTE: TO PREVENT IGNITION OF EXPLOSIVE ATMOSPHERES, READ, UNDERSTAND, AND ADHERE TO THE MANUFACTURERS LIVE MAINTENANCE PROCEDURE.

NON-HAZARDOUS AREA

CLASS I, DIVISION 1, GROUPS B, C, D (T4) WITH INTRINSICALLY SAFE OUTPUT FOR HART COMMUNICATION.

CLASS I, DIVISION 2, GROUPS A, B, C, D (T4)
 {AMBIENT TEMPERATURE LIMITS: -40°C TO +75°C}

INTRINSICALLY SAFE HART PORT: REFERENCE NFPA 70 (NEC), ARTICLE 504. OR C22.1 (CEC), APPENDIX F.	FOR ZONE CLASSIFICATIONS U _o = 4.0V I _o = 100mA C _o = 20µF L _o = 500µH	FOR DIVISION CLASSIFICATIONS U _o = 3.47V I _o = 116.8mA
---	--	--



ROSEMOUNT/EMERSON HART COMMUNICATOR
 (NOTE: THIS DRAWING SUPERCEDES ALL ROSEMOUNT/EMERSON HART COMMUNICATOR CONTROL DRAWINGS)

5 IN ORDER TO MAINTAIN SYSTEM APPROVAL, THE CONTROL UNIT CONNECTED TO THE PIRECL(X)4 DETECTOR, SHALL HAVE THE APPROPRIATE THIRD PARTY CERTIFICATION TO PROCESS THE SPECIFIED LON SIGNAL AND PROVIDE THE APPROPRIATE INDICATION.

4 APPROVAL OF THE MODEL PIRECL DOES NOT INCLUDE OR IMPLY APPROVAL OF THE APPARATUS TO WHICH THE DETECTOR MAY BE CONNECTED AND WHICH PROCESSES THE ELECTRONIC SIGNAL FOR EVENTUAL END USE.

3. THE MODEL PIRECL IS CSA CERTIFIED FOR COMBUSTIBLE GAS PERFORMANCE IN ACCORDANCE WITH CSA C22.2 #152.
2. THE MODEL PIRECL IS FM APPROVED FOR COMBUSTIBLE GAS PERFORMANCE IN ACCORDANCE WITH FM 6310/6320 & ANSI/ISA-12.13.01.
1. FM APPROVED/CSA CERTIFIED DRAWING - NO MODIFICATIONS PERMITTED WITHOUT REFERENCE TO APPROVAL AGENCY.

A

A

UNLESS OTHERWISE SPECIFIED TOLERANCES ARE:			
DIMENSION	(MM)	TOLERANCE	(MM)
INCH	(0)	±.02	±(0.5)
	(0.0)	±.01	±(0.25)
	(0.00)	±.005	±(0.13)
ANGLE ±1°			
REMOVE ALL BURRS BREAK ALL EDGES AND SHARP CORNERS			

DET-TRONICS[®]
 DETECTOR ELECTRONICS CORP.
 MINNEAPOLIS, MINNESOTA 55438

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SHEET	1 OF 1	DO NOT SCALE DRAWING	SCALE	NONE	SIZE	DRAWING NO.	REV
TITLE	CONTROL DRAWING PIRECL, FM/CSA				A	007283-001	J

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1



95-8526



X3301 Multispectrum
IR Flame Detector



PointWatch Eclipse®
IR Combustible Gas Detector



FlexVu® Universal Display
w/ GT3000 Toxic Gas Detector



Eagle Quantum Premier®
Safety System

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Instructions

95-8661

FlexVu® Explosion-Proof
Universal Display Unit
Model UD10



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**FlexVu® Explosion-Proof
Universal Display Unit
Model UD10****IMPORTANT**

Be sure to read and understand the entire instruction manual before installing or operating the gas detection system. This product can be used with a variety of Det-Tronics gas detectors to provide early warning of the presence of a toxic or explosive gas mixture. Proper device installation, operation, and maintenance is required to ensure safe and effective operation. If this equipment is used in a manner not specified in this manual, safety protection may be impaired.

APPLICATION

The FlexVu® Model UD10 is recommended for applications that require a gas detector with digital readout of detected gas levels as well as analog 4-20 mA output with HART, relay contacts, and Modbus RS485 (FOUNDATION™ Fieldbus option available). The UD10 Universal Display Unit is designed for use with Det-Tronics gas detectors listed in Table 1.

The display unit is designed and approved as a 'stand alone' device and performs all the functions of a gas controller.

When furnished with the CGS interface board, the device can be used only with a CGS sensor for detection of combustible gas. The UD10/CGS combination is certified as a "Gas Detector".

Gas concentration and unit of measurement are displayed on a digital display. The display unit provides a linear isolated/non-isolated 4-20 mA DC output signal (with HART) that corresponds to the detected gas concentration.

All electronics are enclosed in an explosion-proof aluminum or stainless steel housing. The display unit is used with a single detector that may be either coupled directly to the UD10, or remotely located using a sensor termination box.

The UD10 features non-intrusive calibration. A magnet is used to perform calibration as well as to navigate the UD10's internal menu.

**DESCRIPTION**

The UD10 Universal Display can be used with various 4-20 mA gas detection devices, with or without HART. The unit provides display, output and control capabilities for the gas detector.

The UD10 utilizes the following I/O:

- Signal Inputs: 4-20 mA loop from the sensing device
- User Inputs: Magnetic switches (4) on the display panel
HART communication (handheld field communicator or AMS)
FOUNDATION™ Fieldbus (if selected)
- Signal Outputs: 4-20 mA output loop with HART
Modbus RS485 or FOUNDATION™ Fieldbus
Three alarm relays and one fault relay
- Visible Outputs: Backlit LCD display
HART slave interface via HART Communicator

Table 1—Range and Default Values for Alarms and Calibration Gas Concentration

UD10 ALARM DATA					CALIBRATION
Gas Detector		High Alarm Value	Low Alarm Value	Aux alarm Value	Cal Gas
GT3000--Hydrogen Sulfide	Range	10-90%	5-50%	5-90%	30-90%
	Default	40%	10%	40%	50%
GT3000--Ammonia	Range	10-90%	5-50%	5-90%	30-90%
	Default	40%	10%	40%	50%
GT3000--Chlorine	Range	10-90%	5-50%	5-90%	30-90%
	Default	40%	10%	40%	50%
GT3000--Hydrogen	Range	10-60%	5-50%	5-90%	30-90%
	Default	40%	10%	40%	50%
GT3000--Oxygen	Range	5-20.5% v/v	5-20.5% v/v	5-20.5% v/v	20.9% v/v
	Default	18% v/v	18% v/v	18% v/v	20.9% v/v
GT3000--Carbon Monoxide	Range	10-90%	5-50%	5-90%	30-90%
	Default	40%	10%	40%	50%
GT3000--Sulfur Dioxide	Range	10-90%	5-50%	5-90%	30-90%
	Default	40%	10%	40%	50%
PIR9400	Range	10-60%	5-50%	5-90%	50%
	Default	40%	10%	40%	50%
PIRECL	Range	10-60%	5-50%	5-90%	30-90%
	Default	40%	10%	40%	50%
OPECL	Range	1-3 LFL-meters	0.25-3 LFL-meters	NA	NA
	Default	2 LFL-meters	1 LFL-meter	NA	NA
C706X*	Range	10-90%	5-50%	5-90%	30-90%
	Default	40%	10%	40%	50%
CGS Combustible	Range	10-60%	5-50%	5-90%	50%
	Default	40%	10%	40%	50%
Model 505/CGS Combustible	Range	10-60%	5-50%	5-90%	N/A
	Default	40%	10%	40%	N/A
NTMOS--Hydrogen Sulfide	Range	10-90%	5-50%	5-90%	50%
	Default	40%	10%	40%	50%
Generic Detector	Range	10-90%	5-50%	5-90%	N/A
	Default	40%	10%	40%	50%

Notes: All values are a percentage of full scale with the exception of Oxygen, which is the actual percent of Oxygen, and OPECL, which is the value in LFL-meters.

Low alarm must be less than or equal to the high alarm.

Changing the Measurement Range will reset all alarm and Cal Gas values to the default settings for the selected range.

Alarm relays are selectable for either normally energized or normally de-energized coils, with selectable latching or non-latching contacts. Fault relay is normally energized (with no faults).

*Does not support C7064C hydrogen sulfide or C7065E oxygen, but includes C7064E hydrogen sulfide, C7067E chlorine, C7066E carbon monoxide, and C7068E sulfur dioxide.

HART COMMUNICATION

A HART interface provides device status information and field programming capability.

MAGNETIC SWITCHES

Four internal magnetic switches provide a non-intrusive user interface that allows navigation through the menu and adjustment of configuration parameters in the field without the use of a HART handheld device. See Figure 1 for switch locations.

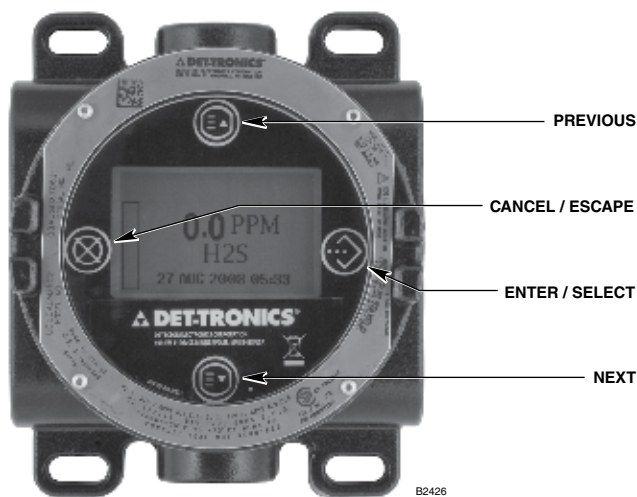
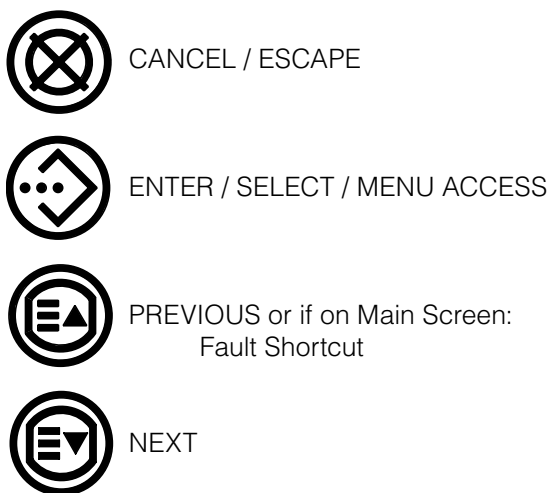


Figure 1—Faceplate of UD10

These switches are used for device configuration, checking status and event logs, and performing calibration. The switches are labeled as follows:



To actuate a magnetic switch, lightly touch the magnet to the viewing window of the UD10 directly over the switch icon on the faceplate.

CAUTION

Handle magnets with care! Personnel wearing pacemakers/defibrillators should not handle magnets. Modern magnet materials are extremely strong magnetically and somewhat weak mechanically. Injury is possible to personnel, and magnets themselves can easily get damaged if allowed to snap towards each other, or if nearby metal objects are allowed to be attracted to the magnets.

NOTE

Det-Tronics offers two magnet options for activating internal magnetic switches. While the two magnets can usually be used interchangeably, the best results will be achieved if they are used as follows: The Magnetic Tool (p/n 009700-001) is the stronger magnet and is recommended for activating the switches on the UD10 viewing window. The Calibration Magnet (p/n 102740-002) is recommended for applications that involve initiating calibration or resetting the detector by touching the side of a metal junction box or detector housing (PIRECL, OPECL, etc). Throughout this manual, the term “magnet” can refer to either device.

Access To Menus

To access the menus, use the magnet to activate the ENTER/SELECT button. This will display the Main Menu.

The actual menu structure varies depending upon the device that is connected to the UD10. Menus for the various devices can be found in the corresponding Appendix in this manual.

Some areas of the menu contain additional information, which is indicated by the presence of an arrow on that particular line. By placing the magnet to the glass over the ENTER/SELECT button, the next screen with the additional information will be shown.

The UD10 automatically returns to the main screen after 10 minutes if no activity occurs.

Quick Access/Shortcut: Fault Menu

To access the fault menu quickly, when a fault is present, touch the magnet to the glass by the PREVIOUS button.

RELAYS

The display unit has 4 output relays — high alarm, low alarm, auxiliary alarm, and fault. The relays have form C (SPDT) contacts. Low, auxiliary and high alarm relay contacts are selectable for latching or non-latching operation, as well as normally energized or normally de-energized (default) coils. During normal operation, the fault relay is energized.

IMPORTANT

Direct connection of 120/240 VAC to the relay terminals inside the UD10 enclosure is not allowed, since switching relay contacts can induce electrical noise into the electronic circuitry, possibly resulting in a false alarm or other system malfunction. If the application requires that AC powered equipment be controlled by the transmitter, the use of externally located relays is recommended.

External relays, solenoids, motors, or other devices that can cause inductive transients should be transient suppressed. Place a diode across the coil for DC devices. See Figure 2.

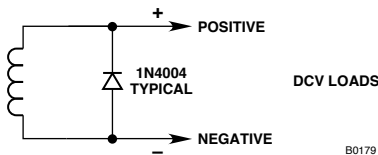


Figure 2—Transient Suppression for Inductive Loads

4-20 MA OUTPUT MODES

The UD10 offers two operating modes for its 4-20 mA output circuit.

NOTE

A minimum output of 1 mA is required for proper HART communication.

In the **Standard (default) Mode**, the linear 4-20 mA output corresponds to 0-100% full scale gas detected at the sensor, with 3.8 mA indicating calibrate mode, and 3.6 mA or lower indicating a fault condition. This mode ensures that the current level is always high enough to support HART communication and must be selected when using HART communication for fault diagnostics.

In **Replicate Mode**, the output of the UD10 matches the output of the connected detector (except for loop test/trim, response test, calibration, or if the UD10 has an internal fault). This mode can be used with

detectors such as PIR9400 or PIRECL where multiple current levels below 4 mA are used for fault diagnostic purposes.

UD10 with Model PIRECL

PIRECL supports two fault modes: PIR9400 and Eclipse mode. PIR9400 fault mode uses fault codes below 1 mA, while Eclipse mode uses no levels below 1 mA. In the Standard (default) mode, the UD10 programs the PIRECL for Eclipse fault mode to ensure proper HART communication in the event of a fault. In the Replicate mode, the UD10 programs the PIRECL for PIR9400 fault mode.

MODBUS / FIELD BUS COMPATIBILITY

The UD10 supports RS485 Modbus RTU communication. See Addendum number 95-8639 for details. A model with Modbus RS485 or FOUNDATION™ Fieldbus communication (field selectable via jumpers) is also available.

DEVICE ENCLOSURE

The UD10 housing is a 5 port aluminum or stainless steel explosion-proof junction box with a clear viewing window.

DEVICE DISPLAY

The UD10 is provided with a 160 x 100 dot matrix backlit LCD display. See Figure 1.

During normal operation, the LCD continuously displays the detected gas level, gas type, and units of measurement. The real time clock can also be displayed if desired.

The display shows the following alarm information:

- High gas alarm
- Low gas alarm
- Aux alarm

The display indicates the following fault information:

- Device fault
- Display fault

The UD10 has smart capabilities to allow easy access to the following information:

- Detector information
- Measurement range
- Alarm setpoints
- Alarm and event logs

For detailed HART menu structure, refer to the appropriate Appendix.

LOGGING

Events that can be logged in the UD10 include:

- Calibration (Date, time and success Y/N are logged for detectors that do not provide their own calibration logging capabilities.)

Faults that are logged in the UD10 include:

- Detector fault
- Low power
- General fault

Alarms that are logged in the UD10 for gas detector inputs include:

- High gas alarm
- Low gas alarm
- Aux alarm.

The UD10 has its own battery backed real time clock (RTC) and its own event logs. The RTC in the UD10 can be set from the UD10 display, Modbus or HART interfaces. The RTC in the gas detector (any HART detector having an RTC) can be set independently using the UD10 menu, or by using the synchronize command, which will set the detector RTC to the same time as the UD10 RTC. See Figure 3.

The UD10 can display the detector event and calibration logs (if available). The UD10 has its own 1,000-entry event log available under the Display Status->History->Event Log menu.

UD10 event logs can be read from the HART interface or the Modbus interface.

Detector calibration and event logs can also be read from the detector HART interface (where available).

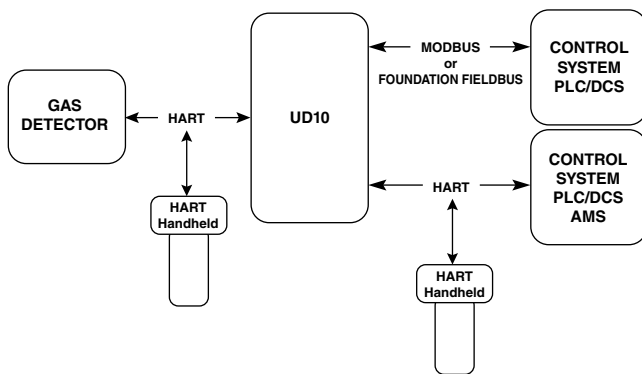


Figure 3—UD10 Logging

IMPORTANT SAFETY NOTES

CAUTION

The wiring procedures in this manual are intended to ensure proper functioning of the device under normal conditions. However, because of the many variations in wiring codes and regulations, total compliance to these ordinances cannot be guaranteed. Be certain that all wiring complies with the NEC as well as all local codes. If in doubt, consult the authority having jurisdiction before wiring the system. Installation must be done by a properly trained person.

CAUTION

This product has been tested and approved for use in hazardous areas. However, it must be properly installed and used only under the conditions specified within this manual and the specific approval certificates. Any device modification, improper installation, or use in a faulty or incomplete configuration will render warranty and product certifications invalid.

CAUTION

The device contains no user serviceable components. Service or repair should never be attempted by the user. Device repair should be performed only by the manufacturer.

LIABILITIES

The manufacturer's warranty for this product is void, and all liability for proper function of the detector is irrevocably transferred to the owner or operator in the event that the device is serviced or repaired by personnel not employed or authorized by Detector Electronics Corporation, or if the device is used in a manner not conforming to its intended use.

CAUTION

Observe precautions for handling electrostatic sensitive devices.

CAUTION

Unused conduit entries must be closed with suitably certified blanking elements upon installation.

INSTALLATION

NOTE

The gas detector housing must be electrically connected to earth ground. A dedicated earth ground terminal is provided on the UD10.

NOTE

Refer to the Model UD10 Safety Manual (number 95-8668) for specific requirements and recommendations applicable to the proper installation, operation, and maintenance of SIL-Certified Model UD10 displays.

The detector must always be installed per local installation codes.

Before installing the gas detector, define the following application details:

IDENTIFICATION OF VAPOR(S) TO BE DETECTED

It is necessary to identify the vapor(s) of interest at the job site. The fire hazard properties of the vapor, such as vapor density, flashpoint, and vapor pressure should be identified and used to assist in selecting the optimum detector mounting location within the area.

For cross sensitivity information, refer to each gas detector's corresponding instruction manual. Refer to Table 5 in the Specifications section for a list of gas detectors and their corresponding instruction manuals.

IDENTIFICATION OF DETECTOR MOUNTING LOCATIONS

Identification of the most likely leak sources and leak accumulation areas is typically the first step in identifying the best detector mounting locations. In addition, identification of air current/wind patterns within the protected area is useful in predicting gas leak dispersion behavior. This information should be used to identify optimum detector installation points.

If the vapor of interest is lighter than air, place the detector above the potential gas leak. Place the detector close to the floor for gases that are heavier than air. Note that air currents may cause a gas that is slightly heavier than air to rise under some conditions. Heated gases may also exhibit the same phenomenon.

The most effective number and placement of detectors varies depending on the conditions on site. The individual designing the installation must often rely on experience and common sense to determine the detector quantity and best locations to adequately protect the area. Note that it is typically advantageous to locate detectors where they are accessible for maintenance. Locations near excessive heat or vibration sources should be avoided.

Final suitability of possible gas detector locations should be verified by a job site survey.

The gas detector must be mounted with the sensor in the correct orientation as shown in Table 2.

If the UD10 faceplate is not correctly oriented, it can be rotated at 90 degree increments by pulling the electronic module from the four mounting posts that secure it to the junction box and repositioning it as desired. Note that the module is held in place by a compression fitting – no screws are involved.

Table 2—Device Orientation

Device	Orientation
GT3000	Vertical with Sensor Pointing Down
PIR9400	Horizontal
PIRECL	Horizontal
OPECL	Horizontal (Fixed to a vertical post)
CGS	Vertical with Sensor Pointing Down
505/CGS	Vertical with Sensor Pointing Down
C706X	Vertical with Sensor Pointing Down
NTMOS	Vertical with Sensor Pointing Down

WIRING

POWER SUPPLY REQUIREMENTS

Calculate the total gas detection system power consumption rate in watts from cold start-up. Select a power supply with adequate capability for the calculated load. Ensure that the selected power supply provides regulated and filtered 24 Vdc output power for the entire system. If a back-up power system is required, a float-type battery charging system is recommended. If an existing source of 24 Vdc power is being utilized, verify that system requirements are met. The acceptable voltage range is 18-30 Vdc measured at the input to the UD10.

NOTE

The power supply must meet the noise requirements for HART systems. If noise or ripple on the main power source could interfere with the HART function, an isolated power source (Figure 11) is recommended. (For detailed information regarding power supply specifications, refer to the HART Communication Foundation's document "FSK Physical Layer Specification" HCF_SPEC-54.)

WIRING CABLE REQUIREMENTS

Always use proper cabling type and diameter for input power as well as output signal wiring. 14 to 18 AWG shielded stranded copper wire is recommended. Correct wire size depends on the device and wire length. Refer to the appropriate Appendix for additional information. The maximum cable length from power source to UD10 is 2000 feet. Maximum cable length from UD10 to sensor is 2000 feet.

NOTE

The use of shielded cable in conduit or shielded armored cable is highly recommended. In applications where the wiring is installed in conduit, dedicated conduit is recommended. Avoid low frequency, high voltage, and non-signaling conductors to prevent nuisance EMI problems.

CAUTION

The use of proper conduit installation techniques, breathers, glands, and seals is required to prevent water ingress and/or maintain the explosion-proof rating.

SHIELD CONNECTIONS

The UD10 provides terminals for proper grounding of wiring cable shields (located on the sensor, 4-20 mA, and operating power terminal blocks). These shield terminals are not connected internally, but are connected to ground through capacitors. The capacitors ensure an RF ground, while preventing 50/60 Hz ground loops.

Ground all shields as shown in the wiring examples throughout this manual.

IMPORTANT

For proper grounding, all junction boxes / metal enclosures must be connected to earth ground.

The following are required for installations requiring CE Mark compliance:

- For shielded cable installed in conduit, attach the wire shields to the "shield" connections on the terminal blocks, or to earth ground on the case.
- For installations without conduit, use double shielded cable. Terminate the outer shield to earth ground on the case. Terminate the inner shield to the "shield" connection on the terminal blocks.

JUMPER SETTING FOR 4-20 MA LOOP

In order for the 4-20 mA current loop to operate properly, +24 Vdc must be applied to terminal P1-3. This can be accomplished in one of two ways:

- For a **non-isolated** 4-20 mA loop, set jumper plug as shown in Figure 4. This applies +24 Vdc to P1-3 via an internal connection to terminals P2-2 and P2-5.
- If the 4-20 mA loop will receive power from a source other than the UD10's main power source (**isolated**), set the jumper plug as shown in Figure 5 to remove the internal connection.

FOUNDATION FIELDBUS (Optional)

Some UD10 models allow the use of either RS485/MODBUS or Foundation Fieldbus communication via connection to J2 on the terminal board. Four jumpers are provided to select between the two protocols. If the device is equipped for Foundation Fieldbus, it will be shipped from the factory with the jumpers preset for that mode. If the user wants to switch to RS485/MODBUS (for example, to retrieve logs), the four jumpers can easily be moved. Figures 6 and 7 show the jumper settings for each mode of communication.

Note that the pin identification for the J2 connector is different for each communication protocol. For Foundation Fieldbus it is "- +". For RS485/MODBUS it is "B A com".

WIRING PROCEDURE

NOTE

The following section shows the output of the UD10 wired to a generic 4-20 mA signal receiver in various configurations. Since the UD10 can be used with a variety of different detection devices, information that is specific to each detector model (wiring, calibration, HART menus, etc.) is covered in an Appendix that is dedicated to that device. Refer to the appropriate Appendix at the back of this manual for specific information when wiring the detection system. For information on devices not covered in an Appendix, refer to the manual provided by the device's manufacturer.

Figure 4 shows jumper plug P12 positioned to power the 4-20 mA loop from the main power source (non-isolated output).

Figure 5 shows jumper plug P12 positioned for powering the 4-20 mA loop from an external wire/jumper of from a separate power source (isolated output).

Figure 6 shows the correct jumper positions and J2 terminal identification for using Foundation Fieldbus communication.

Figure 7 shows the correct jumper positions and J2 terminal identification for using MODBUS communication.

Refer to Figure 8 for an illustration of the UD10 wiring terminal board (see Figure 6 for Foundation Fieldbus connections).

Figure 9 shows a UD10 Wired to a PLC using 3-Wire Shielded Cable with a 4-20 mA Non-Isolated Sourcing Output.

Figure 10 shows a UD10 Wired to a PLC using 4-Wire Shielded Cable with a 4-20 mA Non-Isolated Sourcing Output.

Figure 11 shows a UD10 Wired to a PLC with a 4-20 mA Isolated Sourcing Output.

GREASE/LUBRICATION

To ease installation and future removal, ensure that all junction box covers and sensor threads are properly lubricated. If the need arises for additional lubrication, use either Lubriplate grease (see Ordering Information for part number) or Teflon tape. Avoid the use of silicone grease.

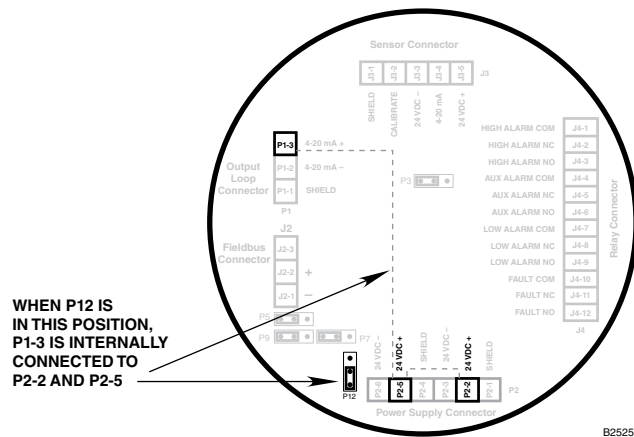


Figure 4—Position of Jumper P12 for Non-Isolated 4-20 mA Loop Output

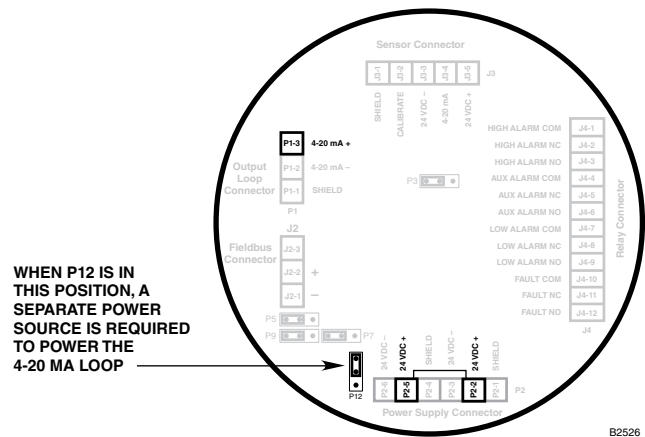
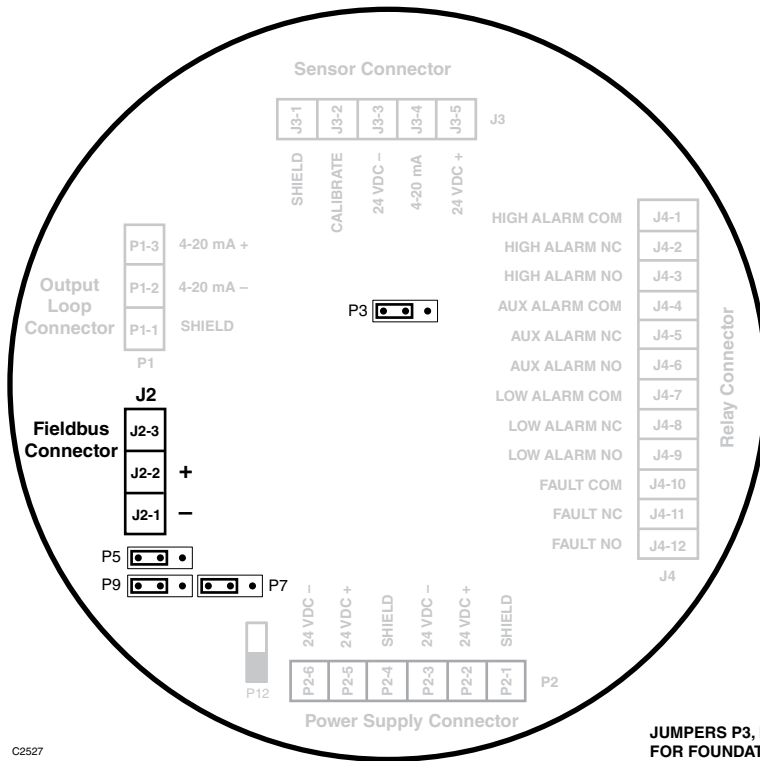


Figure 5—Position of Jumper P12 for Isolated 4-20 mA Loop Output

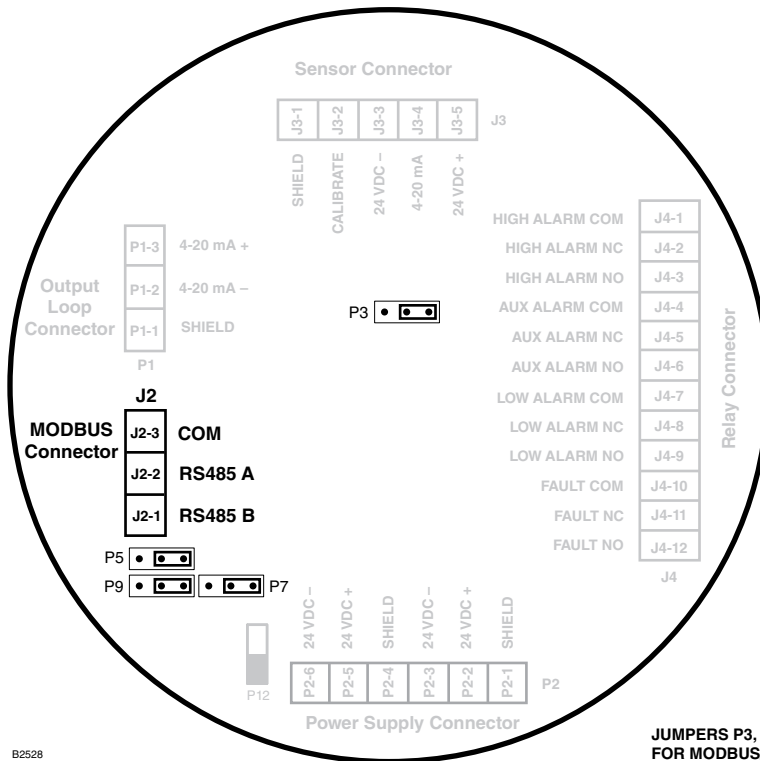


NOTE: FOUNDATION FIELDBUS IS AVAILABLE ON SELECT MODELS. REFER TO THE MODEL MATRIX IN THE ORDERING INFORMATION SECTION FOR DETAILS.

JUMPERS P3, P5, P7, AND P9 MUST BE POSITIONED AS SHOWN FOR FOUNDATION FIELDBUS COMMUNICATION

C2527

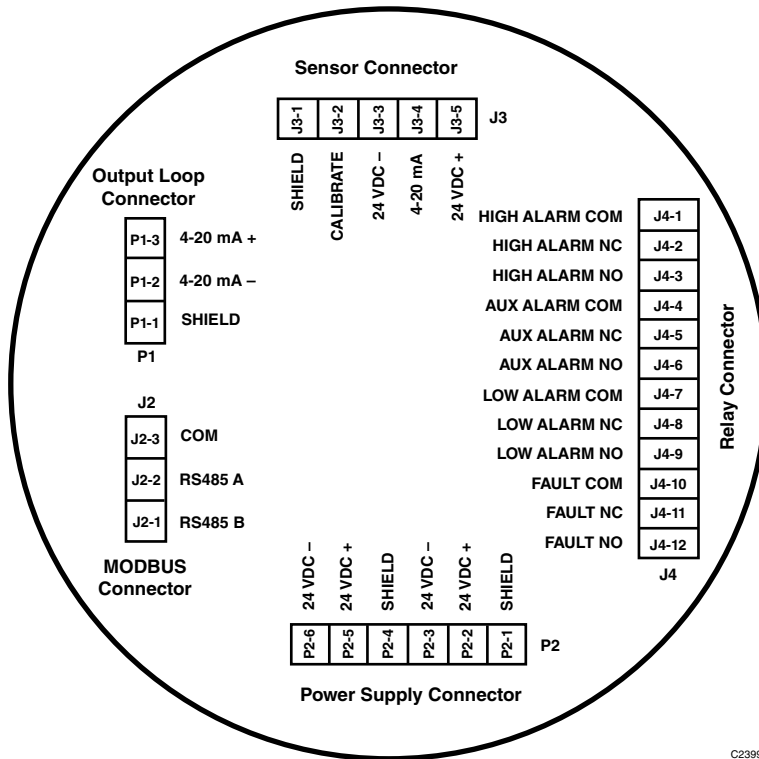
Figure 6—Foundation Fieldbus Communication



JUMPERS P3, P5, P7, AND P9 MUST BE POSITIONED AS SHOWN FOR MODBUS/RS485 COMMUNICATION

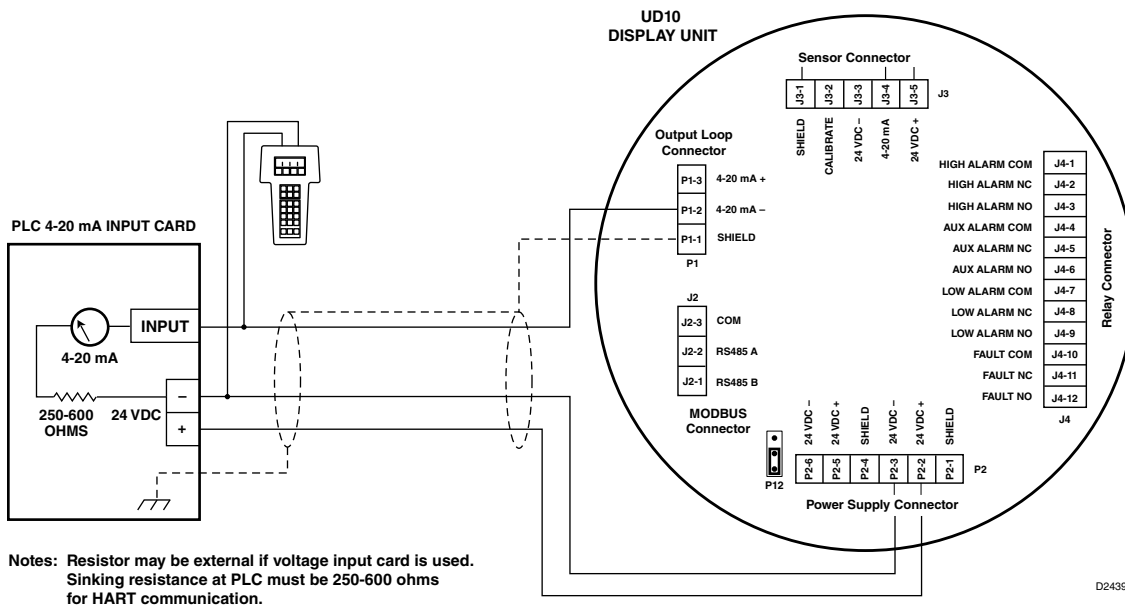
B2528

Figure 7—MODBUS Communication



C2399

Figure 8—Wiring Terminals on UD10 Terminal Board



D2439

Figure 9—UD10 Wired to PLC using 3-Wire Shielded Cable with 4-20 mA Non-Isolated Sourcing Output

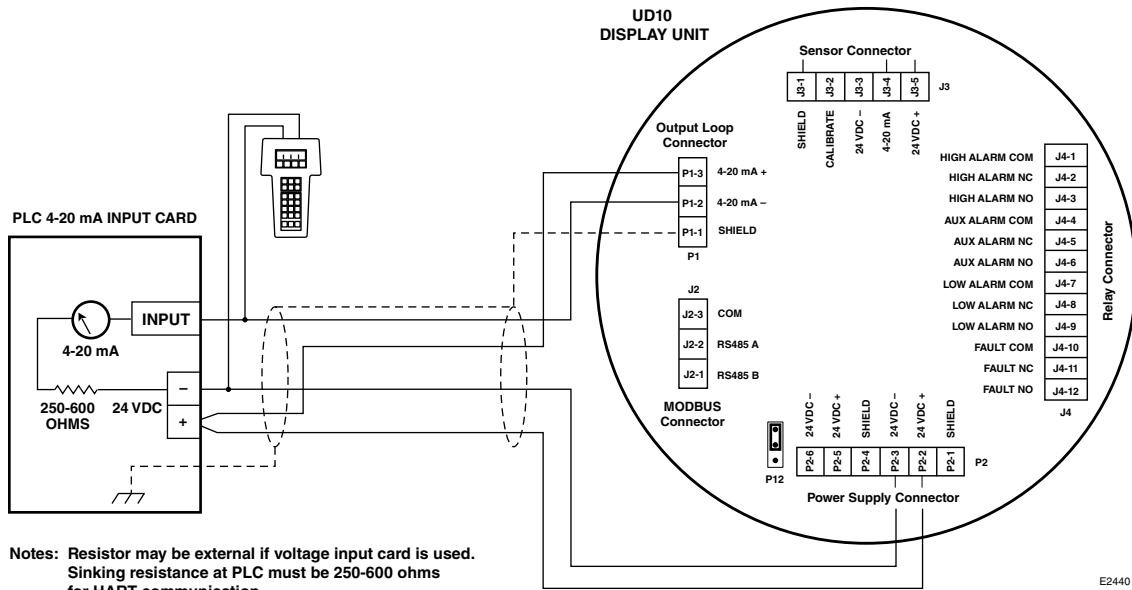


Figure 10—UD10 Wired to PLC using 4-Wire Shielded Cable with 4-20 mA Non-Isolated Sourcing Output

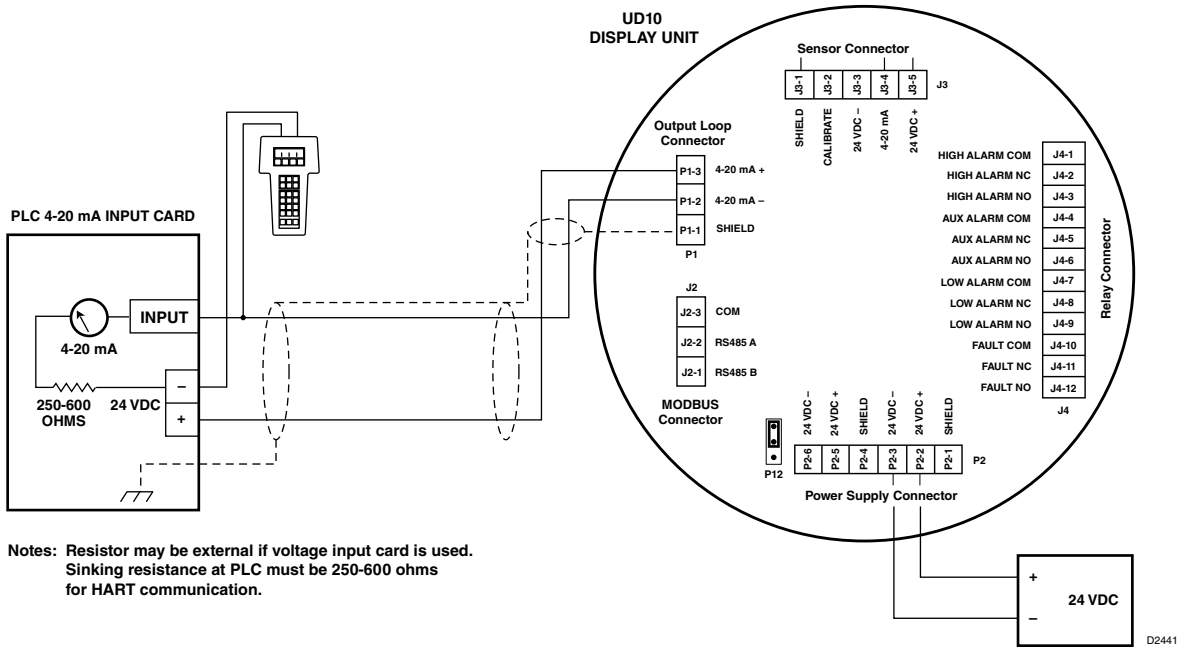


Figure 11—UD10 Wired to PLC with 4-20 mA Isolated Sourcing Output

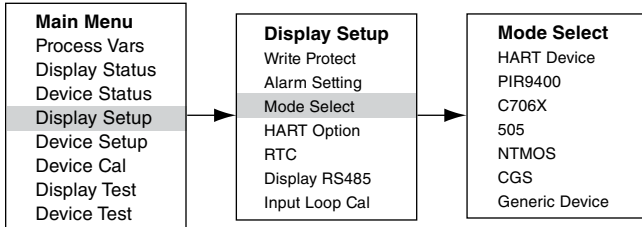
IMPORTANT

Isolated operation is highly recommended to prevent noise or ripple on the main power source from interfering with the HART function.

STARTUP

After power has been applied and the warm-up period is complete, select the UD10 operating mode. To do this:

1. Access the Main Menu by touching the magnet to the ENTER/SELECT button. From there, navigate to the "Mode Select" menu.



2. From the "Mode Select" menu, select and enter the appropriate operating mode based on the type of detector being used.

NOTE

If using a PIR9400, note that changing the gas type on the UD10 does not change the gas type at the PIR9400. This change is made using a switch located in the PIR9400. Refer to the PIR9400 instruction manual (95-8440) for details.

NOTE

If using a C706X detector, navigate to the "Device Setup" menu and select the appropriate gas type and unit of measurement.

3. To exit, activate CANCEL/ESCAPE three times to return to the main display screen.
4. If the detector is replaced with another detector type, the UD10 will not recognize it until the mode is changed.
5. If the UD10 Display is in PIR9400 mode and if:
 - a. The connection between PIR9400 and the UD10 is removed, the UD10 will show a FAULT on the Gas Screen. When the connection between PIR9400 and UD10 is restored, the UD10 will remove the FAULT indication when current increases beyond 3.6 mA.
 - b. Someone removes the PIR9400 & connects a HART enabled Gas Detector, it will not be recognized by the UD10 Display until the mode is changed to HART.

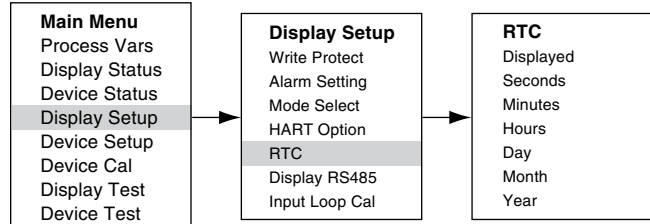
RTC

NOTE

The UD10 is set at the factory for US Central Standard time.

To display and set the Real Time Clock and Date for the UD10:

1. Using the magnet to activate the switches on the UD10 display, navigate to the RTC menu.



2. The first item on the RTC screen is "Displayed". Y (Yes) or N (NO) is shown to indicate whether the time and date will be displayed on the main screen. To change the setting, use the ENTER/SELECT button to go to the next screen, then use the PREVIOUS or NEXT buttons to toggle between Y and N. Once the chosen input is selected, use the ENTER/SELECT button to enter the selection. Use the CANCEL/ESCAPE button to exit without changing.

3. Use the same method to set time and date.

Specifically for the GT3000 Transmitter, the RTC for the transmitter can be synchronized to the RTC of the display by going through the Main Menu->Device Setup->RTC-> 1st slot "Sync W/Disp".

Latching Alarms

The high, auxiliary and low alarm relay settings are programmable and can be set for latching or non-latching operation. Alarm configuration can be done using the local display menu or external HART interface. Latched alarms on the display can be cleared through the Display Setup > Alarm Setting submenu using the magnet or external HART interface.

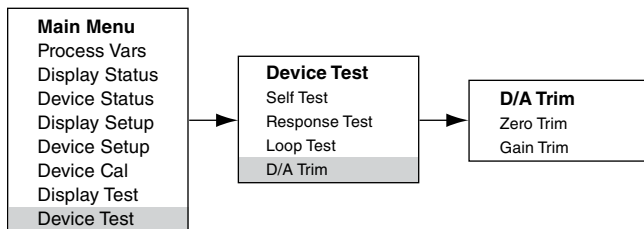
4-20 mA LOOP CALIBRATION

Both the input and output current loops of the UD10 are trimmed at the factory. They can also be trimmed in the field for maximum accuracy using the following procedures. If the detector connected to the UD10 is HART enabled, its 4-20 mA output signal can also be trimmed.

When the UD10 is used with a detector that supports HART communication, the output of the detector should be calibrated first.

HART Detector Signal Calibration

Navigate down the menu to Device Test > D/A (Digital to Analog) Trim.

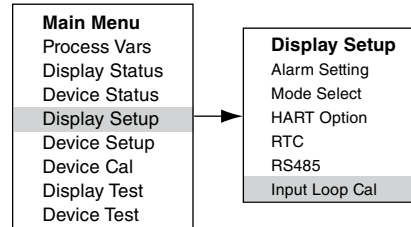


Select Zero Trim. When this screen is entered, a warning message is presented. Select ENTER to continue. When the message “Connect Reference Meter” is presented, install the current meter on the mA line between the detector and UD10. Select ENTER to continue. When the message “Set Input Current to 4mA?” is presented, select ENTER to begin the Zero Trim function. The detector will now set its 4 mA output value. If the value indicated on the current meter is not 4.00 mA, enter the measured value into the UD10 using the Previous and Next switches. The UD10 calculates and corrects for the difference between the actual and entered values. When the current meter value is at the desired 4.00 mA, select ENTER to accept the new zero trim value.

Select Gain Trim. Follow the same procedure for gain/span calibration.

UD10 Input Trim

When the UD10 is used with a detector that supports HART communication, an automated process can be used to trim the UD10 input. Navigate down the menu to “Input Loop Cal”.

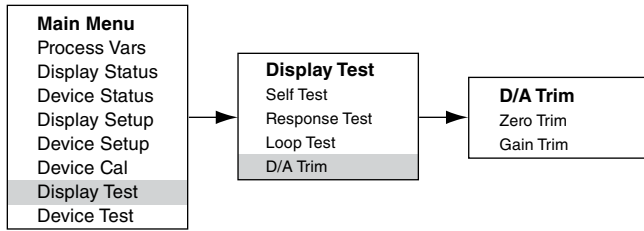


Upon entering Input Loop Cal, the UD10 commands the detector to output 4 mA, and then automatically calibrates its own input. The UD10 then commands the detector to output 20 mA and subsequently calibrates its own input.

If a non-HART detector is being used, the Input Loop Cal may be performed with a mA current source or loop calibrator connected to the UD10 Sensor Connector. Follow the loop calibration instructions shown by the UD10 for this procedure.

UD10 Output Trim

To calibrate the UD10 output loop, navigate down the menu to Display Test > D/A Trim.



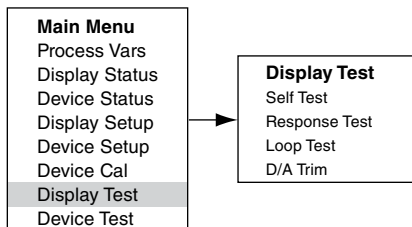
Select Zero Trim. When this screen is entered, a warning message is presented. Select ENTER to continue. When the message “Connect Reference Meter” is presented, install the current meter on the UD10 mA output. Select ENTER to continue. When the message “Set Output Current to 4mA?” is presented, select ENTER to begin the Zero Trim function. The UD10 will now set its 4 mA output value. If the measured value on the current meter is not 4.00 mA, enter the measured value into the UD10 using the Previous and Next switches. The UD10 calculates and corrects for the difference between the actual and entered values. When the current meter value is at the desired 4.00 mA, select ENTER to accept the new zero trim value.

Select Gain Trim. Follow the same procedure for gain/span calibration.

OPTIONAL SYSTEM TESTS

The following tests are available for verifying proper operation of various functions of the gas detection system:

- The Self Test, Response Test, and Loop Test are accessed from the “Display Test” screen. (A “Device Test” screen is available for performing the same tests on HART enabled detectors.)
- The Proof Test is performed by applying test gas to the sensor. It is **not** accessed from the “Display Test” screen and does **not** inhibit the outputs.



Self-Test

This test commands the UD10 to perform a fully automatic internal test. At the completion of the test, the UD10 will indicate a pass or fail.

Response Test

This test inhibits the UD10’s outputs, thereby providing a means of testing the system by applying gas to the detector without activating any alarms or affecting the output.

NOTE

If the Response Test is not terminated by the operator, the test will automatically time out after ten minutes and the UD10 will return to normal operation.

Loop Test

This test temporarily forces the UD10’s 4-20 mA output to a specific level. This is an easy way to test the output signal of the UD10 for accuracy, to verify the capabilities of the system, and to verify the input signal of a receiver. To perform this test, connect a current meter to the output loop. Navigate to Display Test and select Loop Test, then follow the prompts on the UD10 Screen.

NOTE

If the Loop Test is not terminated by the operator, the test will automatically time out after one minute and the UD10 will return to normal operation.

Proof Test

A Proof Test (bump test) can be performed at any time to verify proper operation and calibration of the system. Since this test does not inhibit the UD10’s outputs, secure any output devices prior to performing the test to prevent unwanted actuation.

HISTORY

There are two separate histories, one for the display and one for the detector (if available). Both will state the number of hours that the unit has been operating, and the highest and lowest recorded temperature (with time and date stamp).

PASSWORD PROTECTION

The UD10 allows the use of a password for restricting changes to configuration parameters and limiting access to safety critical commands. The UD10 is shipped from the factory with the password protection (Write Protect) feature disabled.

The following are locked when Write Protect security is enabled:

Alarm Setting screen – All options except “RST Latch Alarms”

Mode Select screen – All options

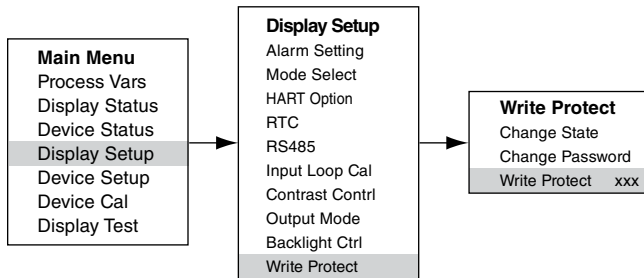
HART Option – All options

RTC – All options except Displayed Y/N

Output Mode

Display Test screen – All options

To enable the Write Protect feature, navigate to the Write Protect screen.



Select “Change State” to toggle between Enabled and Disabled.

Select “Change Password” to enter a new password.

“Write Protect” indicates whether password protection is Enabled or Disabled.

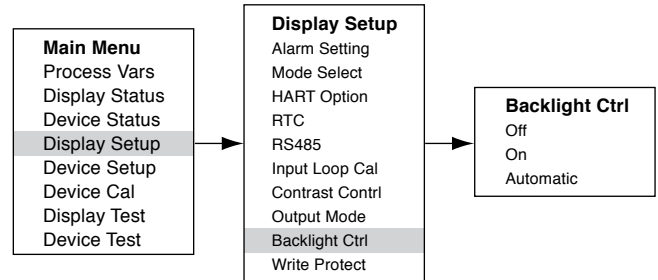
The default password is 1*****.

IMPORTANT

Take care not to lose the password. Future changes cannot be made without a password.

DISPLAY BACKLIGHT OPERATION

The UD10 can be programmed to turn on the backlight feature of the digital display when an alarm or fault occurs or a magnetic switch is activated. Navigate to the Backlight Ctrl screen.



Off = The backlight is always off.

On = The backlight is always on.

Automatic = Normal operation – Backlight is off
 Alarm – Backlight flashes on and off
 Fault – Backlight is on steady
 Magnetic Switch – Backlight is on steady

The backlight automatically turns off 10 minutes after the last Magnetic Switch activation.

If the backlight is on following a magnetic switch activation and then an alarm condition occurs, the backlight will remain on steady and not flash until the 10 minute time-out is complete. Then it will begin flashing.

TROUBLESHOOTING

If a Fault condition is indicated on the UD10 faceplate, the nature of the fault can be determined by using the magnetic tool to navigate to the appropriate Fault screen.

NOTE

Refer to the Menu in the appropriate Appendix of this manual for the path to the proper Fault screen.

Shortcut: From the main display screen, touch the magnet to the “Previous” switch to go directly to the Fault screen.

Example:

For a Display (UD10) related fault:

Main Menu > Display Status > Fault/Status > Fault

For a Device (Sensor) related fault:

Main Menu > Device Status > Fault/Status > Sensor Fault

When the active fault has been identified, refer to the Troubleshooting Tables for a description of the fault and suggested corrective action.

Refer to Table 3 for Display Faults and Table 4 for Device Faults.

Table 3—Troubleshooting Guide - Display Faults

Display Faults	Description	Recommended Action
Input Loop FLT	Fault in sensor or sensor loop	Check sensor wiring. Calibrate sensor. Ensure that sensor type matches configuration.
Output Loop FLT	Fault in 4-20 mA output loop	Check 4-20 mA loop wiring for shorts or opens.
EE Fault	Fault in non-volatile memory	Return to factory.
ADC Ref Fault	ADC reference voltage too high or low	Return to factory.
24V Fault	Problem in 24 volt power supply or power wiring	Check power wiring and output voltage of power supply.
Flash Fault	FLASH memory Fault	Return to factory.
RAM Fault	Fault in volatile memory	Return to factory.
WDT Fault	Watchdog timer is non-functional	Return to factory.
12V Fault	12 volt internal power supply out of tolerance	Check power source. Return to factory.
5V Fault	5 volt internal power supply out of tolerance	Check power source. Return to factory.
3V Fault	3 volt internal power supply out of tolerance	Check power source. Return to factory.

Note: A fault condition will cause an oxygen detector to generate an alarm output as the decreasing 4-20 mA signal passes through the alarm range.

Table 4—Troubleshooting Guide - Device Faults

Device Faults	Description	Recommended Action
Loop Fault	Current loop below fault threshold	Check 4-20 mA loop wiring for shorts or opens.
Supply Voltage Fault	24 volt power supply voltage too low	Verify proper wiring to the device and correct voltage output from the power supply.
Calibration Fault	Bad calibration	This fault can be caused if the calibration is allowed to time out. If so, recalibrate. Ensure that there is enough gas in the calibration bottle to complete the calibration. Ensure that the gas being used for calibration is the correct type and concentration. It must match the configured setting.
Memory Fault	Self-detected memory fault	Return to factory.
ADC Fault	Self-detected ADC fault	Return to factory.
Internal Voltage Fault	Self-detected voltage fault	Check supply voltage. Return to factory.
Zero Drift	Sensor signal has drifted negative	Device may have been calibrated with background gas present. Recalibrate the detector. Purge with clean air if needed.
Temperature Sensor Fault	Temperature sensor is out of range	Return to factory.
Wrong Sensor Type	Wrong sensor type is installed	Sensor type must match configuration. Change sensor or configuration.
Lamp Fault	Open or shorted lamp	Replace lamp. Return to factory.
Alignment Fault	Open path alignment problem	Align the device as specified in the instruction manual.
Blocked Optic Fault	Optical path is blocked	Locate and remove obstruction from the optical path.
Cal Line Active	Cal line is active at start-up	Ensure that the Cal line wiring is not shorted and the switch is open.
Low Cal Line	Cal line is shorted.	Check wiring.
Sensor Fault	Self-detected fault with the sensor	Check sensor wiring. Calibrate sensor. Ensure that sensor type matches configuration.
Noise Fault*	Excessive noise on signal	Check OPECL alignment.
Align ADC Fault*	Alignment ADC saturated	Check OPECL alignment.
Align Fault*	Alignment fault	Check OPECL alignment.
Align Warning*	Alignment warning	Check OPECL alignment.
DAC Fault	DAC fault detected	Return to factory.
General Fault	Unspecified fault	Verify correct power wiring and supply voltage. Consult the factory.
High Fault	Detector output is higher than specified limit	Verify correct sensor type and calibration.
Low Fault	Detector output is lower than specified limit	Verify correct sensor type and calibration.
Dirty Optics	Detector optics are dirty	Perform the cleaning procedure as described in the detector manual, then perform calibration.
Start Cal Fault	Calibration fault	Verify correct sensor type and calibrate.

*OPECL only.

Table 4—Troubleshooting Guide - Device Faults, Continued

Device Faults	Description	Recommended Action
EE Fault	Fault in non-volatile memory	Power may have been interrupted while the device was updating its internal data logs. Recycle power.
Ref ADC Sat	Sensor signal level is outside the range of the AD converter	Return to factory.
Active ADC Sat	Sensor signal level is outside the range of the AD converter	Return to factory.
24V Fault	Problem in 24 volt power supply or power wiring	Check power wiring and output voltage of power supply.
Flash CRC Fault	Memory fault	Return to factory.
RAM Fault	Fault in volatile memory	Return to factory.
Low Voltage	Power supply voltage outside of limits	Check power supply voltage. Return to factory.
Temp Fault	Temperature sensor fault	Return to factory.
Software Fault	Internal software fault	Return to factory.
EE Safety Fault	Internal configuration fault	Return to factory.
Gas Under Range	Sensor signal has drifted negative	Device may have been calibrated with background gas present. Recalibrate the detector. Purge with clean air if needed.
Sensor Mismatch	Wrong sensor type is installed	Sensor type must match configuration. Change sensor or configuration.
ADC CNTR Fault	Internal hardware fault	Return to factory.
3V Fault	3 volt internal power supply out of tolerance	Return to factory.
Comm Fault	Communication fault	Check detector wiring and power supply.
GEN Fault	Unspecified fault	Verify correct power wiring and supply voltage. Consult the factory.
12V Fault	12 volt internal power supply out of tolerance	Return to factory.
5V Fault	5 volt internal power supply out of tolerance	Return to factory.

SPECIFICATIONS

OPERATING VOLTAGE—

24 Vdc nominal, operating range is 18 to 30 Vdc.
Ripple cannot exceed 0.5 volt P-P.

OPERATING POWER—

Standard model, with heater and backlight off:

No alarm: 1.5 watts @ 24 Vdc.
Alarm: 3 watts @ 24 Vdc (20 mA current loop output, and all 3 alarm relays energized.)

Backlight on: 0.5 watt additional.
Heater on: 3.5 watts additional.
CGS model: Add 4 watts with CGS interface board and CGS sensor installed.

Maximum power in alarm, with heater and backlight on:
7 watts @ 30 Vdc (Standard model)
11 watts @ 30 Vdc (CGS model)

NOTE

Heater turns on when the internal temperature drops below -10°C (default operation). Heater function can be disabled to save power.

NOTE

Appropriate relays will be activated when a fault or alarm occurs.

CURRENT OUTPUT—

Linear isolated 4-20 mA output with HART.
3.8 mA indicates calibrate mode.
3.6 mA or less indicates a fault condition.
Maximum loop resistance is 600 ohms at 18 to 30 Vdc.

CURRENT OUTPUT RESPONSE TIME—

Toxic gas mode: T90 \leq 5 seconds.
Combustible gas mode: T90 \leq 4 seconds.
Combustible gas - open path mode: T90 \leq 4 seconds.
UD10 with CGS: T90 <12 seconds.

CURRENT OUTPUT ACCURACY—

Toxic gas mode: <1% error.
Combustible gas mode: <1% error.
Combustible gas - open path mode: \leq 0.01 LFL-m.
UD10 with CGS: \pm 3% LFL 0-50 range,
 \pm 5% LFL 51-100 range.

RELAY CONTACTS—

Three Alarm Relays: Form C, 5 amperes at 30 Vdc.
Selectable energized/de-energized.
Selectable latching or non-latching.
Refer to Table 1 for range and default settings.

WARNING

When in non-latching mode, the control device must latch the alarm output.

One Fault Relay: Form C, 5 amperes at 30 Vdc.
Normally energized for no fault condition with power applied.

RELAY RESPONSE TIME—

\leq 2 seconds.

WIRING TERMINALS—

14 to 18 AWG wire can be used.

OPERATING TEMPERATURE—

-55°C to $+75^{\circ}\text{C}$.

STORAGE TEMPERATURE—

-55°C to $+75^{\circ}\text{C}$.

HUMIDITY RANGE—

5 to 95% RH (Det-Tronics verified).

ELECTRO-MAGNETIC COMPATIBILITY—

EMC Directive 2004/108/EC
EN55011 (Emissions)
EN50270 (Immunity)

DIMENSIONS—

See Figures 12 and 13.

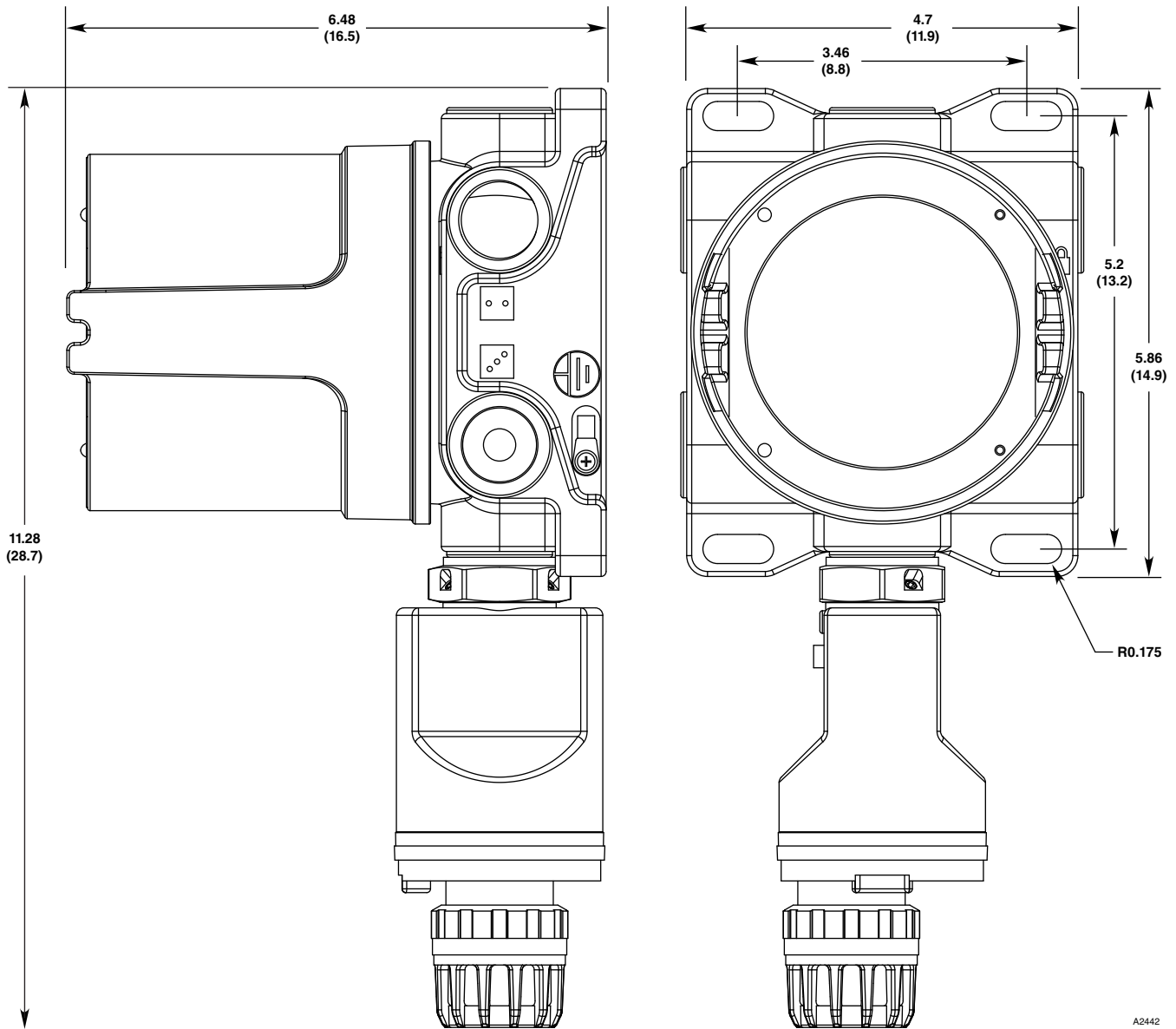


Figure 12—Dimensions of UD10 with GT3000 in Inches (Centimeters)

CONDUIT ENTRIES—

3/4" NPT or M25.

ENCLOSURE MATERIAL—

Epoxy coated aluminum or 316 stainless steel.

SHIPPING WEIGHT—

Aluminum: 4.15 pounds (1.88 kilograms).
 Stainless steel: 10.5 pounds (4.76 kilograms).

WARRANTY—

12 months from date of installation or 18 months from date of shipment, whichever occurs first.

DETECTOR COMPATIBILITY—

The UD10 can be used with the Det-Tronics gas detectors listed in Table 5.

UNIT OF MEASUREMENT—

PPM, % LFL, % V/V, LFL-m, or mg/m³.

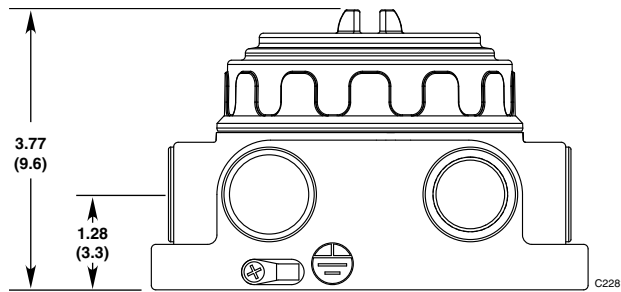
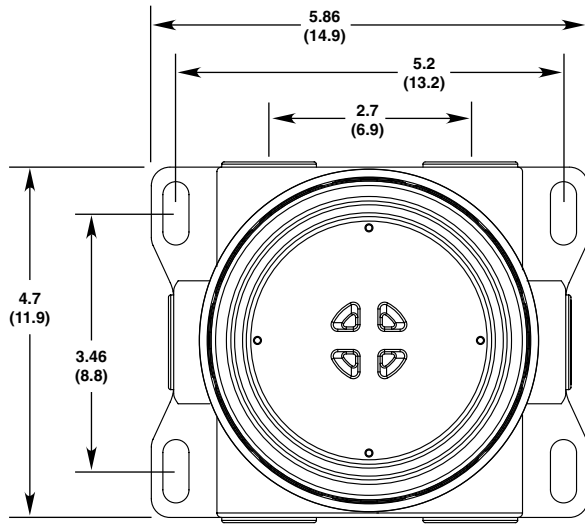


Figure 13—Dimensions of Model STB Termination Box in Inches (Centimeters)

CERTIFICATION—

For complete approval details, refer to the appropriate Appendix:



- Appendix A – FM
- Appendix B – CSA
- Appendix C – ATEX
- Appendix D – IECEx
- Appendix E – INMETRO

SIL Approval - IEC 61508
Certified SIL 2 Capable.

For specific information regarding SIL safety certification, refer to the Model UD10 Safety Reference Manual (form 95-8668).

Table 5—Gas Detectors Compatible with the UD10

Device	Toxic ¹	Catalytic Combustible	IR ² Combustible	Instruction Manual
GT3000	X			95-8616
PIR9400			X	95-8440
PIRECL			X	95-8526
OPECL			X	95-8556
CGS		X		90-1041
505/CGS		X		95-8472
C706X ³	X			95-8396 95-8411 95-8414 95-8439
NTMOS ⁴	X			95-8604

1 Hydrogen sulfide, Ammonia, Chlorine, Hydrogen, Oxygen, Carbon Monoxide, and Sulfur Dioxide.

2 Methane, Ethane, Ethylene, Propane, and Propylene.

3 C7065E Oxygen detector is not supported.

4 Hydrogen sulfide only.

DEVICE REPAIR AND RETURN

Prior to returning devices, contact the nearest local Detector Electronics office so that a Return Material Identification (RMI) number can be assigned. **A written statement describing the malfunction must accompany the returned device or component to assist and expedite finding the root cause of the failure.**

Pack the unit properly. Always use sufficient packing material. Where applicable, use an antistatic bag as protection from electrostatic discharge. The RMI number should be clearly marked on the outside of the box.

NOTE

Inadequate packaging that ultimately causes damage to the returned device during shipment will result in a service charge to repair the damage incurred during shipment.

Return all equipment transportation prepaid to the factory in Minneapolis.

NOTE

It is highly recommended that a spare be kept on hand for field replacement to ensure continuous protection.

ORDERING INFORMATION

Sensor module, transmitter module and termination boxes (if used) must be ordered separately.

Refer to the UD10 Model Matrix for ordering details.

ACCESSORIES

Part Number	Description
009700-001	Magnetic Tool
103922-001	475 Field Communicator
010268-001	Gas Inspector CD
010204-001	W6300G1003 Gas Inspector Connector
005003-001	Lubriplate grease, 1 oz.
101197-001*	Stop Plug, 3/4" NPT, AL
101197-004*	Stop Plug, 3/4" NPT, SS
101197-005	Stop Plug, M25, AL, IP66
101197-003	Stop Plug, M25, SS, IP66
010816-001	Stop Plug, 20PK, 3/4" NPT, AL
010817-001	Stop Plug, 20PK, 3/4" NPT, SS
010818-001	Stop Plug, 20PK, M25, AL, IP66, EXDE
010819-001	Stop Plug, 20PK, M25, SS, IP66, EXDE
104190-001	Stop Plug, M25, AL, INMETRO
104190-002	Stop Plug, 3/4" NPT, AL, INMETRO
104190-003	Stop Plug, M25, SS, INMETRO
104190-004	Stop Plug, 3/4" NPT, SS, INMETRO
102804-001	Reducer, M25 to M20, AL
102804-003	Reducer, M25 to M20, SS

*NEMA/Type 4X, IP66 rating requires addition of Teflon tape.

REPLACEMENT PARTS

Part Number	Description
010569-001	Electronics Module - Relay/4-20 mA
010550-001	Electronics Module - Foundation Fieldbus

ASSISTANCE

For assistance in ordering a system to meet the needs of a specific application, please contact:

Detector Electronics Corporation
6901 West 110th Street
Minneapolis, Minnesota 55438 USA
Operator: (952) 941-5665 or (800) 765-FIRE
Customer Service: (952) 946-6491
Fax: (952) 829-8750
Web site: www.det-tronics.com
E-mail: det-tronics@det-tronics.com

UD10 MODEL MATRIX

MODEL	DESCRIPTION	
UD10	Universal Display Unit	
	TYPE	MATERIAL
	A	Aluminum
	S	Stainless Steel (316)
	TYPE	THREAD TYPE
	5M	5 Port, Metric M25
	5N	5 Port, 3/4" NPT
	TYPE	OUTPUTS
	25	Relay, 4-20 mA, RS485, HART
	27	Relay, 4-20 mA, FOUNDATION™ Fieldbus, HART
	28	EQP / DCU Emulator
	TYPE	APPROVALS*
	B	INMETRO (Brazil)
	R	VNIIFTRI (Russia)
	S	SIL
T	SIL/FM/CSA/ATEX/CE/IECEX	
W	FM/CSA/ATEX/CE/IECEX	
TYPE	CLASSIFICATION (Div/Zone)	
2	Ex d (Flameproof)	
TYPE	OPTIONAL CONDITIONING BOARD	
(Blank)	None	
C	CGS	
N	NTMOS**	

* Type Approvals can use one or more letters to designate the approvals of the product.

** Not required for DCU Emulator model.

APPENDIX A

FM APPROVAL DESCRIPTION

Class I, Div. 1, Groups B, C & D (T5);
Class I, Div. 2, Groups B, C & D (T4);
Class I, Zone 1/2 AEx d IIC (T5);
Class II/III, Div. 1/2, Groups E, F & G.
Tamb -55°C to +75°C
NEMA/Type 4X, IP66
Conduit seal not required.

Performance verified in accordance with:
ANSI/ISA-92.00.01
ANSI/ISA-12.13.01 (CGS excluded)
FM 6310/6320
ANSI/ISA-12.13.04/FM 6325

This approval does not include or imply approval of gas detector heads or other apparatus to which the subject instrument may be connected. In order to maintain a Factory Mutual Research approved system, the measurement input signal to which this instrument is connected must also be approved by Factory Mutual Research.

NOTE

Consideration must be given to overall Gas System Performance Requirements.

WARNING

When a sensor/detector is connected directly to the UD10 housing, the lower ratings of the two devices will prevail.

APPENDIX B

CSA CERTIFICATION DESCRIPTION

CSA 08 2029512.
Class I, Div. 1, Groups B, C & D (T5);
Class I, Div. 2, Groups B, C & D (T4);
Class II/III, Div. 1/2, Groups E, F & G.
(Tamb = -55°C to +75°C)
Type 4X
Conduit seal not required.
Performance verified in accordance with:
CSA C22.2 #152.

NOTE

Consideration must be given to overall Gas System Performance Requirements.

WARNING

When a sensor/detector is connected directly to the UD10 housing, the lower ratings of the two devices will prevail.

APPENDIX C

ATEX APPROVAL DESCRIPTION

CE 0539 II 2 G
Ex d IIC T5 Gb
Tamb -55°C to +75°C
FM08ATEX0042X
IP66.

Performance verified in accordance with:
EN 60079-29-1 and EN 60079-29-4.

Special Conditions for Safe Use ('X'):

The UD10 control unit complies with EN 60079-29-1 and EN 60079-29-4 only when connected to a Detector Head that also has been evaluated to EN 60079-29-1 and EN 60079-29-4.

NOTE

Consideration must be given to overall Gas System Performance Requirements.

WARNING

When a sensor/detector is connected directly to the UD10 housing, the lower ratings of the two devices will prevail.

APPENDIX D

IECEX APPROVAL DESCRIPTION

Ex d IIC T5 Gb
Tamb -55°C to +75°C
IECEX FMG 08.0010X
IP66.

Performance verified in accordance with:
IEC 60079-29-1

Special Conditions for Safe Use ('X'):

The UD10 control unit complies with IEC 60079-29-1 when connected to a Detector Head with an IEC certificate of conformity to IEC 60079-29-1.

NOTE

Consideration must be given to overall Gas System Performance Requirements.

WARNING

When a sensor/detector is connected directly to the UD10 housing, the lower ratings of the two devices will prevail.

APPENDIX E

ADDITIONAL APPROVALS

INMETRO (Brazil)

CEPEL 09.1803

Ex d IIC T5 Gb IP66

T5 (Tamb -40°C to +75°C) With integral CGS

– OR –

Ex d IIC T6 Gb IP66

T6 (Tamb -55°C to +75°C) Without integral CGS

All cable entry devices shall be Brazil certified in the type of explosion protection, flameproof enclosure 'd', suitable for the conditions of use and correctly installed, with an ingress protection rating of IP66.

A screw or cover lock is provided for a secondary means of fastening the cover.

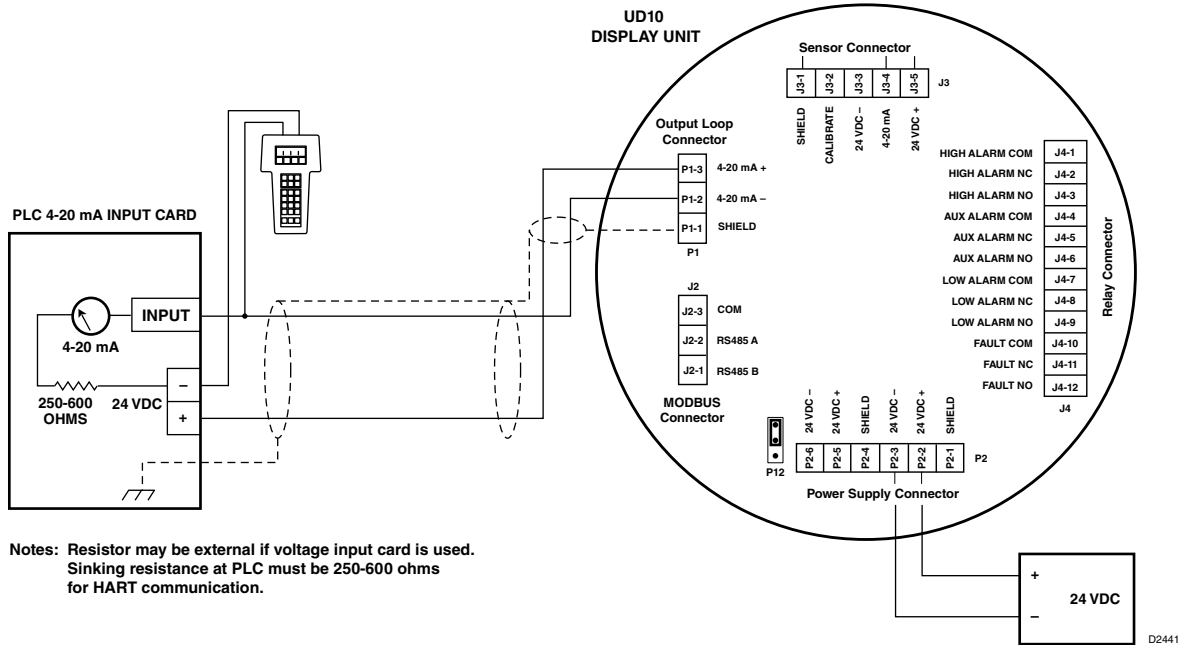
APPENDIX F

USING A HANDHELD HART DEVICE CONNECTED TO THE UD10'S 4-20 MA OUTPUT (UD10 WITH ANY DETECTOR)

NOTE

Refer to the front of this manual for complete information regarding installation, wiring and startup of the UD10.

WIRING



HART Handheld Communicator Connected to the UD10's 4-20 mA Output

IMPORTANT

To ensure proper operation of the HART communication system, a power supply with low noise and ripple must be used. If noise or ripple on the main power source could interfere with the HART function, an isolated power source is recommended. For additional information, refer to "Power Supply Requirements" in the Wiring section of this manual.

MENU STRUCTURE

Refer to the following menu tree when using a HART handheld communicator, connected to the UD10's 4-20 mA output.

MENU HELP

Status menus only allow the user to view the data.
The Setup menus allow the user to both view and edit the data.

Main Menu

- 1) Process Variables →
- 2) Display Status Menu →
- 3) Device Status Menu →
- 4) Display Setup →
- 5) Device Setup →
- 6) Device Cal →
- 7) Display Test Menu →

Process Variables

1) Gas Name	xxxxx
2) Gas Value	xxxx.x
3) High Alarm	T/F
4) Low Alarm	T/F
5) AUX Alarm	T/F
6) Analog Output	xxxxx
7) Upper Range Value	xxxxx
8) Lower Range Value	xxxxx
9) Fault	T/F
10) SV Value	xxxxx
11) TV Value	xxxxx
12) QV Value	xxxxx

Display Status Menu

- 1) Display General Info
- 2) Display Fault/Status Info
- 3) Display History
- 4) Display Info

Device Status Menu

- 1) Device Info
- 2) Device Fault/Status
- 3) Device Info 2
- 4) Sensor Info
- 5) Device History Info

Write Protect

- 1) Change Mode →
- 2) Write Protect Y/N

Alarm Setting

Rst Latch Alarms	
High Alarm Level	xx.xx
High Alarm Latch	Y/N
High Alarm NE/NDE	→
Low Alarm Level	xx.xx
Low Alarm Latch	Y/N
Low Alarm NE/NDE	→
Auxiliary Alarm Level	xx.xx
Aux Alarm Latch	Y/N
Aux Alarm NE/NDE	→

Display HART Option

- 1) Tag xxxxxx
- 2) Descriptor xxxxxx
- 3) Message xxxxxx
- 4) Date xxxxxx
- 5) Final assembly num xxxxxx

Display Setup

- 1) Write Protect
- 2) Alarm Setting
- 3) Display HART Option
- 4) Display RTC

Display RTC

- 1) Seconds xxxxxx
- 2) Minutes xxxxxx
- 3) Hours xxxxxx
- 4) Day xxxxxx
- 5) Month xxxxxx
- 6) Year xxxxxx

Device Setup

- 1) Device HART Option

Device HART Option

- 1) Tag xxxxxx
- 2) Descriptor xxxxxx
- 3) Message xxxxxx
- 4) Final assembly num xxxxxx

Device Cal

- 1) Sensor Calibration

Calibration

- 1) Execute
- 2) Abort

Display Test Menu

- 1) Self Test
- 2) Response Test
- 3) Reset
- 4) Loop Test
- 5) D/A Trim

Loop Test

- 1) 4 mA
- 2) 20 mA
- 3) Other
- 4) End

Device Info

- 1) Manufacturer xxxxxx
- 2) Tag xxxxxx
- 3) Descriptor xxxxxx
- 4) Message xxxxxx
- 5) Final Assembly Num xxxxxx
- 6) Dev ID xxxxxx
- 7) Write Protect xxxxxx
- 8) Model xxxxxx

Device Fault/Status

- 1) Operating Mode xxxxxx
- 2) Calibration State xxxxxx
- 3) Device Status 1 xxxxxx
- 4) Device Status 2 xxxxxx
- 5) Device Fault 1 xxxxxx
- 6) Device Fault 2 xxxxxx
- 7) Device Fault 3 xxxxxx
- 8) Device Fault 4 xxxxxx
- 9) Extended Fault/Status →

Device Info 2

- 1) Serial Number xxxxxx
- 2) Hardware Revision xxxxxx
- 3) Firmware Revision xxxxxx
- 4) Universal Rev xxxxxx
- 5) Fld Dev Rev xxxxxx
- 6) Software Rev xxxxxx

Sensor Info

- 1) Sensitivity xxxxxx
- 2) Gas Name xxxxxx
- 3) Revision xxxxxx
- 4) PV USL xxxxxx
- 5) PV LSL xxxxxx
- 6) Hours xxxxxx
- 7) Serial Number xxxxxx
- 8) Hardware Revision xxxxxx
- 9) Firmware Revision xxxxxx
- Cal Point Zero xxxxxx
- Cal Point Span xxxxxx

Device History Info

- 1) Calibration Log

Device Status 1

Calibration Active	ON/OFF
Warm Up	ON/OFF
Low Alarm	ON/OFF
Aux Alarm	ON/OFF
High Alarm	ON/OFF
Self Test	ON/OFF
Configuration Change	ON/OFF
Alignment Mode	ON/OFF

Device Status 2

Write Protect	ON/OFF
Response Test	ON/OFF
4-20 Fixed	ON/OFF
Sensor Removed	ON/OFF
Sensor End Of Life	ON/OFF
Loop Test Active	ON/OFF
TDSA Alarm	ON/OFF
Quick Alarm	ON/OFF

Device Fault 1

Loop Fault	ON/OFF
Supply Voltage Fault	ON/OFF
Calibration Fault	ON/OFF
Memory Fault	ON/OFF
ADC Fault	ON/OFF
Internal Voltage Fault	ON/OFF
Zero Drift	ON/OFF
Temperature Sensor Fault	ON/OFF

Device Fault 2

Wrong Sensor Type	ON/OFF
Lamp Fault	ON/OFF
Alignment Fault	ON/OFF
Blocked Optic Fault	ON/OFF
Cal Line Active	ON/OFF
Sensor Fault	ON/OFF
Noise Fault	ON/OFF
Align ADC Fault	ON/OFF

Device Fault 3

Align Fault	ON/OFF
Align Warning	ON/OFF
DAC Fault	ON/OFF
High Fault	ON/OFF
Low Fault	ON/OFF
Device Warm Up	ON/OFF
Ref Channel Fault	ON/OFF
Act Channel Fault	ON/OFF

Device Fault 4

Incompatible Version	ON/OFF
Detection Disable Fault	ON/OFF
Oi Fault	ON/OFF
Diminished Detect Fault	ON/OFF
Communication Fault	ON/OFF
Reserved	ON/OFF
Reserved	ON/OFF
General Fault	ON/OFF

Extended Fault/Status

Extended Byte 0	xxxxx
Extended Byte 1	xxxxx
Extended Byte 2	xxxxx
Extended Byte 3	xxxxx
Extended Byte 4	xxxxx
Extended Byte 5	xxxxx
Extended Byte 6	xxxxx
Extended Byte 7	xxxxx

Calibration Log

Calibration Log
CalCode: xx Timestamp: xxxxxxxx

First
Previous
Next
End

Display General Info

- 1) Manufacturer →
- 2) Tag xxxxxx
- 3) Descriptor xxxxxx
- 4) Message xxxxxx
- 5) Final Assembly Num xxxxxx
- 6) Dev ID xxxxxx
- 7) Write Protect xxxxxx
- 8) Model xxxxxx

DET-TRONICS

Display Fault/Status Info

- 1) Operating Mode xxxxxx
- 2) Display Status 1 xxxxxx
- 3) Display Status 2 xxxxxx
- 4) Display Fault 1 xxxxxx
- 5) Display Fault 2 xxxxxx

Display Status 1

Cal Line Active	ON/OFF
Cal SW Active	ON/OFF
HART Test	ON/OFF
LON Attached	ON/OFF
Response Test	ON/OFF
Manual Self Test	ON/OFF
Input HART	ON/OFF
Reserved	ON/OFF

Display Status 2

Any Fault	ON/OFF
CAL Active	ON/OFF
Warm up Mode	ON/OFF
Low Relay Active	ON/OFF
Hi Relay Active	ON/OFF
Aux Relay Active	ON/OFF
Current Fixed	ON/OFF
MB Write Protect	ON/OFF

Display Fault 1

12V Fault	ON/OFF
5V Fault	ON/OFF
3V Fault	ON/OFF
Reserved	ON/OFF
Output Loop FLT	ON/OFF
Input Loop FLT	ON/OFF
Reserved	ON/OFF
Reserved	ON/OFF

Display Fault 2

Reserved	ON/OFF
Reserved	ON/OFF
FRAM Fault	ON/OFF
ADC Ref Voltage Fault	ON/OFF
24V Fault	ON/OFF
Flash Fault	ON/OFF
RAM Fault	ON/OFF
WDT Fault	ON/OFF

Display History

- 1) History
- 2) Event Log

History

- 1) Running Hrs xxxx
- 2) Max Temp xx.xx C
- 3) Max Temp Time
- 4) Min Temp xx.xx C
- 5) Min Temp Time

DD/MM/YY HR:MM:SS
xx / xx / xx xx:xx:xx

Display Info

- 1) Display RTC
- 2) Serial Number xxxxxx
- 3) Hardware Rev xxxxxx
- 4) Firmware Revision xxxxxx
- 5) Universal Rev xxxxxx
- 6) Fld Dev Rev xxxxxx
- 7) Software Rev xxxxxx
- 8) DD Build Version

Event Log

- 1) Event Log

XXXX On dd/mm/yy-hh:mm:ss

First
Previous
Next
End

Display RTC

- 1) Seconds xxxxxx
- 2) Minutes xxxxxx
- 3) Hours xxxxxx
- 4) Day xxxxxx
- 5) Month xxxxxx
- 6) Year xxxxxx

Detector Electronics

HART Handheld	20-Feb-13	4.21
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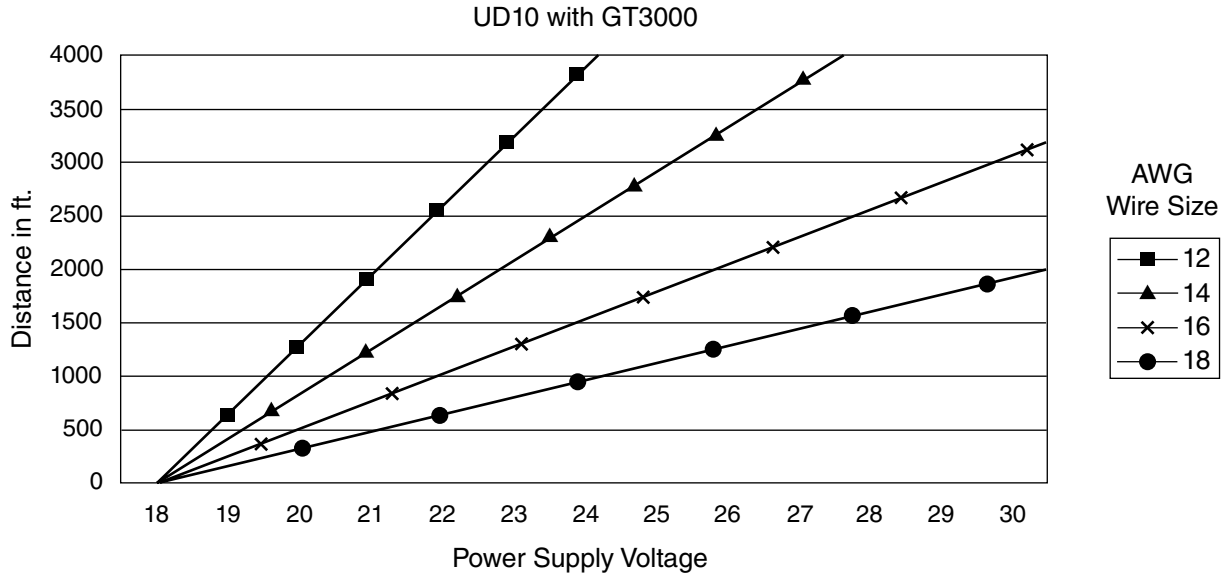
APPENDIX G

UD10 with GT3000 TOXIC GAS DETECTOR

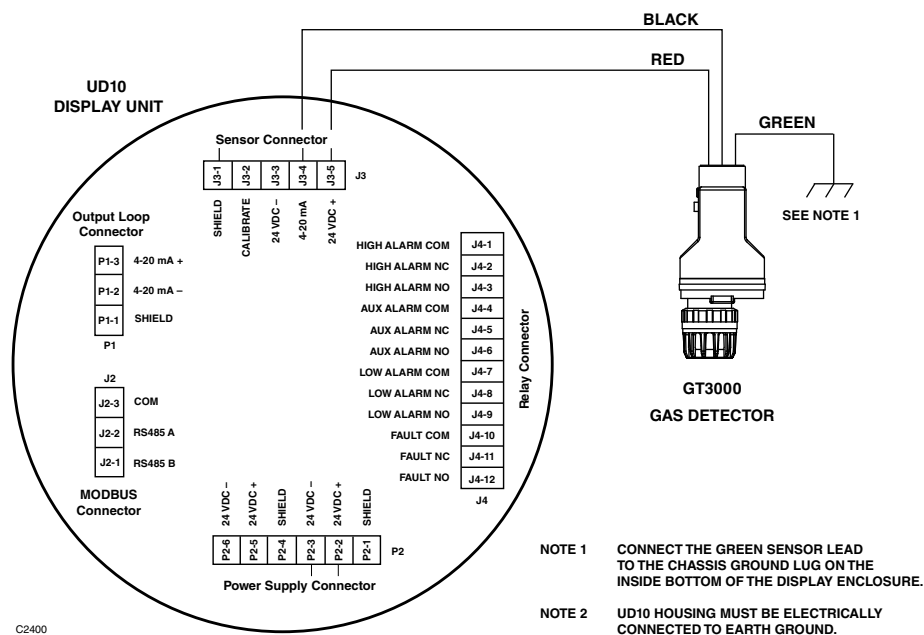
NOTE

For complete information regarding the GT3000 Gas Detector, refer to instruction manual 95-8616.

WIRING

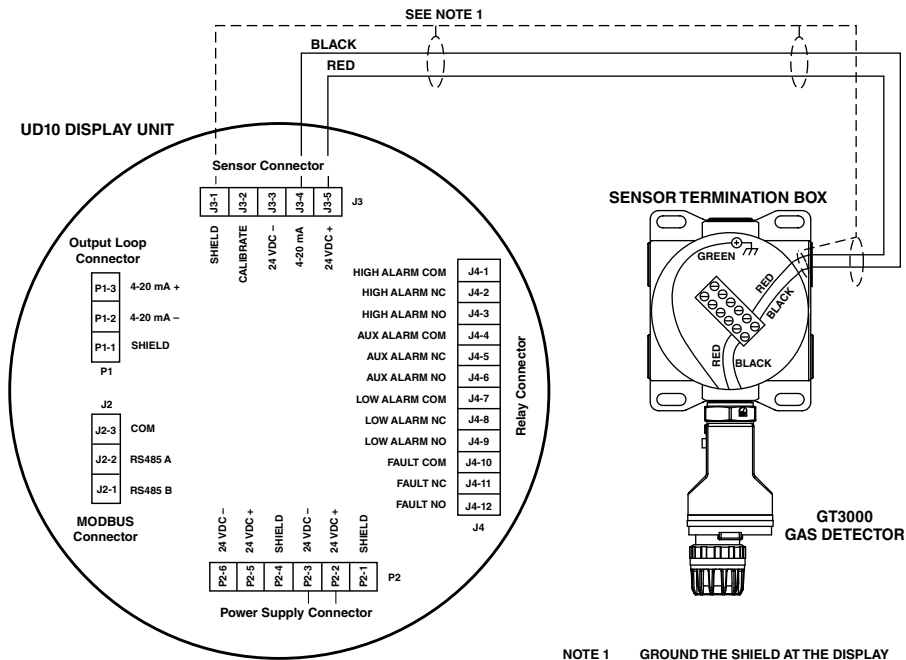


Notes: Maximum cable length from power source to UD10 is 2000 feet.
Maximum cable length from UD10 to sensor/STB termination box is 2000 feet.



NOTE 1 CONNECT THE GREEN SENSOR LEAD TO THE CHASSIS GROUND LUG ON THE INSIDE BOTTOM OF THE DISPLAY ENCLOSURE.
NOTE 2 UD10 HOUSING MUST BE ELECTRICALLY CONNECTED TO EARTH GROUND.

GT3000 Detector Wired Directly to UD10



C2401

UD10 Wired to GT3000 Detector with Sensor Termination Box

ORIENTATION

The device must be mounted in a vertical position only, with the GT3000 pointing down.



LIVE MAINTENANCE

NOTE

The sensor module on the GT3000 Gas Detector can be hot swapped, i.e. replaced without removing power or de-classifying the area. To replace a GTX Transmitter connected to the UD10 with a new transmitter or a different detector type, the area **must** be de-classified.

NOTE

Removing the sensor module with power applied will result in a fault condition until a new sensor module of the same type is installed. When replacing an oxygen sensor, this action will also result in an alarm condition as the decreasing 4-20 mA signal passes through the alarm range. Inhibit response devices to prevent unwanted actuation.

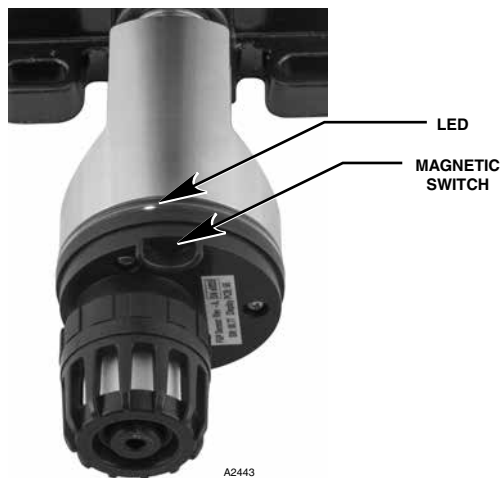
For complete information regarding sensor replacement with the GT3000 Gas Detector, refer to the GT3000 instruction manual number 95-8616.

CALIBRATION

GT3000 WITH TOXIC GAS SENSOR

From GT3000:

- Using the magnet, activate the magnetic calibration switch on the GT3000. The green LED turns to yellow.

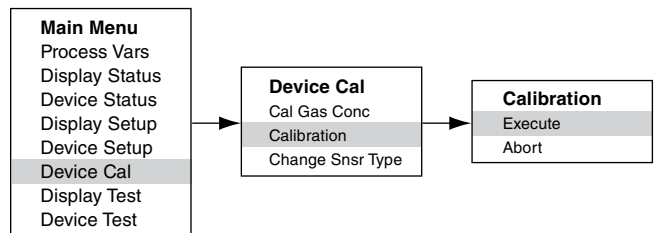


Location of Magnetic Switch on GT3000

- The UD10 will display “Waiting for Zero” on the main display screen, with the yellow LED on the detector housing illuminated continuously.
- The UD10 will then display “Waiting for Signal” on the screen, while the yellow LED on the detector is flashing. The device automatically performs the zero calibration.
- The UD10 will display “Waiting for Gas” on the screen, while the yellow LED on the detector is flashing.
- Apply calibration gas to the sensor.
- The UD10 will display “Waiting for Span” on the screen, while the yellow LED on the detector is flashing.
- When the UD10 displays “Remove Cal Gas” on the screen and all LEDs on the detector housing are off, remove the calibration gas.
- After successful calibration, the UD10 automatically returns to the normal display with the green LED illuminated on the detector.

From UD10

- Using the magnet to activate the switches on the UD10 display, navigate to the Calibration menu.



- Activate “Execute” (Enter/Select) to start calibration.
- The UD10 will display “Waiting for Zero” on the main display screen, with the yellow LED on the detector housing illuminated continuously. The device automatically performs the zero calibration.
- The UD10 will then display “Waiting for Gas” on the screen, while the yellow LED on the detector is flashing.
- Apply calibration gas to the sensor.
- The UD10 will display “Waiting for Span” on the screen, while the yellow LED on the detector is flashing.
- When the UD10 displays “Remove Cal Gas” on the screen and the LEDs on the detector housing are off, remove the calibration gas.
- After completion of a successful calibration, the UD10 automatically returns to the normal mode with the green LED illuminated on the detector.

UD10 mA Output During Calibration (UD10 with GT3000)		
UD10 Display Reading	Standard Mode	Replicate Mode
Waiting for Zero	3.8	3.8
Waiting for Gas	3.8	3.8
Waiting for Span	3.8	3.8
Remove Cal Gas	3.8	3.8
Back to Normal	4.0	4.0

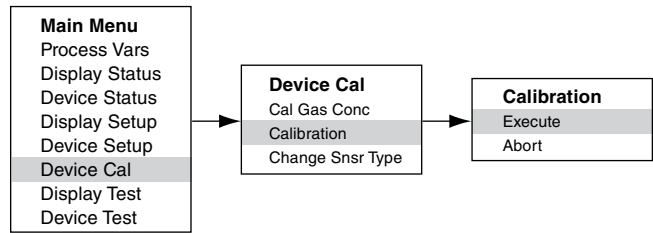
GT3000 WITH OXYGEN SENSOR

From GT3000:

1. Using the magnet, activate the magnetic calibration switch on the GT3000. The green LED turns to yellow.
2. The device automatically performs the zero calibration. The yellow LED on the GT3000 is on continuously. The UD10 displays "Waiting for Zero" on the main display screen.
3. When the yellow LED on the GT3000 flashes, the device automatically performs the span calculation. If using bottled 20.9% oxygen, apply immediately. The UD10 displays "Waiting for Span" on the screen.
4. After successful calibration, the green LED on the GT3000 is on continuously and the UD10 automatically returns to the normal display. Remove calibration gas (if used).

From UD10

1. Using the magnet to activate the switches on the UD10 display, navigate to the Calibration menu.



2. Activate "Execute" (Enter/Select) to start calibration.
3. The UD10 will display "Waiting for Zero" on the main display screen, with the yellow LED on the detector housing illuminated continuously. The device automatically performs the zero calibration.
4. When the UD10 displays "Waiting for Span" on the screen and the yellow LED on the detector is flashing, the device automatically performs the span calculation. If using bottled 20.9% oxygen, apply immediately.
5. After completion of a successful calibration, the UD10 automatically returns to the normal mode with the green LED illuminated on the detector. Remove calibration gas (if used).

MENU STRUCTURE

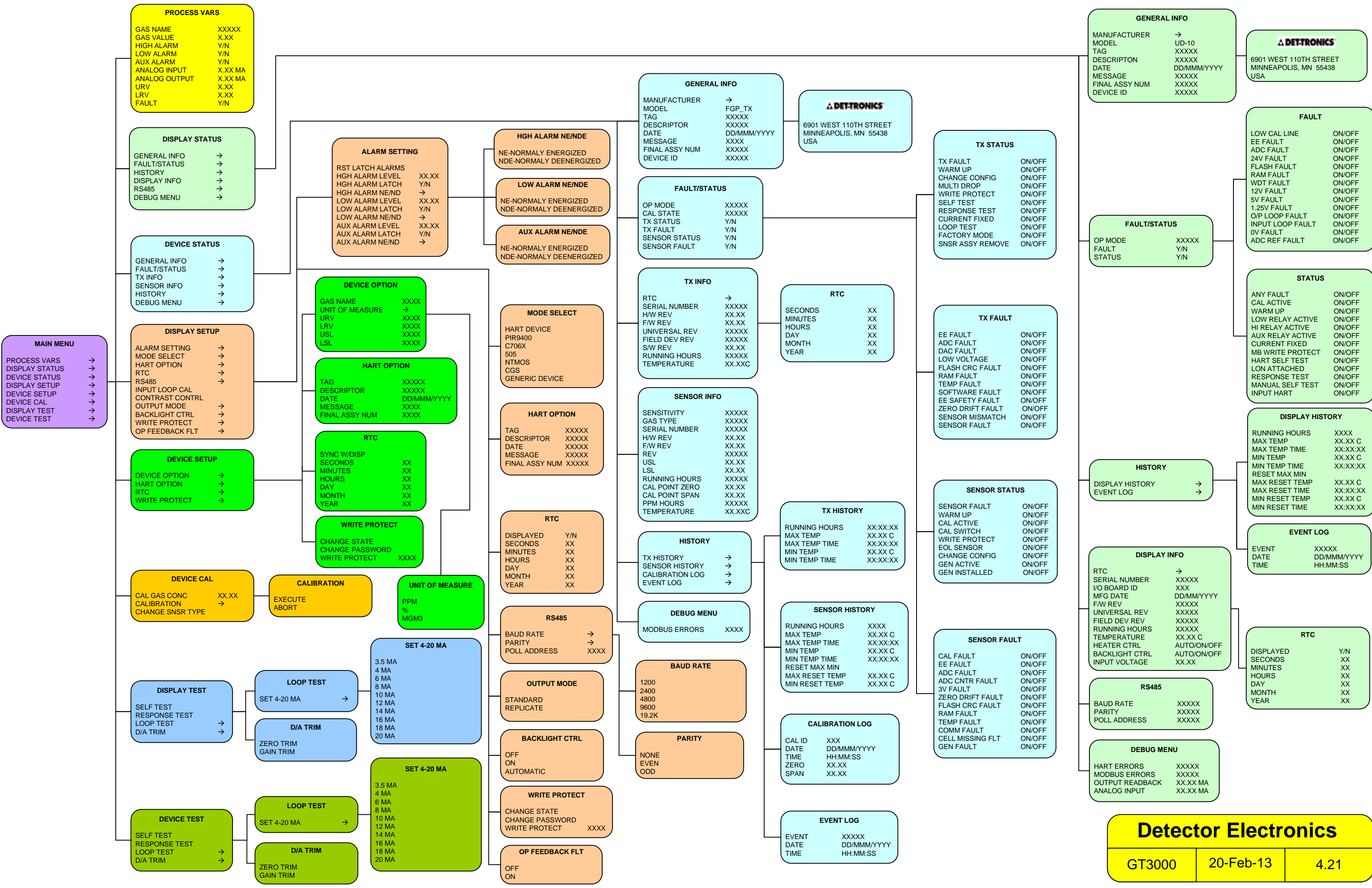
UD10 with GT3000 Detector

Refer to the following menu when using the UD10's LCD display and internal magnetic switches.

When connecting a HART Communicator to the UD10's 4-20 mA output, refer to the "UD10 HART" menu in Appendix E.

MENU HELP

Status menus only allow the user to view the data. The Setup menus allow the user to both view and edit the data.



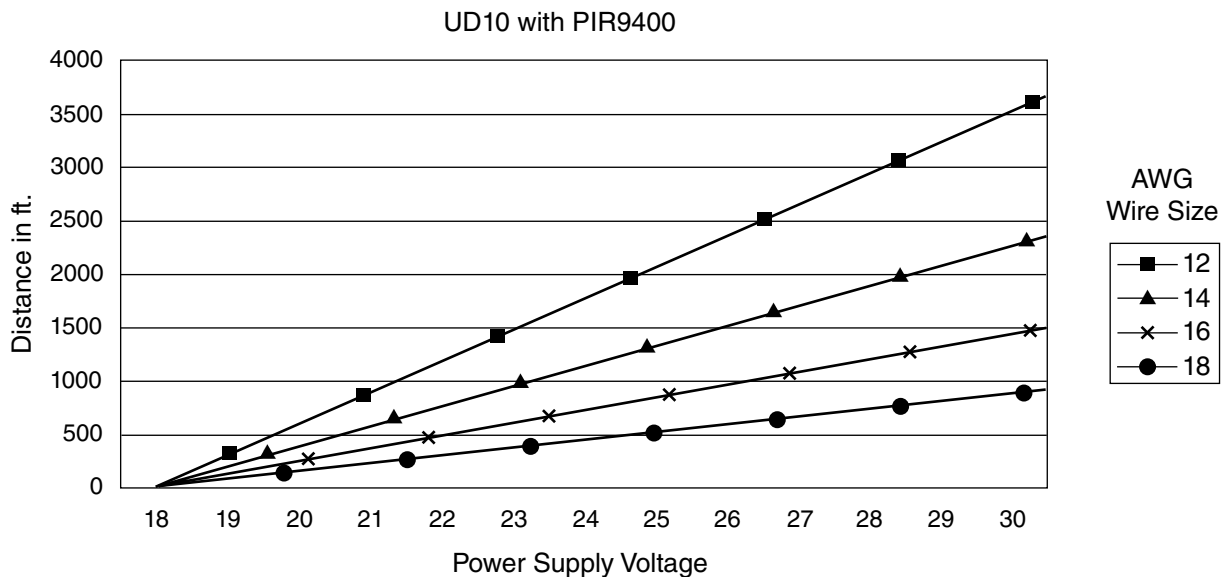
APPENDIX H

UD10 with PIR9400 POINTWATCH IR GAS DETECTOR

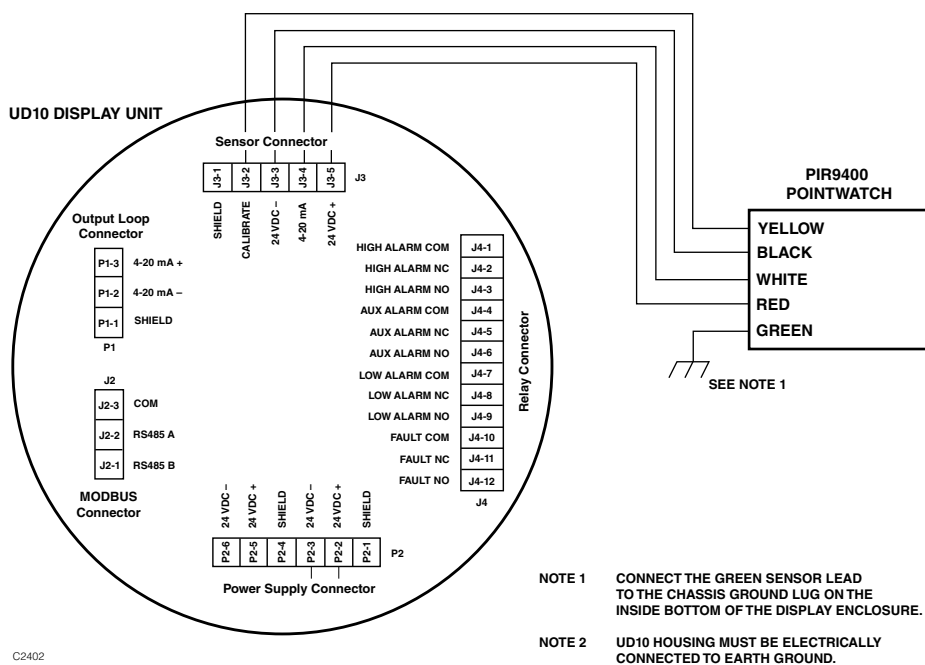
NOTE

For complete information regarding the PIR9400 Gas Detector, refer to instruction manual 95-8440.

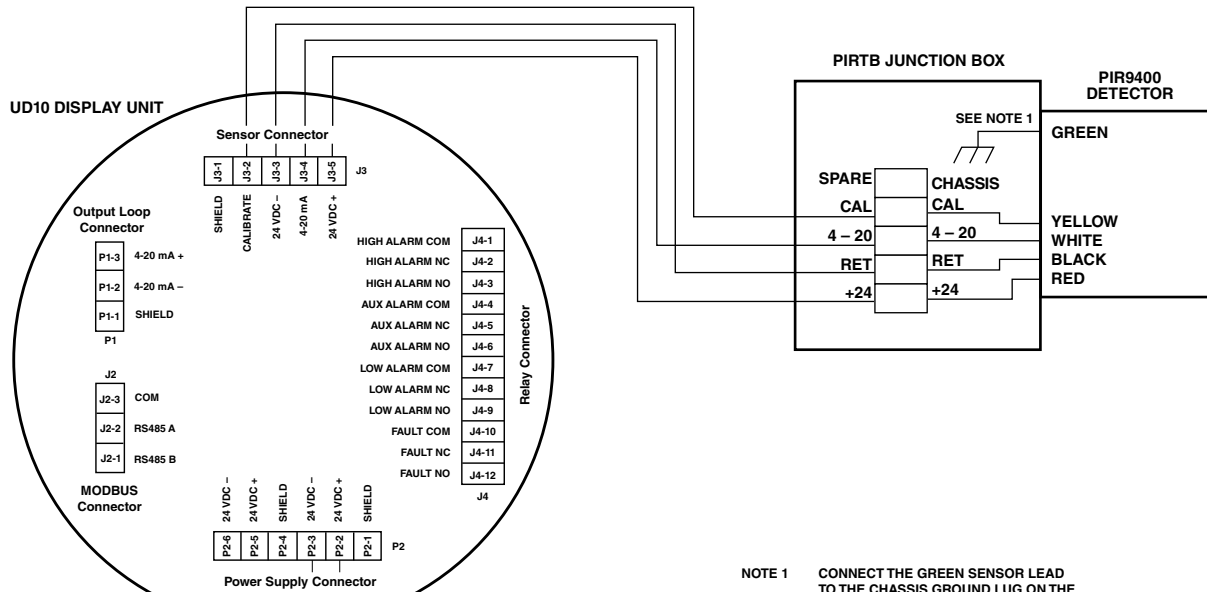
WIRING



Notes: Maximum cable length from power source to UD10 is 2000 feet.
Maximum cable length from UD10 to PIR9400/PIRTB termination box is 2000 feet.



PIR9400 Wired Directly to UD10



- NOTE 1 CONNECT THE GREEN SENSOR LEAD TO THE CHASSIS GROUND LUG ON THE INSIDE BOTTOM OF THE PIRTB.
- NOTE 2 HOUSINGS MUST BE ELECTRICALLY CONNECTED TO EARTH GROUND.

UD10 Wired to PIR9400 with PIRTB Termination Box

INSTALLATION NOTES

IMPORTANT

Hydrocarbon-based grease emits hydrocarbon vapors that will be measured by PointWatch, resulting in inaccurate gas level readings. Use only low vapor pressure Lubriplate grease or Teflon tape on the PointWatch detector and associated termination box. Do not get grease on the optics of the detector. A suitable grease is listed in the "Ordering Information" section in this manual.

IMPORTANT

In applications where both PointWatch and catalytic type sensors are used, ensure that the grease used to lubricate the PointWatch detector threads does not come into contact with the catalytic sensors, since poisoning of the catalytic sensors could result. It is strongly recommended that maintenance personnel wash their hands between handling the two types of sensors.

ORIENTATION

It is highly recommended that the PIR9400 be installed in the horizontal position. The detector is not position-sensitive in terms of its ability to detect gas. However, the weather baffle assembly provides superior performance when installed in a horizontal position. (See illustration below).



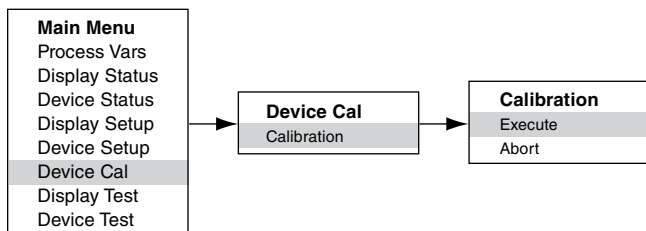
CHANGING OPERATING MODES

When used with a PIR9400, the operating mode of the UD10 must be changed from “HART Device” to “PIR9400” mode. Refer to the “Startup” section of this manual for details.

CALIBRATION

To initiate calibration of the PIR9400 from the UD10 Display:

- Using the magnet to activate the switches on the UD10 display, navigate to the “Calibration” menu.



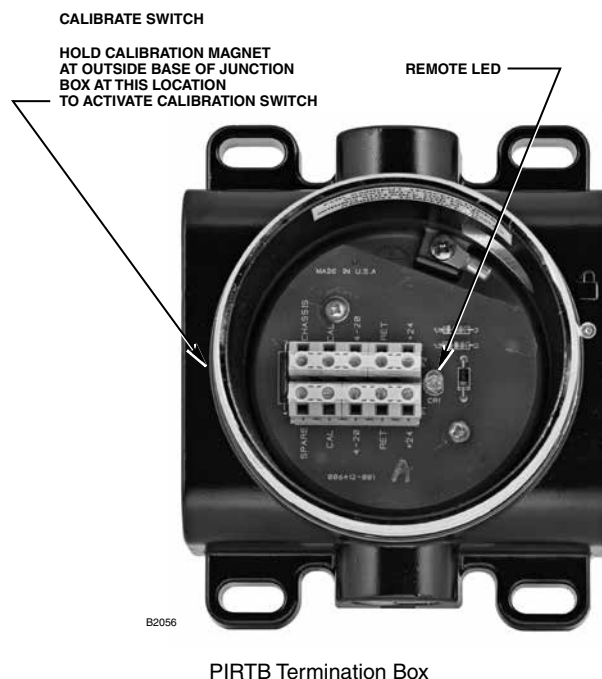
- Activate “Execute” (Enter/Select) to start calibration.
- The UD10 will display “Waiting for Zero” on the main display screen.
- The UD10 will then display “Waiting for Gas” on the screen.
- Apply calibration gas to the PIR9400.
- The UD10 will continue to display “Waiting for Gas” on the screen.
- When the UD10 displays “Remove Cal Gas” on the screen, remove the calibration gas from the PIR9400.
- The UD10 automatically returns to the normal mode after successful calibration.

To initiate calibration from the PIRTB Termination Box while monitoring calibration using the UD10 display:

- Using the magnet, activate the magnetic calibration switch on the PIRTB Termination Box. The LED at the PIRTB turns from off to steady red.
- The UD10 will display “Waiting for Zero” on the main display screen, with a steady red LED at the PIRTB.

UD10 mA Output During Calibration (UD10 with PIR9400)		
UD10 Display Reading	Standard Mode	Replicate Mode
Waiting for Zero	3.8	2.2
Waiting for Gas	3.8	3.8
Waiting for Span	3.8	3.8
Remove Cal Gas	3.8	3.8
Back to Normal	4.0	4.0

- The UD10 will then display “Waiting for Gas” on the screen, while the LED at the PIRTB is flashing red.
- Apply calibration gas to the PIR9400 detector.
- The UD10 will display “Waiting for Span” on the screen, with a red flashing LED at the PIRTB.
- When the UD10 displays “Remove Cal Gas” on the screen and the LED at the PIRTB turns off, remove the calibration gas.
- After successful calibration, the UD10 automatically returns to the normal mode, and the LED on the PIRTB remains off.



MENU STRUCTURE

UD10 with PIR9400 PointWatch Detector

Refer to the following menu when using the UD10's LCD display and internal magnetic switches.

When connecting a HART Communicator to the UD10's 4-20 mA output, refer to the "UD10 HART" menu in Appendix E.

MENU HELP

Status menus only allow the user to view the data.

The Setup menus allow the user to both view and edit the data.

PROCESS VARS	
GAS NAME	XXXX
GAS VALUE	X.XX
HIGH ALARM	Y/N
LOW ALARM	Y/N
AUX ALARM	Y/N
ANALOG INPUT	X.XX MA
ANALOG OUTPUT	X.XX MA
URV	X.XX
LRV	X.XX
FAULT	Y/N

DISPLAY STATUS	
GENERAL INFO	→
FAULT/STATUS	→
HISTORY	→
DISPLAY INFO	→
RS485	→
DEBUG MENU	→

DEVICE STATUS	
DEVICE INFO	→
FAULT/STATUS	→
CALIBRATION LOG	→

DISPLAY SETUP	
ALARM SETTING	→
MODE SELECT	→
HART OPTION	→
RTC	→
RS485	→
INPUT LOOP CAL	→
CONTRAST CONTRL	→
OUTPUT MODE	→
BACKLIGHT CTRL	→
WRITE PROTECT	→
OP FEEDBACK FLT	→

DEVICE SETUP	
DEVICE OPTION	→

DEVICE CAL	
CALIBRATION	→
CAL GAS CONC	XX.XX

DISPLAY TEST	
SELF TEST	→
RESPONSE TEST	→
LOOP TEST	→
D/A TRIM	→

DEVICE INFO	
MANUFACTURER	→
MODEL	PIR9400
GAS NAME	XXXXX
UNIT OF MEASURE	XXXXX
URV	XX.XX
LRV	XX.XX

FAULTS/ STATUS	
FAULTS	Y/N

CALIBRATION LOG	
CAL ID	XXXX
DATE	DD/MMM/YYYY
TIME	HH:MM:SS
ZERO	XXXX
SPAN	XXXX

DEVICE OPTION	
GAS TYPE	→
GAS NAME	XXXXX
UNIT OF MEASURE	%LFL
URV	XX.XX
LRV	XX.XX

CALIBRATION	
EXECUTE	→
ABORT	→

LOOP TEST	
SET 4-20 MA	→

D/A TRIM	
ZERO TRIM	→
GAIN TRIM	→

DETTRONICS	
6901 WEST 110TH STREET MINNEAPOLIS, MN 55438 USA	

FAULTS	
WARM UP	ON/OFF
REF. CHANNEL FLT	ON/OFF
ACT CHANNEL FLT	ON/OFF
STARTUP CAL FLT	ON/OFF
24 V FAULT	ON/OFF
BLOCK OPTICS	ON/OFF
CAL FAULT	ON/OFF
LOW FAULT	ON/OFF
HIGH FAULT	ON/OFF

GAS TYPE	
METHANE	→
ETHANE	→
PROPANE	→
PROPYLENE	→
ETHYLENE	→

SET 4-20 MA	
3.5MA	→
4 MA	→
6 MA	→
8 MA	→
10 MA	→
12 MA	→
14 MA	→
16 MA	→
18 MA	→
20 MA	→

ALARM SETTING	
RST LATCH ALARMS	→
HGH ALARM LEVEL	XX.XX
HGH ALARM LATCH	Y/N
HGH ALARM NE/ND	→
LOW ALARM LEVEL	XX.XX
LOW ALARM LATCH	Y/N
LOW ALARM NE/ND	→
AUX ALARM LEVEL	XX.XX
AUX ALARM LATCH	Y/N
AUX ALARM NE/ND	→

HGH ALARM NE/NDE	
NE-NORMALY ENERGIZED	→
NDE-NORMALY DEENERGIZED	→

LOW ALARM NE/NDE	
NE-NORMALY ENERGIZED	→
NDE-NORMALY DEENERGIZED	→

AUX ALARM NE/NDE	
NE-NORMALY ENERGIZED	→
NDE-NORMALY DEENERGIZED	→

MODE SELECT	
HART DEVICE	→
PIR9400	→
C706X	→
505	→
NTMOS	→
CGS	→
GENERIC DEVICE	→

HART OPTION	
TAG	XXXXX
DESCRIPTOR	XXXXX
DATE	DD/MMM/YYYY
MESSAGE	XXXXX
FINAL ASSY NUM	XXXXX

RTC	
DISPLAYED	Y/N
SECONDS	XX
MINUTES	XX
HOURS	XX
DAY	XX
MONTH	XX
YEAR	XX

RS485	
BAUD RATE	→
PARITY	→
POLL ADDRESS	XXXX

BAUD RATE	
1200	→
2400	→
4800	→
9600	→
19.2K	→

PARITY	
NONE	→
EVEN	→
ODD	→

OUTPUT MODE	
STANDARD	→
REPLICATE	→

BACKLIGHT CTRL	
OFF	→
ON	→
AUTOMATIC	→

WRITE PROTECT	
CHANGE STATE	→
CHANGE PASSWORD	→
WRITE PROTECT	XXXX

OP FEEDBACK FLT	
OFF	→
ON	→

GENERAL INFO	
MANUFACTURER	→
MODEL	UD-10
TAG	XXXXX
DESCRIPTOR	XXXXX
DATE	DD/MMM/YYYY
MESSAGE	XXXXX
FINAL ASSY NUM	XXXXX
DEVICE ID	XXXXX

DETTRONICS	
6901 WEST 110TH STREET MINNEAPOLIS, MN 55438 USA	

FAULT	
LOW CAL LINE	ON/OFF
EE FAULT	ON/OFF
ADC FAULT	ON/OFF
24V FAULT	ON/OFF
FLASH FAULT	ON/OFF
RAM FAULT	ON/OFF
WDT FAULT	ON/OFF
12V FAULT	ON/OFF
5V FAULT	ON/OFF
1.25V FAULT	ON/OFF
O/P LOOP FAULT	ON/OFF
INPUT LOOP FAULT	ON/OFF
0V FAULT	ON/OFF
ADC REF FAULT	ON/OFF

FAULT/STATUS	
OP MODE	XXXXX
FAULT	Y/N
STATUS	Y/N

STATUS	
ANY FAULT	ON/OFF
CAL ACTIVE	ON/OFF
WARM UP	ON/OFF
LOW RELAY ACTIVE	ON/OFF
HI RELAY ACTIVE	ON/OFF
AUX RELAY ACTIVE	ON/OFF
CURRENT FIXED	ON/OFF
MB WRITE PROTECT	ON/OFF
HART SELF TEST	ON/OFF
LON ATTACHED	ON/OFF
RESPONSE TEST	ON/OFF
MANUAL SELF TEST	ON/OFF
INPUT HART	ON/OFF

DISPLAY HISTORY	
RUNNING HOURS	XXXX
MAX TEMP	XX.XX C
MAX TEMP TIME	XX:XX:XX
MIN TEMP	XX.XX C
MIN TEMP TIME	XX:XX:XX
RESET MAX MIN	→
MAX RESET TEMP	XX.XX C
MAX RESET TIME	XX:XX:XX
MIN RESET TEMP	XX.XX C
MIN RESET TIME	XX:XX:XX

HISTORY	
DISPLAY HISTORY	→
EVENT LOG	→

EVENT LOG	
EVENT	XXXXX
DATE	DD/MMM/YYYY
TIME	HH:MM:SS

DISPLAY INFO	
RTC	→
SERIAL NUMBER	XXXXX
I/O BOARD ID	XXX
MFG DATE	DD/MM/YYYY
F/W REV	XXXXX
UNIVERSAL REV	XXXXX
FIELD DEV REV	XXXXX
RUNNING HOURS	XXXXX
TEMPERATURE	XX.XX C
HEATER CTRL	AUTO/ON/OFF
BACKLIGHT CTRL	AUTO/ON/OFF
INPUT VOLTAGE	XX.XX

RTC	
DISPLAYED	Y/N
SECONDS	XX
MINUTES	XX
HOURS	XX
DAY	XX
MONTH	XX
YEAR	XX

RS485	
BAUD RATE	XXXXX
PARITY	XXXXX
POLL ADDRESS	XXXXX

DEBUG MENU	
HART ERRORS	XXXXX
MODBUS ERRORS	XXXXX
OUTPUT READBACK	XX.XX MA
ANALOG INPUT	XX.XX MA

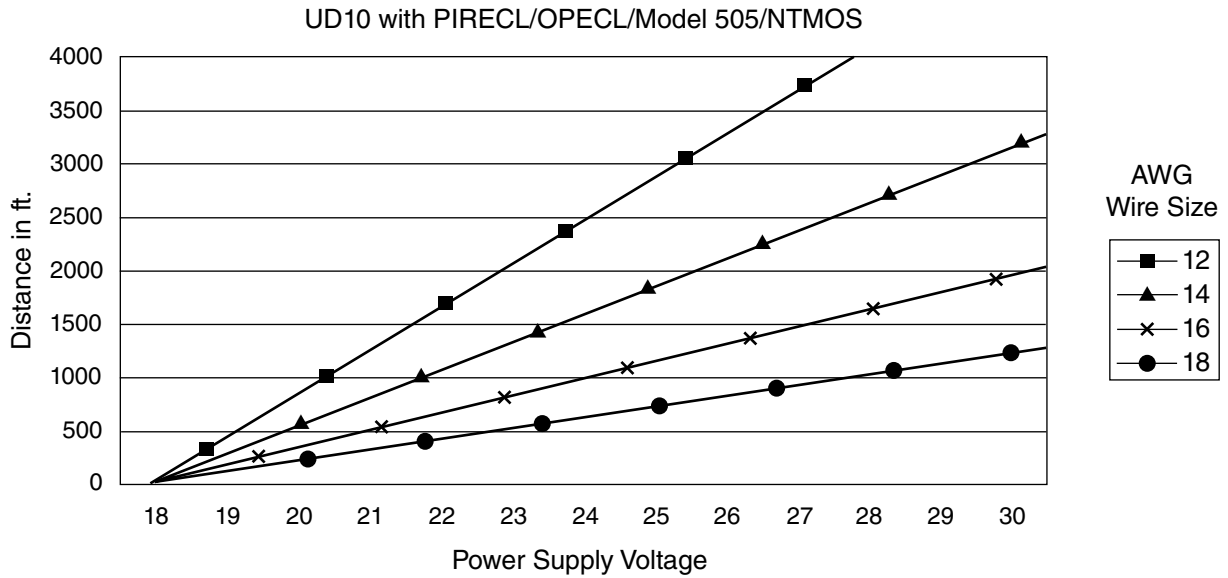
APPENDIX I

UD10 with MODEL PIRECL

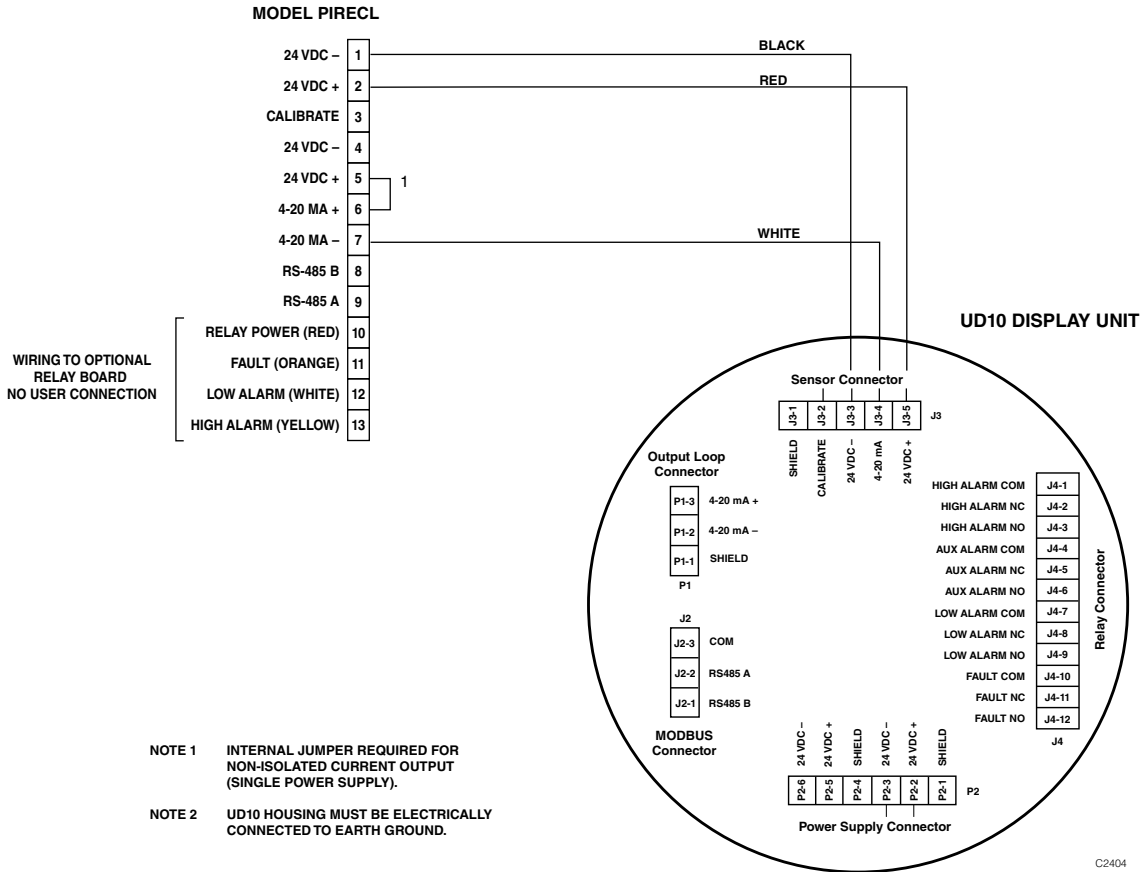
NOTE

For complete information regarding the PIRECL Gas Detector, refer to instruction manual 95-8526.

WIRING



Notes: Maximum cable length from power source to UD10 is 2000 feet.
Maximum cable length from UD10 to detector/STB termination box is 2000 feet.



Model PIRECL Wired Directly to UD10

ORIENTATION

It is highly recommended that the PIRECL be installed in the horizontal position. The detector is not position-sensitive in terms of its ability to detect gas. However, the weather baffle assembly provides superior performance when the PIRECL is installed with the baffle in a horizontal position.



CORRECT

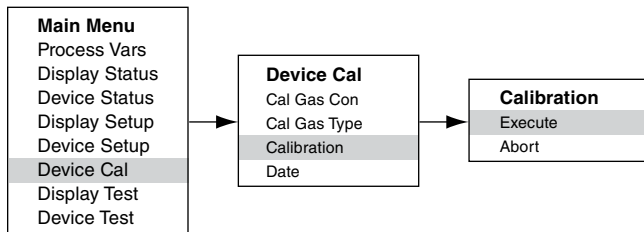


INCORRECT

CALIBRATION

To initiate calibration of the PIRECL from the UD10 Display:

- Using the magnet to activate the switches on the UD10 display, navigate to the "Calibration" menu.

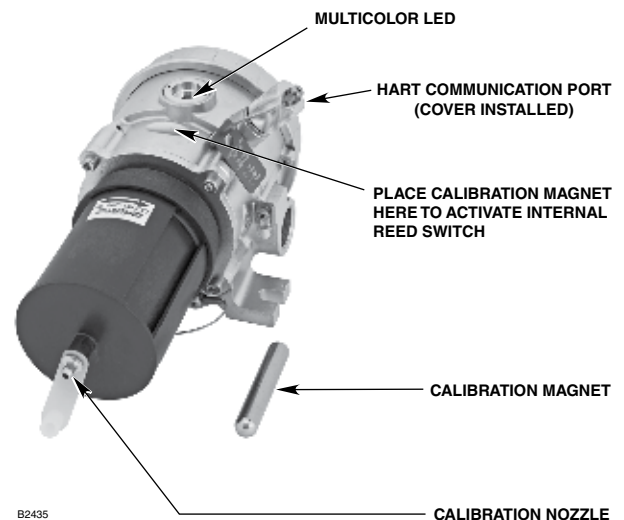


- Activate "Execute" (Enter/Select) to start calibration.
- The UD10 will display "Waiting for Zero" on the main display screen, with a solid red LED on the PIRECL housing illuminated.
- The UD10 will then display "Waiting for Gas" on the screen, while the LED on the PIRECL is flashing red.
- Apply calibration gas to the PIRECL
- The UD10 will display "Waiting for Span" on the screen, while a red flashing LED on the PIRECL housing is illuminated.
- When the UD10 displays "Remove Cal Gas" on the screen and the LED on the PIRECL housing is off, remove the calibration gas.
- After successful calibration, the UD10 automatically returns to the normal display with the green LED illuminated on the PIRECL housing.

To initiate calibration from the PIRECL while monitoring calibration using the UD10 display:

- Using the magnet, activate the magnetic calibration switch on the PIRECL detector. See Figure below. The LED turns from green to red.
- The UD10 will display "Waiting for Zero" on the main display screen, with a solid red LED on the PIRECL housing illuminated.
- The UD10 will then display "Waiting for Gas" on the screen, while the LED on the PIRECL is flashing red.
- Apply calibration gas to the PIRECL detector.
- The UD10 will display "Waiting for Span" on the screen, while a red flashing LED on the PIRECL housing is illuminated.
- When the UD10 displays "Remove Cal Gas" on the screen and the LED on the PIRECL housing is off, remove the calibration gas.
- After successful calibration, the UD10 automatically returns to the normal mode with the green LED illuminated on the PIRECL.

UD10 mA Output During Calibration (UD10 with PIRECL)		
UD10 Display Reading	Standard Mode	Replicate Mode
Waiting for Zero	3.8	2.2
Waiting for Gas	3.8	2.0
Waiting for Span	3.8	2.0
Remove Cal Gas	3.8	1.8
Back to Normal	4.0	4.0



Model PIRECL Gas Detector

MENU STRUCTURE

UD10 with Model PIRECL

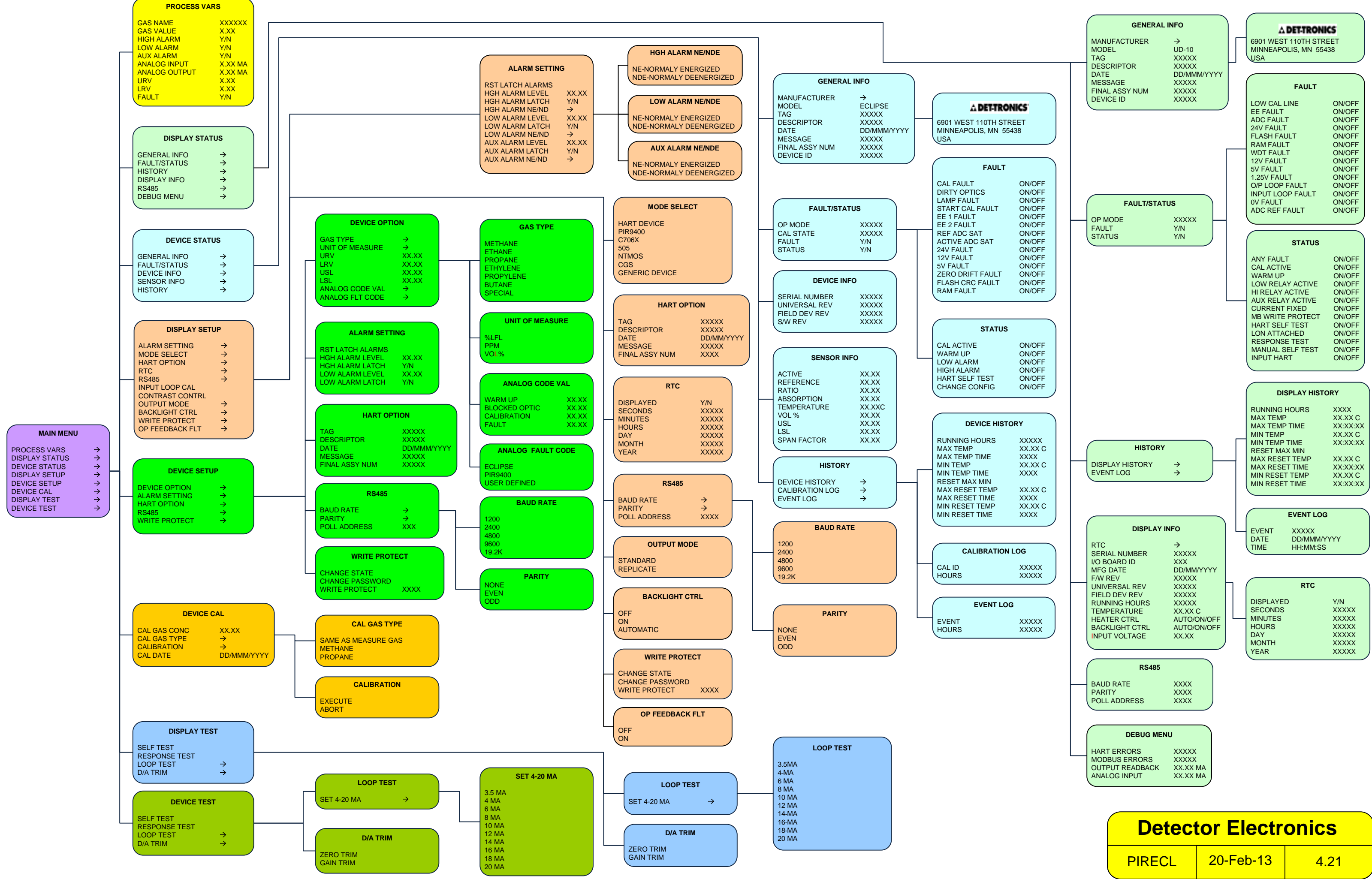
Refer to the following menu when using the UD10's LCD display and internal magnetic switches.

When connecting a HART Communicator to the UD10's 4-20 mA output, refer to the "UD10 HART" menu in Appendix E.

MENU HELP

Status menus only allow the user to view the data.

The Setup menus allow the user to both view and edit the data.



MAIN MENU

- PROCESS VARS →
- DISPLAY STATUS →
- DEVICE STATUS →
- DISPLAY SETUP →
- DEVICE SETUP →
- DEVICE CAL →
- DISPLAY TEST →
- DEVICE TEST →

PROCESS VARS

GAS NAME	XXXXXX
GAS VALUE	X.XX
HIGH ALARM	Y/N
LOW ALARM	Y/N
AUX ALARM	Y/N
ANALOG INPUT	X.XX MA
ANALOG OUTPUT	X.XX MA
URV	X.XX
LRV	X.XX
FAULT	Y/N

DISPLAY STATUS

- GENERAL INFO →
- FAULT/STATUS →
- HISTORY →
- DISPLAY INFO →
- RS485 →
- DEBUG MENU →

DEVICE STATUS

- GENERAL INFO →
- FAULT/STATUS →
- DEVICE INFO →
- SENSOR INFO →
- HISTORY →

DISPLAY SETUP

- ALARM SETTING →
- MODE SELECT →
- HART OPTION →
- RTC →
- RS485 →
- INPUT LOOP CAL →
- CONTRAST CONTRL →
- OUTPUT MODE →
- BACKLIGHT CTRL →
- WRITE PROTECT →
- OP FEEDBACK FLT →

DEVICE SETUP

- DEVICE OPTION →
- ALARM SETTING →
- HART OPTION →
- RS485 →
- WRITE PROTECT →

DEVICE CAL

CAL GAS CONC	XX.XX
CAL GAS TYPE	→
CALIBRATION	→
CAL DATE	DD/MM/YYYY

DISPLAY TEST

- SELF TEST →
- RESPONSE TEST →
- LOOP TEST →
- D/A TRIM →

DEVICE TEST

- SELF TEST →
- RESPONSE TEST →
- LOOP TEST →
- D/A TRIM →

DEVICE OPTION

- GAS TYPE →
- UNIT OF MEASURE →
- URV XX.XX
- LRV XX.XX
- USL XX.XX
- LSL XX.XX
- ANALOG CODE VAL →
- ANALOG FLT CODE →

ALARM SETTING

- RST LATCH ALARMS →
- HGH ALARM LEVEL XX.XX
- HGH ALARM LATCH Y/N
- LOW ALARM LEVEL XX.XX
- LOW ALARM LATCH Y/N

HART OPTION

- TAG XXXXX
- DESCRIPTOR XXXXX
- DATE DD/MM/YYYY
- MESSAGE XXXXX
- FINAL ASSY NUM XXXXX

RS485

- BAUD RATE →
- PARITY →
- POLL ADDRESS XXX

WRITE PROTECT

- CHANGE STATE →
- CHANGE PASSWORD →
- WRITE PROTECT XXXX

CAL GAS TYPE

- SAME AS MEASURE GAS
- METHANE
- PROPANE

CALIBRATION

- EXECUTE
- ABORT

LOOP TEST

- SET 4-20 MA →

D/A TRIM

- ZERO TRIM
- GAIN TRIM

ALARM SETTING

- RST LATCH ALARMS →
- HGH ALARM LEVEL XX.XX
- HGH ALARM LATCH Y/N
- HGH ALARM NE/ND →
- LOW ALARM LEVEL XX.XX
- LOW ALARM LATCH Y/N
- LOW ALARM NE/ND →
- AUX ALARM LEVEL XX.XX
- AUX ALARM LATCH Y/N
- AUX ALARM NE/ND →

HGH ALARM NE/NDE

- NE-NORMALLY ENERGIZED
- NDE-NORMALLY DEENERGIZED

LOW ALARM NE/NDE

- NE-NORMALLY ENERGIZED
- NDE-NORMALLY DEENERGIZED

AUX ALARM NE/NDE

- NE-NORMALLY ENERGIZED
- NDE-NORMALLY DEENERGIZED

MODE SELECT

- HART DEVICE
- PIR9400
- C706X
- 505
- NTMOS
- CGS
- GENERIC DEVICE

HART OPTION

- TAG XXXXX
- DESCRIPTOR XXXXX
- DATE DD/MM/YYYY
- MESSAGE XXXXX
- FINAL ASSY NUM XXXXX

RTC

- DISPLAYED Y/N
- SECONDS XXXXX
- MINUTES XXXXX
- HOURS XXXXX
- DAY XXXXX
- MONTH XXXXX
- YEAR XXXXX

RS485

- BAUD RATE →
- PARITY →
- POLL ADDRESS XXXX

OUTPUT MODE

- STANDARD
- REPLICATE

BACKLIGHT CTRL

- OFF
- ON
- AUTOMATIC

WRITE PROTECT

- CHANGE STATE →
- CHANGE PASSWORD →
- WRITE PROTECT XXXX

OP FEEDBACK FLT

- OFF
- ON

LOOP TEST

- SET 4-20 MA →

D/A TRIM

- ZERO TRIM
- GAIN TRIM

GENERAL INFO

- MANUFACTURER →
- MODEL →
- TAG XXXXX
- DESCRIPTOR XXXXX
- DATE DD/MM/YYYY
- MESSAGE XXXXX
- FINAL ASSY NUM XXXXX
- DEVICE ID XXXXX

FAULT/STATUS

- OP MODE XXXXX
- CAL STATE XXXXX
- FAULT Y/N
- STATUS Y/N

DEVICE INFO

- SERIAL NUMBER XXXXX
- UNIVERSAL REV XXXXX
- FIELD DEV REV XXXXX
- S/W REV XXXXX

SENSOR INFO

- ACTIVE XX.XX
- REFERENCE XX.XX
- RATIO XX.XX
- ABSORPTION XX.XX
- TEMPERATURE XX.XXC
- VOL % XX.XX
- USL XX.XX
- LSL XX.XX
- SPAN FACTOR XX.XX

HISTORY

- DEVICE HISTORY →
- CALIBRATION LOG →
- EVENT LOG →

BAUD RATE

- 1200
- 2400
- 4800
- 9600
- 19.2K

PARITY

- NONE
- EVEN
- ODD

LOOP TEST

- 3.5 MA
- 4 MA
- 6 MA
- 8 MA
- 10 MA
- 12 MA
- 14 MA
- 16 MA
- 18 MA
- 20 MA

DET-TRONICS

6901 WEST 110TH STREET
MINNEAPOLIS, MN 55438
USA

FAULT

CAL FAULT	ON/OFF
DIRTY OPTICS	ON/OFF
LAMP FAULT	ON/OFF
START CAL FAULT	ON/OFF
EE 1 FAULT	ON/OFF
EE 2 FAULT	ON/OFF
REF ADC SAT	ON/OFF
ACTIVE ADC SAT	ON/OFF
24V FAULT	ON/OFF
12V FAULT	ON/OFF
5V FAULT	ON/OFF
1.25V FAULT	ON/OFF
O/P LOOP FAULT	ON/OFF
INPUT LOOP FAULT	ON/OFF
0V FAULT	ON/OFF
ADC REF FAULT	ON/OFF

STATUS

CAL ACTIVE	ON/OFF
WARM UP	ON/OFF
LOW ALARM	ON/OFF
HIGH ALARM	ON/OFF
HART SELF TEST	ON/OFF
CHANGE CONFIG	ON/OFF

DEVICE HISTORY

RUNNING HOURS	XXXX
MAX TEMP	XX.XX C
MAX TEMP TIME	XX:XX:XX
MIN TEMP	XX.XX C
MIN TEMP TIME	XX:XX:XX
RESET MAX MIN	XX.XX C
MAX RESET TEMP	XX.XX C
MAX RESET TIME	XX:XX:XX
MIN RESET TEMP	XX.XX C
MIN RESET TIME	XX:XX:XX

CALIBRATION LOG

CAL ID	XXXXX
HOURS	XXXXX

EVENT LOG

EVENT HOURS	XXXXXX
HOURS	XXXXXX

GENERAL INFO

- MANUFACTURER →
- MODEL UD-10
- TAG XXXXX
- DESCRIPTOR XXXXX
- DATE DD/MM/YYYY
- MESSAGE XXXXX
- FINAL ASSY NUM XXXXX
- DEVICE ID XXXXX

FAULT/STATUS

- OP MODE XXXXX
- FAULT Y/N
- STATUS Y/N

HISTORY

- DISPLAY HISTORY →
- EVENT LOG →

DISPLAY INFO

- RTC →
- SERIAL NUMBER XXXXX
- I/O BOARD ID XXX
- MFG DATE DD/MM/YYYY
- F/W REV XXXXX
- UNIVERSAL REV XXXXX
- FIELD DEV REV XXXXX
- RUNNING HOURS XXXXX
- TEMPERATURE XX.XX C
- HEATER CTRL AUTO/ON/OFF
- BACKLIGHT CTRL AUTO/ON/OFF
- INPUT VOLTAGE XX.XX

RS485

- BAUD RATE XXXX
- PARITY XXXX
- POLL ADDRESS XXXX

DEBUG MENU

- HART ERRORS XXXXX
- MODBUS ERRORS XXXXX
- OUTPUT READBACK XX.XX MA
- ANALOG INPUT XX.XX MA

DET-TRONICS

6901 WEST 110TH STREET
MINNEAPOLIS, MN 55438
USA

FAULT

LOW CAL LINE	ON/OFF
EE FAULT	ON/OFF
ADC FAULT	ON/OFF
24V FAULT	ON/OFF
FLASH FAULT	ON/OFF
RAM FAULT	ON/OFF
WDT FAULT	ON/OFF
12V FAULT	ON/OFF
5V FAULT	ON/OFF
1.25V FAULT	ON/OFF
O/P LOOP FAULT	ON/OFF
INPUT LOOP FAULT	ON/OFF
0V FAULT	ON/OFF
ADC REF FAULT	ON/OFF

STATUS

ANY FAULT	ON/OFF
CAL ACTIVE	ON/OFF
WARM UP	ON/OFF
LOW RELAY ACTIVE	ON/OFF
HI RELAY ACTIVE	ON/OFF
AUX RELAY ACTIVE	ON/OFF
CURRENT FIXED	ON/OFF
MB WRITE PROTECT	ON/OFF
HART SELF TEST	ON/OFF
LON ATTACHED	ON/OFF
RESPONSE TEST	ON/OFF
MANUAL SELF TEST	ON/OFF
INPUT HART	ON/OFF

DISPLAY HISTORY

RUNNING HOURS	XXXX
MAX TEMP	XX.XX C
MAX TEMP TIME	XX:XX:XX
MIN TEMP	XX.XX C
MIN TEMP TIME	XX:XX:XX
RESET MAX MIN	XX.XX C
MAX RESET TEMP	XX.XX C
MAX RESET TIME	XX:XX:XX
MIN RESET TEMP	XX.XX C
MIN RESET TIME	XX:XX:XX

EVENT LOG

EVENT	XXXXX
DATE	DD/MM/YYYY
TIME	HH:MM:SS

RTC

DISPLAYED	Y/N
SECONDS	XXXXX
MINUTES	XXXXX
HOURS	XXXXX
DAY	XXXXX
MONTH	XXXXX
YEAR	XXXXX

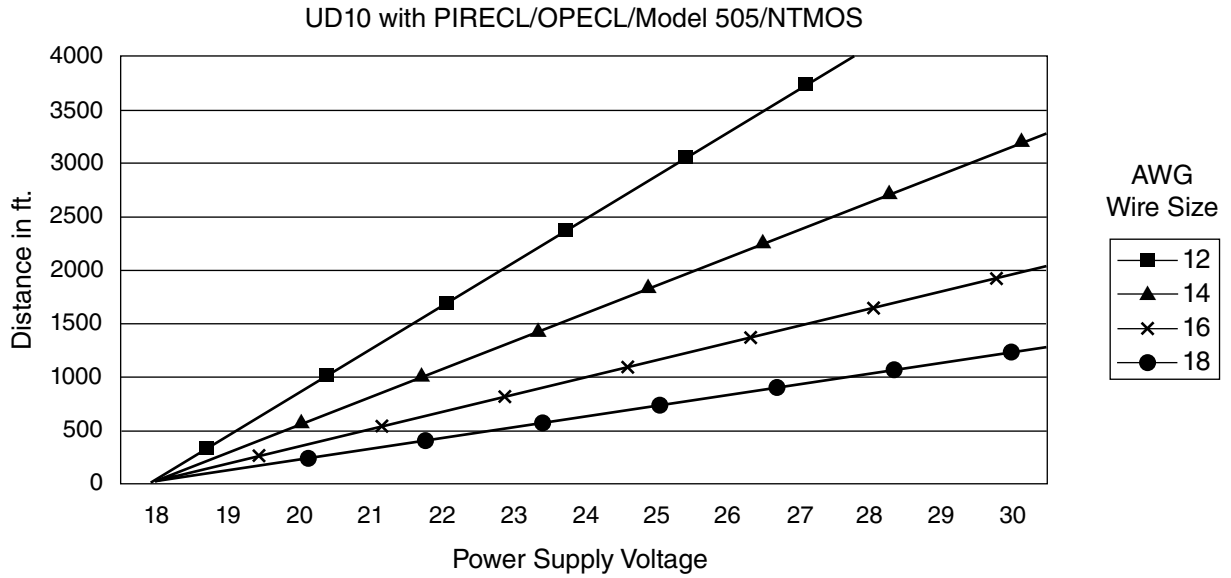
APPENDIX J

UD10 with OPEN PATH ECLIPSE MODEL OPECL

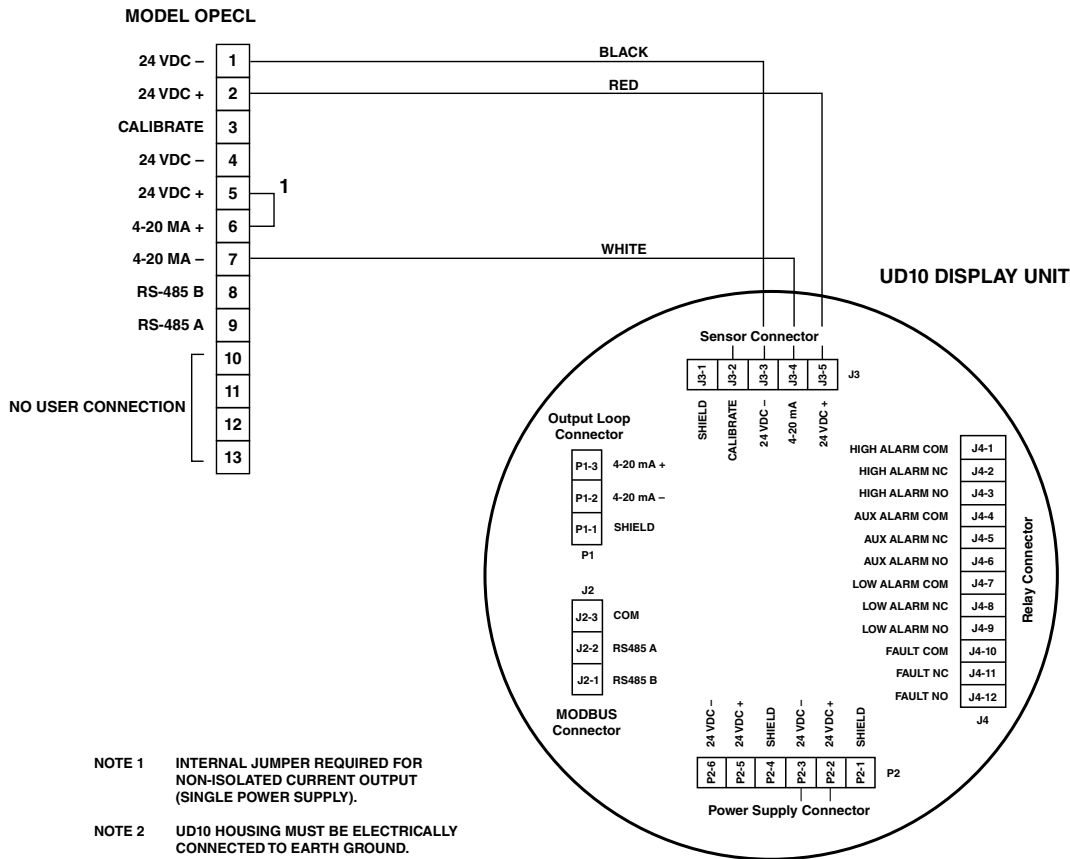
NOTE

For complete information regarding the OPECL Gas Detector, refer to instruction manual 95-8556.

WIRING



Notes: Maximum cable length from power source to UD10 is 2000 feet.
Maximum cable length from UD10 to detector/STB termination box is 2000 feet.



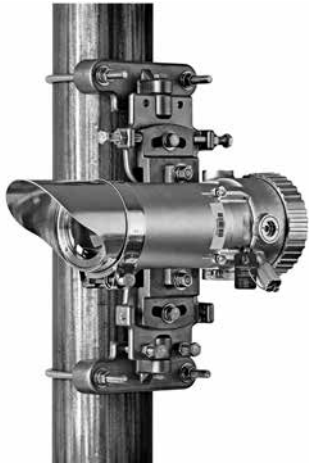
C2405

Model OPECL Wired Directly to UD10

ORIENTATION

OPECL modules must be affixed to a solid, non-vibrating structure capable of supporting a minimum of 100 lbs (46 kg), located within the system's rated separation distance. See examples below.

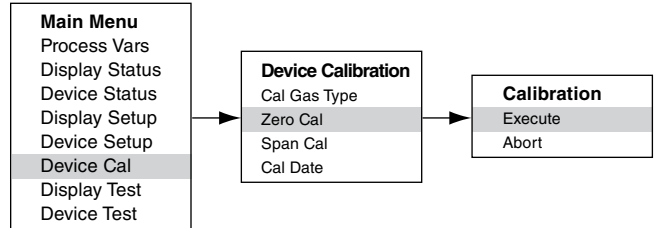
In all cases, the maximum movement of the supporting structure under all anticipated operating conditions must be no more than ± 0.25 degrees. When using a vertical post, the post should be absolutely stable and without vibration. Generally, when the post is set into the ground, the portion below grade should be set in concrete at least 1 meter deep.



CALIBRATION

To initiate zero calibration of the OPECL from the UD10 Display:

- Using the magnet to activate the switches on the UD10 display, navigate to the "Calibration" menu.

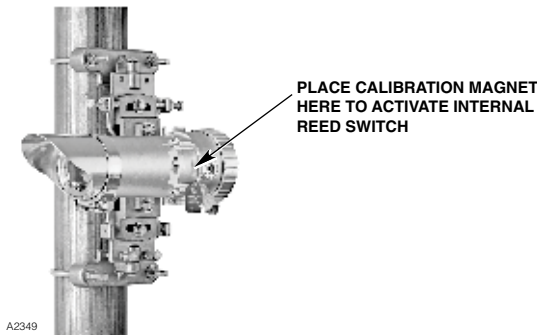


- Activate "Execute" (Enter/Select) to start calibration.
- The UD10 will display "Waiting for Zero" on the main display screen, with a solid red LED on the OPECL housing illuminated.
- After the calibration is successfully completed, the UD10 automatically returns to the normal display with the green LED illuminated on the OPECL housing.

UD10 mA Output During Calibration (UD10 with OPECL)		
UD10 Display Reading	Standard Mode	Replicate Mode
Waiting for Zero	3.8	2.2
Back to Normal	4.0	4.0

To initiate zero calibration from the OPECL:

1. Using the magnet, activate the magnetic calibration switch on the OPECL receiver. See Figure below. The green LED will turn red.
2. The UD10 will display “Waiting for Zero” on the main display screen, with a solid red LED on the OPECL housing illuminated.
3. After the calibration is successfully completed, the UD10 automatically returns to the normal display with the green LED illuminated on the OPECL housing.



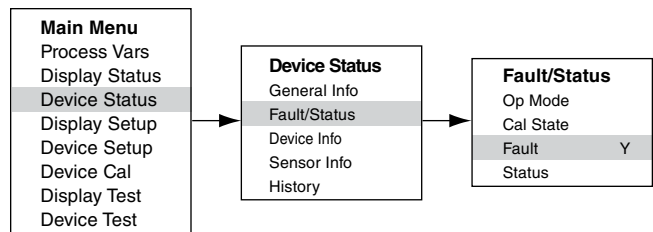
Location of Receiver's Internal Magnetic Switch

OPECL TRANSMITTER LAMP FAULT CONDITION

If the OPECL system experiences a Transmitter (Tx) Lamp Fault condition, the UD10 display will not indicate a fault condition and its output will remain at 4 mA. The OPECL system is still fully functional and able to detect gas. If a gas alarm condition should occur, the alarm condition will override the Tx Lamp Fault condition.

The OPECL system indicates a fault condition by amber indicator LEDs on both the transmitter and the receiver.

To verify an OPECL Tx Lamp Fault condition, within the Menu Structure of the UD10 Display navigate to the device Fault/Status menu:



The Fault status will indicate Y (Yes). Click on “Fault” and the Fault menu will identify the fault as a “Lamp Fault”.

For complete information regarding OPECL fault indications and operation of the OPECL transmitter lamps, refer to the OPECL instruction manual, number 95-8556.

MENU STRUCTURE

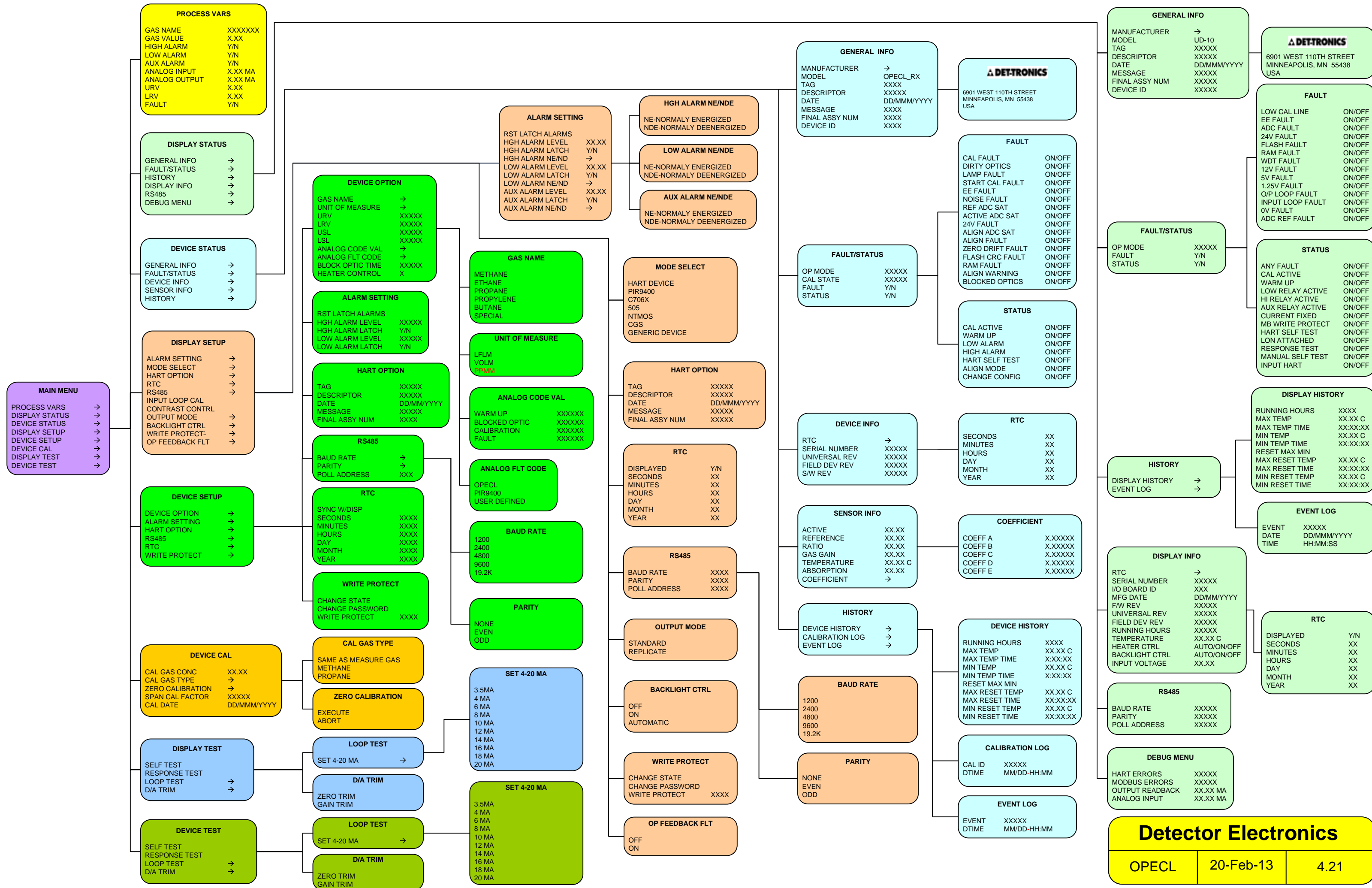
UD10 with Open Patch Eclipse Model OPECL

Refer to the following menu when using the UD10's LCD display and internal magnetic switches.

When connecting a HART Communicator to the UD10's 4-20 mA output, refer to the “UD10 HART” menu in Appendix E.

MENU HELP

Status menus only allow the user to view the data. The Setup menus allow the user to both view and edit the data.



MAIN MENU

- PROCESS VARS →
- DISPLAY STATUS →
- DEVICE STATUS →
- DISPLAY SETUP →
- DEVICE SETUP →
- DEVICE CAL →
- DISPLAY TEST →
- DEVICE TEST →

PROCESS VARS

GAS NAME	XXXXXX
GAS VALUE	X.XX
HIGH ALARM	Y/N
LOW ALARM	Y/N
AUX ALARM	Y/N
ANALOG INPUT	X.XX MA
ANALOG OUTPUT	X.XX MA
URV	X.XX
LRV	X.XX
FAULT	Y/N

DISPLAY STATUS

- GENERAL INFO →
- FAULT/STATUS →
- HISTORY →
- DISPLAY INFO →
- RS485 →
- DEBUG MENU →

DEVICE STATUS

- GENERAL INFO →
- FAULT/STATUS →
- DEVICE INFO →
- SENSOR INFO →
- HISTORY →

DISPLAY SETUP

- ALARM SETTING →
- MODE SELECT →
- HART OPTION →
- RTC →
- RS485 →
- INPUT LOOP CAL →
- CONTRAST CONTRL →
- OUTPUT MODE →
- BACKLIGHT CTRL →
- WRITE PROTECT →
- OP FEEDBACK FLT →

DEVICE SETUP

- DEVICE OPTION →
- ALARM SETTING →
- HART OPTION →
- RS485 →
- RTC →
- WRITE PROTECT →

DEVICE CAL

CAL GAS CONC	XX.XX
CAL GAS TYPE	→
ZERO CALIBRATION	→
SPAN CAL FACTOR	XXXXX
CAL DATE	DD/MMM/YYYY

DISPLAY TEST

- SELF TEST →
- RESPONSE TEST →
- LOOP TEST →
- D/A TRIM →

DEVICE TEST

- SELF TEST →
- RESPONSE TEST →
- LOOP TEST →
- D/A TRIM →

DEVICE OPTION

- GAS NAME →
- UNIT OF MEASURE →
- URV XXXXX
- LRV XXXXX
- USL XXXXX
- LSL XXXXX
- ANALOG CODE VAL →
- ANALOG FLT CODE →
- BLOCK OPTIC TIME XXXXX
- HEATER CONTROL X

ALARM SETTING

RST LATCH ALARMS	
HGH ALARM LEVEL	XXXXX
HGH ALARM LATCH	Y/N
LOW ALARM LEVEL	XXXXX
LOW ALARM LATCH	Y/N
AUX ALARM LEVEL	XX.XX
AUX ALARM LATCH	Y/N
AUX ALARM NE/ND	→

HART OPTION

TAG	XXXXX
DESCRIPTOR	XXXXX
DATE	DD/MMM/YYYY
MESSAGE	XXXXX
FINAL ASSY NUM	XXXX

RS485

- BAUD RATE →
- PARITY →
- POLL ADDRESS XXX

RTC

SYNC W/DISP	
SECONDS	XXXX
MINUTES	XXXX
HOURS	XXXX
DAY	XXXX
MONTH	XXXX
YEAR	XXXX

WRITE PROTECT

- CHANGE STATE
- CHANGE PASSWORD
- WRITE PROTECT XXXX

CAL GAS TYPE

- SAME AS MEASURE GAS
- METHANE
- PROPANE

ZERO CALIBRATION

- EXECUTE
- ABORT

LOOP TEST

- SET 4-20 MA →

D/A TRIM

- ZERO TRIM
- GAIN TRIM

LOOP TEST

- SET 4-20 MA →

D/A TRIM

- ZERO TRIM
- GAIN TRIM

ALARM SETTING

RST LATCH ALARMS	
HGH ALARM LEVEL	XX.XX
HGH ALARM LATCH	Y/N
HGH ALARM NE/ND	→
LOW ALARM LEVEL	XX.XX
LOW ALARM LATCH	Y/N
LOW ALARM NE/ND	→
AUX ALARM LEVEL	XX.XX
AUX ALARM LATCH	Y/N
AUX ALARM NE/ND	→

GAS NAME

- METHANE
- ETHANE
- PROPANE
- PROPYLENE
- BUTANE
- SPECIAL

UNIT OF MEASURE

- LFLM
- VOLM
- PPM

ANALOG CODE VAL

WARM UP	XXXXXX
BLOCKED OPTIC	XXXXXX
CALIBRATION	XXXXXX
FAULT	XXXXXX

ANALOG FLT CODE

- OPECL
- PIR9400
- USER DEFINED

BAUD RATE

- 1200
- 2400
- 4800
- 9600
- 19.2K

PARITY

- NONE
- EVEN
- ODD

SET 4-20 MA

- 3.5MA
- 4 MA
- 6 MA
- 8 MA
- 10 MA
- 12 MA
- 14 MA
- 16 MA
- 18 MA
- 20 MA

SET 4-20 MA

- 3.5MA
- 4 MA
- 6 MA
- 8 MA
- 10 MA
- 12 MA
- 14 MA
- 16 MA
- 18 MA
- 20 MA

HGH ALARM NE/NDE

- NE-NORMALY ENERGIZED
- NDE-NORMALY DEENERGIZED

LOW ALARM NE/NDE

- NE-NORMALY ENERGIZED
- NDE-NORMALY DEENERGIZED

AUX ALARM NE/NDE

- NE-NORMALY ENERGIZED
- NDE-NORMALY DEENERGIZED

MODE SELECT

- HART DEVICE
- PIR9400
- C706X
- 505
- NTMOS
- CGS
- GENERIC DEVICE

HART OPTION

TAG	XXXXX
DESCRIPTOR	XXXXX
DATE	DD/MMM/YYYY
MESSAGE	XXXXX
FINAL ASSY NUM	XXXXX

RTC

DISPLAYED	Y/N
SECONDS	XX
MINUTES	XX
HOURS	XX
DAY	XX
MONTH	XX
YEAR	XX

RS485

- BAUD RATE XXXX
- PARITY XXXX
- POLL ADDRESS XXXX

OUTPUT MODE

- STANDARD
- REPLICATE

BACKLIGHT CTRL

- OFF
- ON
- AUTOMATIC

WRITE PROTECT

- CHANGE STATE
- CHANGE PASSWORD
- WRITE PROTECT XXXX

OP FEEDBACK FLT

- OFF
- ON

GENERAL INFO

MANUFACTURER	→
MODEL	OPECL_RX
TAG	XXXX
DESCRIPTOR	XXXXX
DATE	DD/MMM/YYYY
MESSAGE	XXXX
FINAL ASSY NUM	XXXX
DEVICE ID	XXXX

DET-TRONICS

6901 WEST 110TH STREET
MINNEAPOLIS, MN 55438
USA

FAULT/STATUS

OP MODE	XXXXX
CAL STATE	XXXXX
FAULT	Y/N
STATUS	Y/N

DEVICE INFO

RTC	→
SERIAL NUMBER	XXXXX
UNIVERSAL REV	XXXXX
FIELD DEV REV	XXXXX
S/W REV	XXXXX

SENSOR INFO

ACTIVE	XX.XX
REFERENCE	XX.XX
RATIO	XX.XX
GAS GAIN	XX.XX
TEMPERATURE	XX.XX C
ABSORPTION	XX.XX
COEFFICIENT	→

HISTORY

- DEVICE HISTORY →
- CALIBRATION LOG →
- EVENT LOG →

BAUD RATE

- 1200
- 2400
- 4800
- 9600
- 19.2K

PARITY

- NONE
- EVEN
- ODD

FAULT

CAL FAULT	ON/OFF
DIRTY OPTICS	ON/OFF
LAMP FAULT	ON/OFF
START CAL FAULT	ON/OFF
EE FAULT	ON/OFF
NOISE FAULT	ON/OFF
REF ADC SAT	ON/OFF
ACTIVE ADC SAT	ON/OFF
24V FAULT	ON/OFF
ALIGN ADC SAT	ON/OFF
ALIGN FAULT	ON/OFF
ZERO DRIFT FAULT	ON/OFF
FLASH CRC FAULT	ON/OFF
RAM FAULT	ON/OFF
ALIGN WARNING	ON/OFF
BLOCKED OPTICS	ON/OFF

STATUS

CAL ACTIVE	ON/OFF
WARM UP	ON/OFF
LOW ALARM	ON/OFF
HIGH ALARM	ON/OFF
HART SELF TEST	ON/OFF
ALIGN MODE	ON/OFF
CHANGE CONFIG	ON/OFF

RTC

SECONDS	XX
MINUTES	XX
HOURS	XX
DAY	XX
MONTH	XX
YEAR	XX

COEFFICIENT

COEFF A	X.XXXXX
COEFF B	X.XXXXX
COEFF C	X.XXXXX
COEFF D	X.XXXXX
COEFF E	X.XXXXX

DEVICE HISTORY

RUNNING HOURS	XXXX
MAX TEMP	XX.XX C
MAX TEMP TIME	X:XX:XX
MIN TEMP	XX.XX C
MIN TEMP TIME	X:XX:XX
RESET MAX MIN	
MAX RESET TEMP	XX.XX C
MAX RESET TIME	XX:XX:XX
MIN RESET TEMP	XX.XX C
MIN RESET TIME	XX:XX:XX

CALIBRATION LOG

CAL ID	XXXXX
DTIME	MM/DD-HH:MM

EVENT LOG

EVENT	XXXXX
DTIME	MM/DD-HH:MM

GENERAL INFO

MANUFACTURER	→
MODEL	UD-10
TAG	XXXXX
DESCRIPTOR	XXXXX
DATE	DD/MMM/YYYY
MESSAGE	XXXXX
FINAL ASSY NUM	XXXXX
DEVICE ID	XXXXX

DET-TRONICS

6901 WEST 110TH STREET
MINNEAPOLIS, MN 55438
USA

FAULT/STATUS

OP MODE	XXXXX
FAULT	Y/N
STATUS	Y/N

FAULT

LOW CAL LINE	ON/OFF
EE FAULT	ON/OFF
ADC FAULT	ON/OFF
24V FAULT	ON/OFF
FLASH FAULT	ON/OFF
RAM FAULT	ON/OFF
WDT FAULT	ON/OFF
12V FAULT	ON/OFF
5V FAULT	ON/OFF
1.25V FAULT	ON/OFF
O/P LOOP FAULT	ON/OFF
INPUT LOOP FAULT	ON/OFF
0V FAULT	ON/OFF
ADC REF FAULT	ON/OFF

STATUS

ANY FAULT	ON/OFF
CAL ACTIVE	ON/OFF
WARM UP	ON/OFF
LOW RELAY ACTIVE	ON/OFF
HI RELAY ACTIVE	ON/OFF
AUX RELAY ACTIVE	ON/OFF
CURRENT FIXED	ON/OFF
MB WRITE PROTECT	ON/OFF
HART SELF TEST	ON/OFF
LON ATTACHED	ON/OFF
RESPONSE TEST	ON/OFF
MANUAL SELF TEST	ON/OFF
INPUT HART	ON/OFF

HISTORY

- DISPLAY HISTORY →
- EVENT LOG →

DISPLAY HISTORY

RUNNING HOURS	XXXX
MAX TEMP	XX.XX C
MAX TEMP TIME	XX:XX:XX
MIN TEMP	XX.XX C
MIN TEMP TIME	XX:XX:XX
RESET MAX MIN	
MAX RESET TEMP	XX.XX C
MAX RESET TIME	XX:XX:XX
MIN RESET TEMP	XX.XX C
MIN RESET TIME	XX:XX:XX

EVENT LOG

EVENT	XXXXX
DATE	DD/MMM/YYYY
TIME	HH:MM:SS

DISPLAY INFO

RTC	→
SERIAL NUMBER	XXXXX
I/O BOARD ID	XXX
MFG DATE	DD/MM/YYYY
F/W REV	XXXXX
UNIVERSAL REV	XXXXX
FIELD DEV REV	XXXXX
RUNNING HOURS	XXXXX
TEMPERATURE	XX.XX C
HEATER CTRL	AUTO/ON/OFF
BACKLIGHT CTRL	AUTO/ON/OFF
INPUT VOLTAGE	XX.XX

RTC

DISPLAYED	Y/N
SECONDS	XX
MINUTES	XX
HOURS	XX
DAY	XX
MONTH	XX
YEAR	XX

RS485

- BAUD RATE XXXXX
- PARITY XXXXX
- POLL ADDRESS XXXXX

DEBUG MENU

- HART ERRORS XXXXX
- MODBUS ERRORS XXXXX
- OUTPUT READBACK XX.XX MA
- ANALOG INPUT XX.XX MA

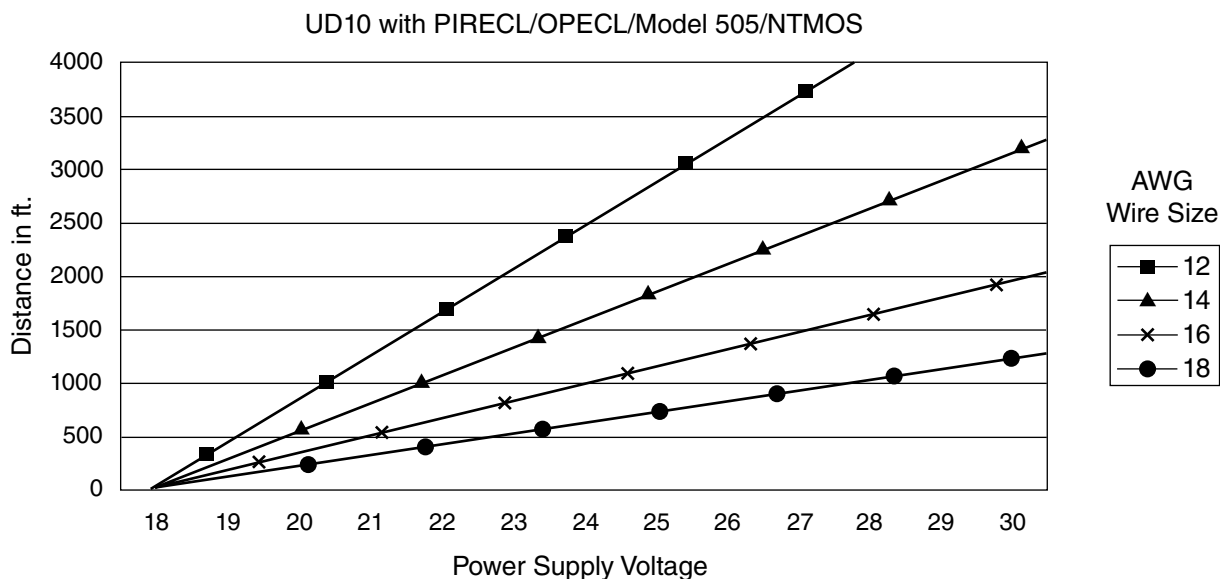
APPENDIX K

UD10 with NTMOS H₂S DETECTOR

NOTE

For complete information regarding the NTMOS Gas Detector, refer to instruction manual 95-8604.

WIRING



Notes: Maximum cable length from power source to UD10 is 2000 feet.
Maximum cable length from UD10 to detector/STB termination box is 2000 feet.

INSTALLATION NOTES

NOTE

Never use silicone grease with the NTMOS detector.

NOTE

A junction box spacer or standoff may be used to increase the distance between the device and the mounting surface, thereby facilitating installation and use of the ampoule calibrator.

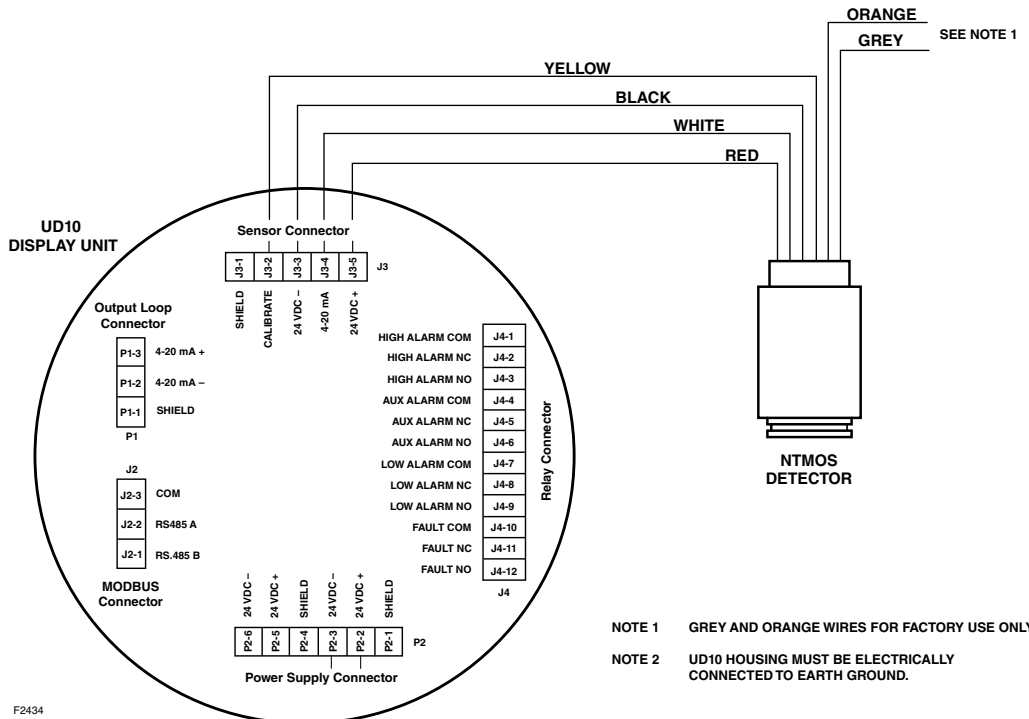
NOTE

For non-HART applications, the NTMOS detector can be wired to the Sensor Connector terminals (J3) on the UD10 module. If HART communication will be used, the NTMOS detector must be wired to the optional NTMOS Connector Board, located on the inside bottom of the UD10 housing. Refer to the appropriate wiring diagram.

Proper Termination of Orange and Grey Wires

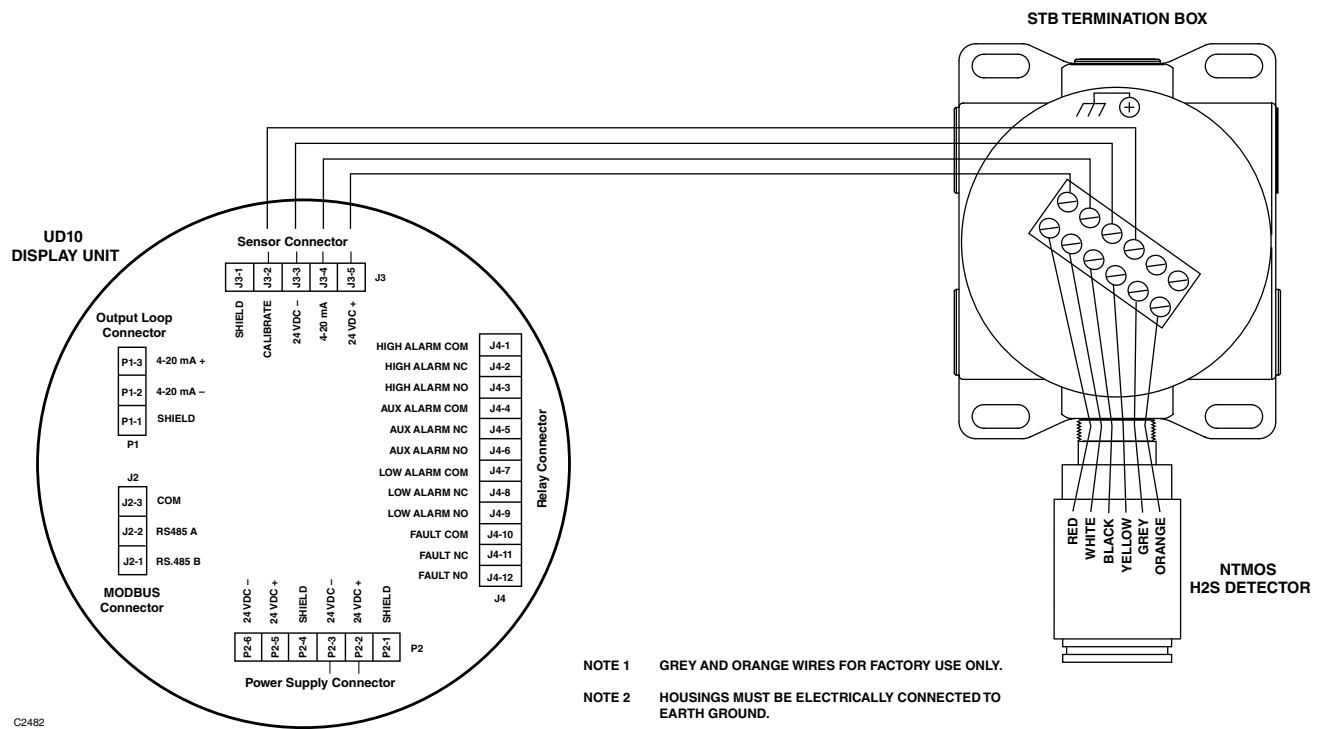
The orange and grey wires on the NTMOS detector are for factory use only. Proper field termination of these wires can be accomplished in any of the following ways:

- If wiring to optional NTMOS Connector Board, use the terminals provided (grey to COM 1 & orange to COM 2).
- If codes allow, they can be taped off and left unconnected.
- Connect both wires to the "Shield" terminal (J3-1).
- Connect both wires to Power Supply Minus (24 Vdc -).
- Connect to unused terminals in the STB Sensor Termination Box.



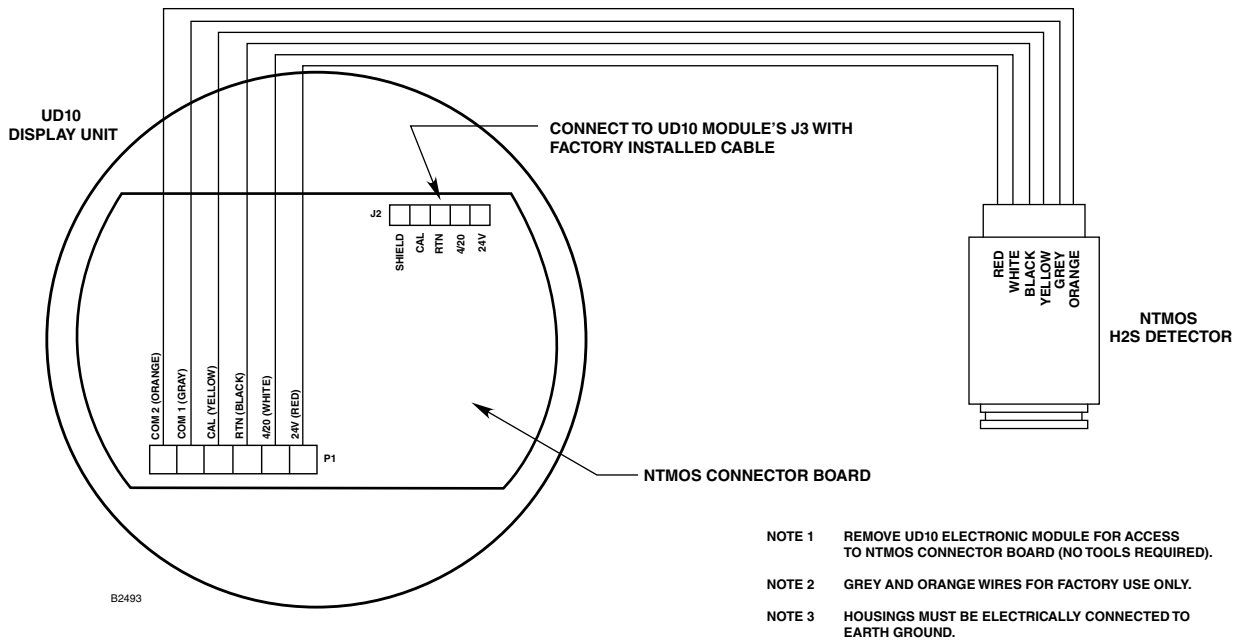
- NOTE 1 GREY AND ORANGE WIRES FOR FACTORY USE ONLY.
- NOTE 2 UD10 HOUSING MUST BE ELECTRICALLY CONNECTED TO EARTH GROUND.

NTMOS Detector Wired Directly to UD10 (Non-HART Applications Only)

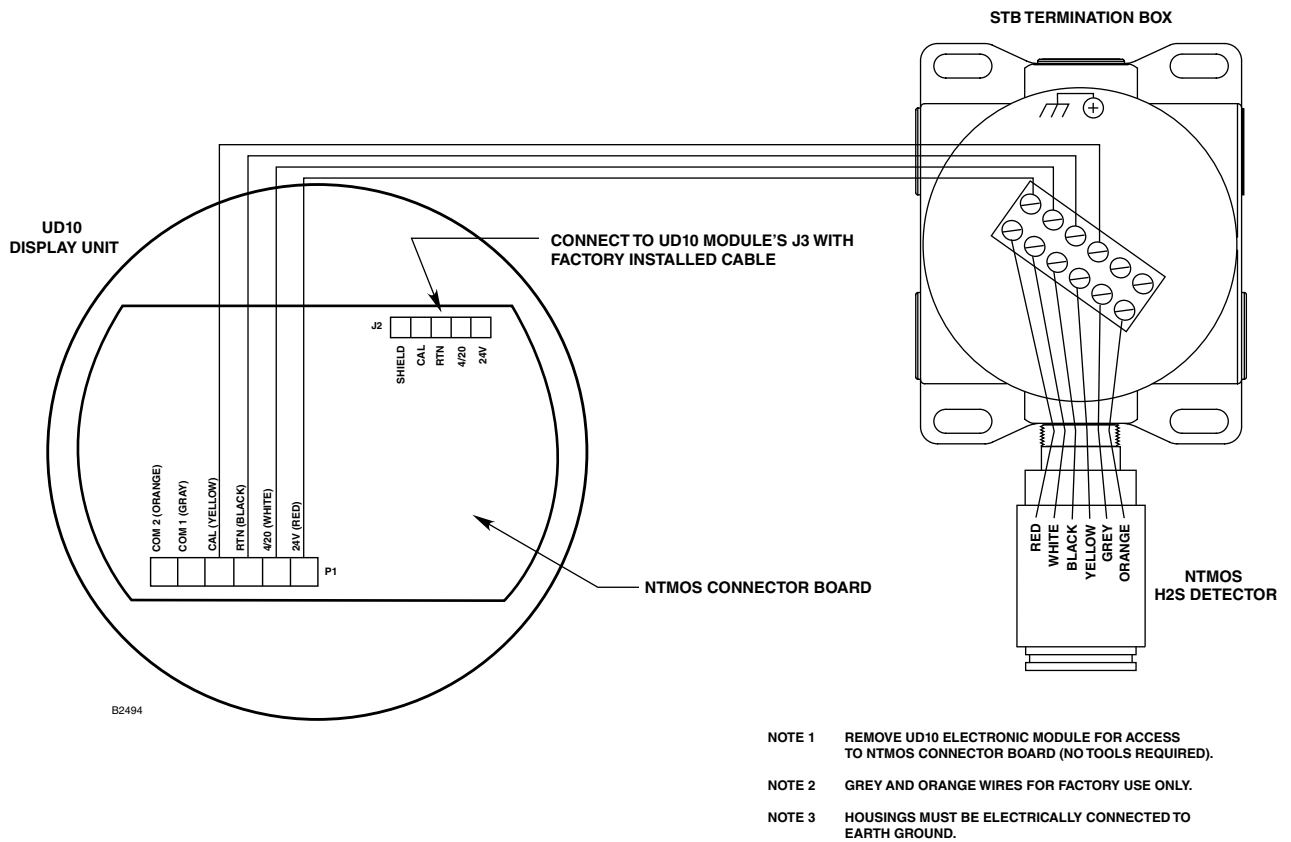


- NOTE 1 GREY AND ORANGE WIRES FOR FACTORY USE ONLY.
- NOTE 2 HOUSINGS MUST BE ELECTRICALLY CONNECTED TO EARTH GROUND.

UD10 Wired to NTMOS Detector with STB Termination Box (Non-HART Applications Only)



NTMOS Detector Wired Directly to UD10 via the NTMOS Connector Board (NTMOS Connector Board is **Required** for HART Communication)



UD10 with NTMOS Connector Board Wired to NTMOS Detector with STB Termination Box (NTMOS Connector Board is **Required** for HART Communication)

ORIENTATION

The UD10/NTMOS assembly must be mounted with the detector pointing down (see photo below).



CALIBRATION

Calibration Notes

The NTMOS detector must be calibrated using 50 ppm H₂S in air (never use H₂S in nitrogen).

Det-Tronics provides two acceptable sources of 50 ppm H₂S calibration gas for use with NTMOS detectors.

WARNING

The use of any other H₂S calibration mixture will produce inaccurate calibration results, possibly resulting in a dangerous condition if the detector under-reports the level of H₂S.

1. 50 ppm Ampoule Calibration Kit (p/n 007098-005) with 50 ppm ampoules (p/n 225741-001)

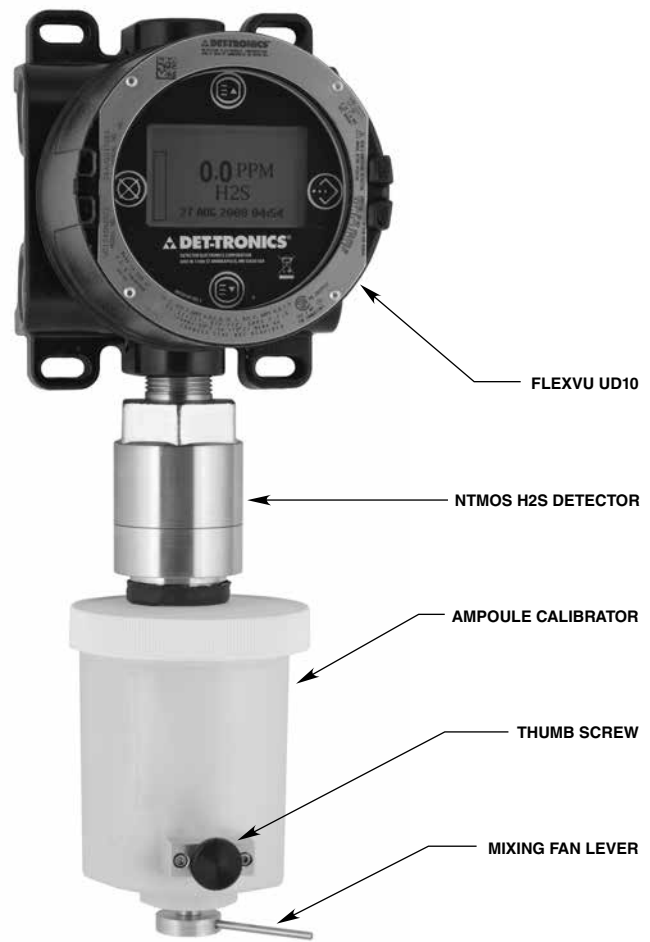
To operate the Ampoule Calibrator:

- Remove the cover and insert a 50 ppm H₂S ampoule into the ampoule holder inside the calibrator. Tighten the thumb screw until snug.
- Place the cover back on the calibrator and connect it snugly to the NTMOS detector.
- Tighten the thumb screw until the ampoule breaks.
- Rotate the mixing fan by slowly turning the mixing fan lever.

2. Humidification Tube Calibration Kit (p/n 010272-001) with bottled 50 ppm H₂S in air (p/n 227117-014). For complete information regarding use of the Humidification Tube Calibration Kit, refer to Instruction Manual number 95-8648.

NOTE

*When calibrating with bottled 50 ppm H₂S in air, the humidification tube **must** be used.*



Ampoule Calibrator Attached to NTMOS Detector



Humidification Tube Calibration Kit Attached to NTMOS Detector

5. Apply calibration gas to the detector.
6. With 50 ppm H₂S applied to the detector, the UD10 display will continue to show “Waiting for Span” while the span calibration is being performed.
7. When the UD10 Display shows “Remove Cal Gas” the calibration is complete. Remove calibration gas from the detector.
8. When the gas level falls below the lowest alarm setpoint, the UD10 automatically exits the Calibrate mode and returns to normal operating mode.

MENU STRUCTURE

UD10 with NTMOS H₂S Detector

Refer to the following menu when using the UD10's LCD display and internal magnetic switches.

When connecting a HART Communicator to the UD10's 4-20 mA output, refer to the “UD10 HART” menu in Appendix E.

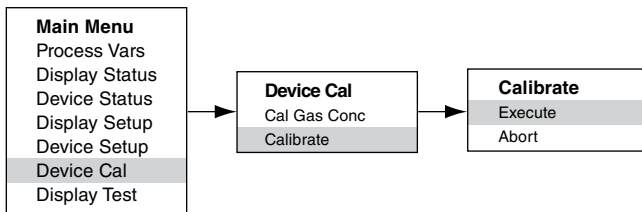
MENU HELP

*Status menus only allow the user to view the data.
The Setup menus allow the user to both view and edit the data.*

Calibration Procedure

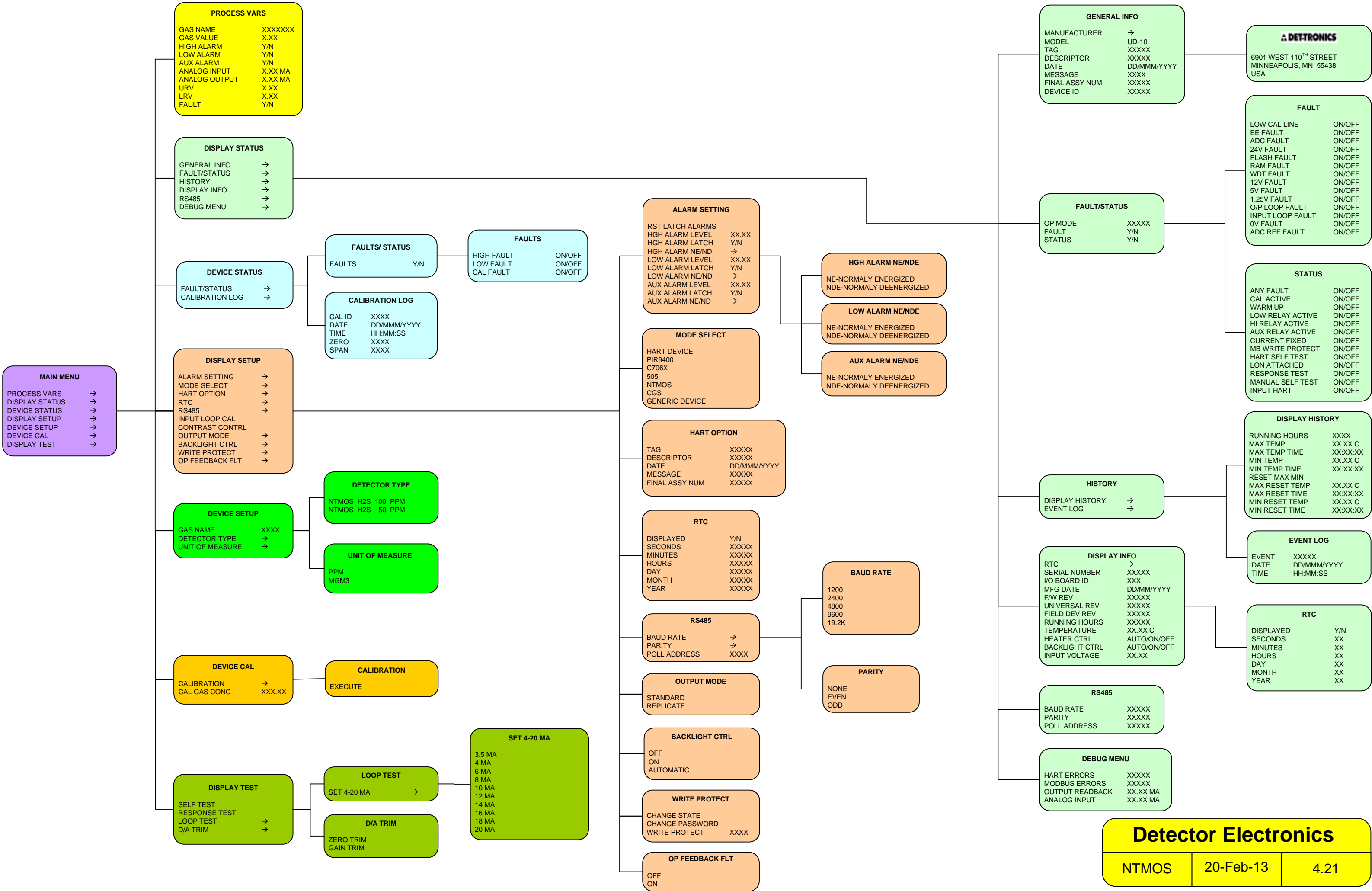
To calibrate the NTMOS detector with the FlexVu UD10 Display:

1. Touch the magnet to the ENTER/SELECT button to display the Main Menu. Follow the illustration below to navigate to the “Calibrate” menu.



2. Activate “Execute” (Enter/Select) to begin the zero calibration.
3. The UD10 will display “Waiting for Zero” on the main display screen.
4. When zero calibration is complete (approximately one minute), the UD10 will display “Waiting for Span” on the main display screen.

UD10 mA Output During Calibration (UD10 with NTMOS)		
UD10 Display Reading	Standard Mode	Replicate Mode
Waiting for Zero	3.8	2.2
Waiting for Gas	3.8	3.8
Waiting for Span	3.8	3.8
Remove Cal Gas	3.8	3.8
Back to Normal	4.0	4.0



MAIN MENU

- PROCESS VARS →
- DISPLAY STATUS →
- DEVICE STATUS →
- DISPLAY SETUP →
- DEVICE SETUP →
- DEVICE CAL →
- DISPLAY TEST →

PROCESS VARS

GAS NAME	XXXXXXX
GAS VALUE	X.XX
HIGH ALARM	Y/N
LOW ALARM	Y/N
AUX ALARM	Y/N
ANALOG INPUT	X.XX MA
ANALOG OUTPUT	X.XX MA
URV	X.XX
LRV	X.XX
FAULT	Y/N

DISPLAY STATUS

- GENERAL INFO →
- FAULT/STATUS →
- HISTORY →
- DISPLAY INFO →
- RS485 →
- DEBUG MENU →

DEVICE STATUS

- FAULT/STATUS →
- CALIBRATION LOG →

DISPLAY SETUP

- ALARM SETTING →
- MODE SELECT →
- HART OPTION →
- RTC →
- RS485 →
- INPUT LOOP CAL →
- CONTRAST CONTRL →
- OUTPUT MODE →
- BACKLIGHT CTRL →
- WRITE PROTECT →
- OP FEEDBACK FLT →

DEVICE SETUP

- GAS NAME → XXXX
- DETECTOR TYPE →
- UNIT OF MEASURE →

DEVICE CAL

- CALIBRATION → EXECUTE
- CAL GAS CONC → XXX.XX

DISPLAY TEST

- SELF TEST
- RESPONSE TEST →
- LOOP TEST →
- D/A TRIM →

FAULTS/ STATUS

FAULTS Y/N

CALIBRATION LOG

CAL ID	XXXX
DATE	DD/MMM/YYYY
TIME	HH:MM:SS
ZERO	XXXX
SPAN	XXXX

DETECTOR TYPE

- NTMOS H2S 100 PPM
- NTMOS H2S 50 PPM

UNIT OF MEASURE

- PPM
- MGM3

CALIBRATION

EXECUTE

LOOP TEST

SET 4-20 MA →

D/A TRIM

- ZERO TRIM
- GAIN TRIM

FAULTS

HIGH FAULT	ON/OFF
LOW FAULT	ON/OFF
CAL FAULT	ON/OFF

SET 4-20 MA

- 3.5 MA
- 4 MA
- 6 MA
- 8 MA
- 10 MA
- 12 MA
- 14 MA
- 16 MA
- 18 MA
- 20 MA

ALARM SETTING

RST LATCH ALARMS	XX.XX
HGH ALARM LEVEL	Y/N
HGH ALARM LATCH	→
HGH ALARM NE/ND	→
LOW ALARM LEVEL	XX.XX
LOW ALARM LATCH	Y/N
LOW ALARM NE/ND	→
AUX ALARM LEVEL	XX.XX
AUX ALARM LATCH	Y/N
AUX ALARM NE/ND	→

MODE SELECT

- HART DEVICE
- PIR9400
- C706X
- 505
- NTMOS
- CGS
- GENERIC DEVICE

HART OPTION

TAG	XXXXX
DESCRIPTOR	XXXXX
DATE	DD/MMM/YYYY
MESSAGE	XXXXX
FINAL ASSY NUM	XXXXX

RTC

DISPLAYED	Y/N
SECONDS	XXXXX
MINUTES	XXXXX
HOURS	XXXXX
DAY	XXXXX
MONTH	XXXXX
YEAR	XXXXX

RS485

- BAUD RATE →
- PARITY →
- POLL ADDRESS XXXX

OUTPUT MODE

- STANDARD
- REPLICATE

BACKLIGHT CTRL

- OFF
- ON
- AUTOMATIC

WRITE PROTECT

- CHANGE STATE
- CHANGE PASSWORD
- WRITE PROTECT XXXX

OP FEEDBACK FLT

- OFF
- ON

HGH ALARM NE/NDE

- NE-NORMALY ENERGIZED
- NDE-NORMALY DEENERGIZED

LOW ALARM NE/NDE

- NE-NORMALY ENERGIZED
- NDE-NORMALY DEENERGIZED

AUX ALARM NE/NDE

- NE-NORMALY ENERGIZED
- NDE-NORMALY DEENERGIZED

BAUD RATE

- 1200
- 2400
- 4800
- 9600
- 19.2K

PARITY

- NONE
- EVEN
- ODD

GENERAL INFO

MANUFACTURER	→
MODEL	UD-10
TAG	XXXXX
DESCRIPTOR	XXXXX
DATE	DD/MMM/YYYY
MESSAGE	XXXX
FINAL ASSY NUM	XXXXX
DEVICE ID	XXXXX

DET-TRONICS

6901 WEST 110TH STREET
MINNEAPOLIS, MN 55438
USA

FAULT/STATUS

OP MODE	XXXXX
FAULT	Y/N
STATUS	Y/N

FAULT

LOW CAL LINE	ON/OFF
EE FAULT	ON/OFF
ADC FAULT	ON/OFF
24V FAULT	ON/OFF
FLASH FAULT	ON/OFF
RAM FAULT	ON/OFF
WDT FAULT	ON/OFF
12V FAULT	ON/OFF
5V FAULT	ON/OFF
1.25V FAULT	ON/OFF
O/P LOOP FAULT	ON/OFF
INPUT LOOP FAULT	ON/OFF
0V FAULT	ON/OFF
ADC REF FAULT	ON/OFF

STATUS

ANY FAULT	ON/OFF
CAL ACTIVE	ON/OFF
WARM UP	ON/OFF
LOW RELAY ACTIVE	ON/OFF
HI RELAY ACTIVE	ON/OFF
AUX RELAY ACTIVE	ON/OFF
CURRENT FIXED	ON/OFF
MB WRITE PROTECT	ON/OFF
HART SELF TEST	ON/OFF
LON ATTACHED	ON/OFF
RESPONSE TEST	ON/OFF
MANUAL SELF TEST	ON/OFF
INPUT HART	ON/OFF

HISTORY

- DISPLAY HISTORY →
- EVENT LOG →

DISPLAY HISTORY

RUNNING HOURS	XXXX
MAX TEMP	XX.XX C
MAX TEMP TIME	XX:XX:XX
MIN TEMP	XX.XX C
MIN TEMP TIME	XX:XX:XX
RESET MAX MIN	XX.XX C
MAX RESET TEMP	XX:XX:XX
MIN RESET TEMP	XX.XX C
MIN RESET TIME	XX:XX:XX

DISPLAY INFO

- RTC →
- SERIAL NUMBER XXXXX
- I/O BOARD ID XXX
- MFG DATE DD/MM/YYYY
- F/W REV XXXXX
- UNIVERSAL REV XXXXX
- FIELD DEV REV XXXXX
- RUNNING HOURS XXXXX
- TEMPERATURE XX.XX C
- HEATER CTRL AUTO/ON/OFF
- BACKLIGHT CTRL AUTO/ON/OFF
- INPUT VOLTAGE XX.XX

EVENT LOG

EVENT	XXXXX
DATE	DD/MMM/YYYY
TIME	HH:MM:SS

RS485

- BAUD RATE XXXXX
- PARITY XXXXX
- POLL ADDRESS XXXXX

RTC

DISPLAYED	Y/N
SECONDS	XX
MINUTES	XX
HOURS	XX
DAY	XX
MONTH	XX
YEAR	XX

DEBUG MENU

HART ERRORS	XXXXX
MODBUS ERRORS	XXXXX
OUTPUT READBACK	XX.XX MA
ANALOG INPUT	XX.XX MA

Detector Electronics

NTMOS	20-Feb-13	4.21
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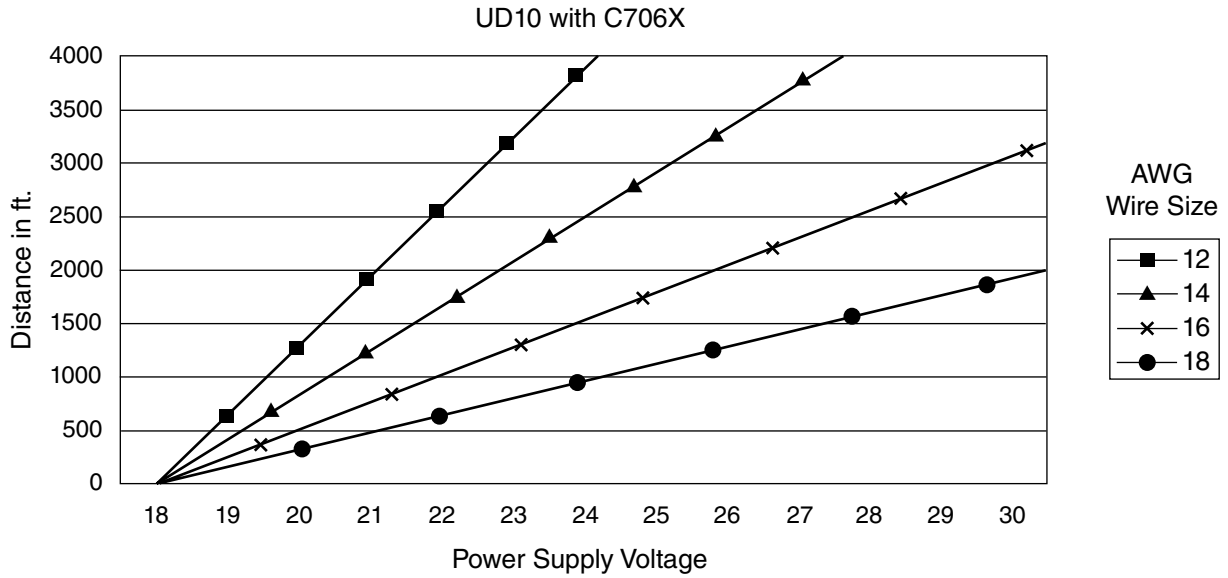
APPENDIX L

UD10 with C706X TOXIC GAS SENSOR

NOTE

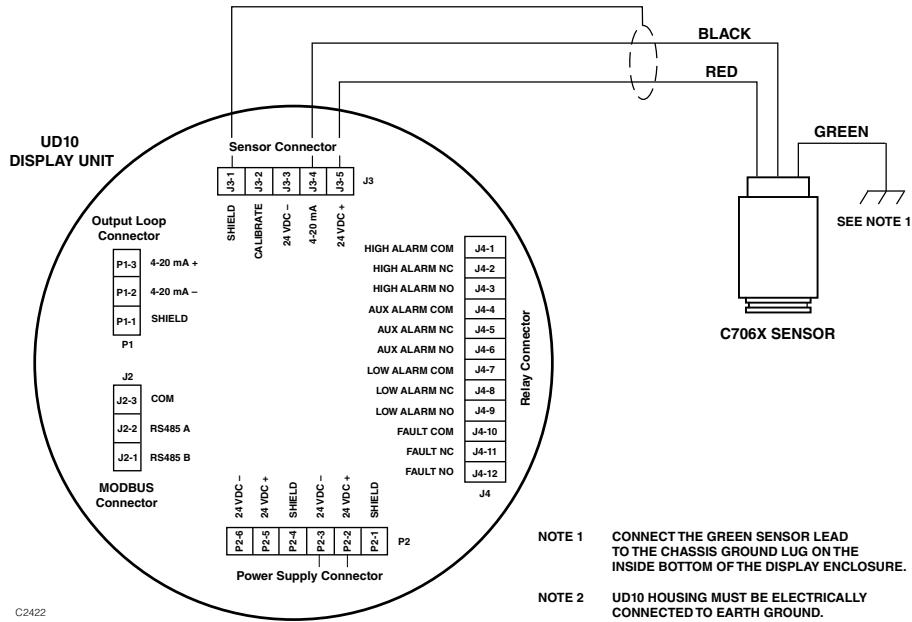
For complete information regarding the C7064E H2S Gas Sensor, refer to instruction manual 95-8396.
For the C7067E Chlorine Gas Sensor, refer to instruction manual 95-8439.

WIRING

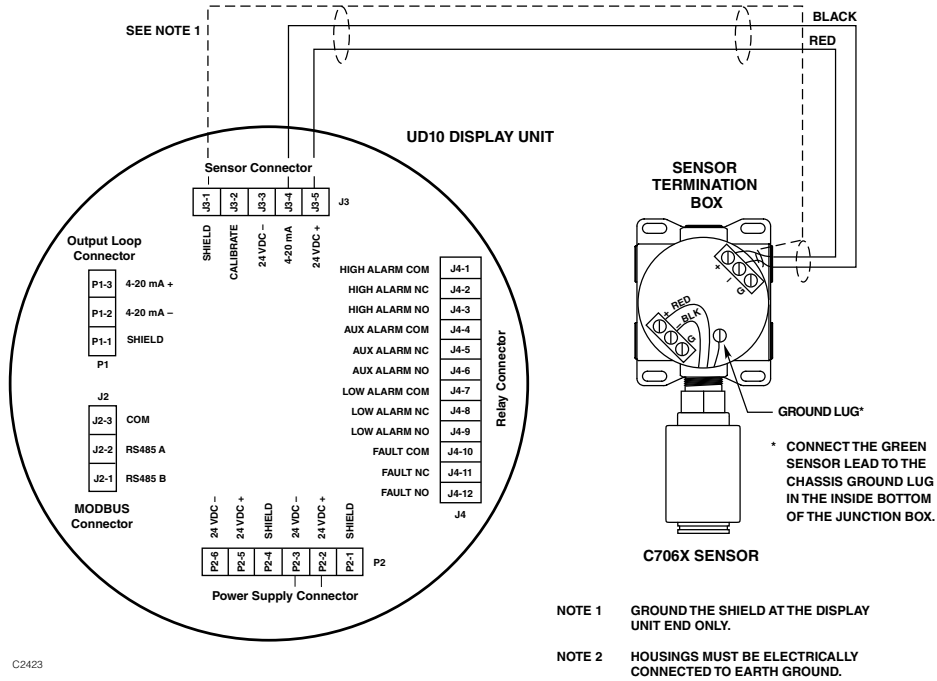


Notes: Maximum cable length from power source to UD10 is 2000 feet.
Maximum cable length from UD10 to sensor/STB termination box is 2000 feet.

Model C7065E oxygen sensor is not supported.



C706X Sensor Wired Directly to UD10



UD10 Wired to C706X Sensor with STB Termination Box

INSTALLATION

WIRING REQUIREMENTS

The simplest installation involves installing the sensor into one of the UD10 openings and connecting the wiring directly to the UD10. If the installation requires separation of the C706X sensor and the UD10 Display, the sensor can be connected to a STB sensor termination box, and the C706X/STB combination wired to the UD10. In this case, shielded cable is recommended to help protect against interference caused by extraneous electrical "noise." In applications where the cable is installed in conduit, the conduit should not be used for wiring to other electrical equipment whenever possible. If other equipment power wiring is run in the same conduit, the cabling **must** be shielded. The maximum allowable distance between the C706X sensor and UD10 Display Unit is limited by the resistance of the cabling used.

INSTALLATION AND WIRING PROCEDURE

1. Determine the best mounting locations for the detectors.
2. Install the C706X sensor within the proper opening in the UD10 or STB junction box. Mount the UD10/C706X with the sensor oriented vertically and the opening pointing down. The UD10 should be electrically connected to earth ground.

NOTE

The electrochemical sensor cell does not need to be installed within the C706X housing while installing and wiring the detector/junction box. It is recommended to keep the sensor in the manufacturer's sealed shipping bag in a cool storage environment until actual power-up and calibration commissioning is performed. This will ensure that the sensor will provide maximum longevity.

3. Terminate all three C706X conductors at the proper terminals. Refer to the appropriate illustration for details.
4. Double check that all wiring is the proper size and type and has been installed correctly. Check operating voltage at the C706X sensor and the UD10 Display Unit.

NOTE

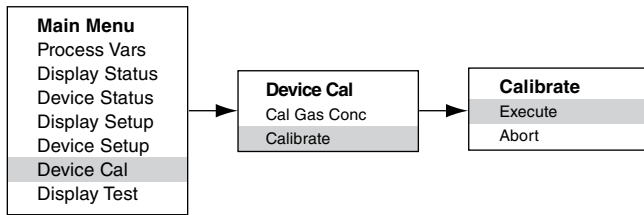
Do not apply power to the system with the junction box cover removed unless the area has been de-classified.

5. Proceed with startup and calibration.

CALIBRATION

To initiate calibration of the C706X sensor from the UD10 Display:

1. Using the magnet to activate the switches on the UD10 display, navigate to the "Calibrate" menu.



2. Activate "Execute" (Enter/Select) to start calibration.
3. The UD10 will display "Waiting for Zero" on the main display screen as it performs zero calibration.
4. When zero calibration is complete, the UD10 will display "Waiting for Gas" on the screen.
5. Apply calibration gas to the sensor.
6. The UD10 will display "Waiting for Span" on the screen while the span calibration is being performed.
7. When the UD10 displays "Remove Cal Gas" on the screen, remove the calibration gas from the sensor.
8. When calibration is complete, "Remove Cal Gas" is no longer displayed on the screen and the UD10 automatically returns to the normal operating mode.

MENU STRUCTURE

UD10 with C706X Series Sensor

Refer to the following menu when using the UD10's LCD display and internal magnetic switches.

When connecting a HART Communicator to the UD10's 4-20 mA output, refer to the "UD10 HART" menu in Appendix E.

MENU HELP

*Status menus only allow the user to view the data.
The Setup menus allow the user to both view and edit the data.*

MAIN MENU

- PROCESS VARS →
- DISPLAY STATUS →
- DEVICE STATUS →
- DISPLAY SETUP →
- DEVICE CAL →
- DISPLAY TEST →

PROCESS VARS

GAS NAME	XXXXXX
GAS VALUE	X.XX
HIGH ALARM	Y/N
LOW ALARM	Y/N
AUX ALARM	Y/N
ANALOG INPUT	X.XX MA
ANALOG OUTPUT	X.XX MA
URV	X.XX
LRV	X.XX
FAULT	Y/N

DISPLAY STATUS

- GENERAL INFO →
- FAULT/STATUS →
- HISTORY →
- DISPLAY INFO →
- RS485 →
- DEBUG MENU →

DEVICE STATUS

- FAULT/STATUS →
- CALIBRATION LOG →

DISPLAY SETUP

- ALARM SETTING →
- MODE SELECT →
- HART OPTION →
- RTC →
- RS485 →
- INPUT LOOP CAL →
- CONTRAST CONTRL →
- OUTPUT MODE →
- BACKLIGHT CTRL →
- WRITE PROTECT →
- OP FEEDBACK FLT →

DEVICE SETUP

- GAS NAME XXXX
- DETECTOR TYPE →

FAULT/STATUS

FAULTS Y/N

FAULTS

HIGH FAULT	ON/OFF
ZERO DRIFT FAULT	ON/OFF
CAL FAULT	ON/OFF

CALIBRATION LOG

CAL ID	XXXX
DATE	DD/MMM/YYYY
TIME	HH:MM:SS
ZERO	XXXX
SPAN	XXXX

DETECTOR TYPE

C7064	H2S	20	PPM
C7064	H2S	50	PPM
C7064	H2S	100	PPM
C7067	CL2	10	PPM
C7066	CO	100	PPM
C7066	CO	500	PPM
C7066	CO	1000	PPM
C7068	SO2	100	PPM
C7069	NO2	20	PPM

DEVICE CAL

- CALIBRATION →
- CAL GAS CONC XXX.XX

CALIBRATION

- EXECUTE
- ABORT

DISPLAY TEST

- SELF TEST
- RESPONSE TEST
- LOOP TEST →
- D/A TRIM →

LOOP TEST

- SET 4-20 MA →

D/A TRIM

- ZERO TRIM
- GAIN TRIM

SET 4-20 MA

- 3.5 MA
- 4 MA
- 6 MA
- 8 MA
- 10 MA
- 12 MA
- 14 MA
- 16 MA
- 18 MA
- 20 MA

ALARM SETTING

RST LATCH ALARMS	→
HGH ALARM LEVEL	XX.XX
HGH ALARM LATCH	Y/N
HGH ALARM NE/ND	→
LOW ALARM LEVEL	XX.XX
LOW ALARM LATCH	Y/N
LOW ALARM NE/ND	→
AUX ALARM LEVEL	XX.XX
AUX ALARM LATCH	Y/N
AUX ALARM NE/ND	→

HIGH ALARM NE/NDE

- NE-NORMALY ENERGIZED
- NDE-NORMALY DEENERGIZED

LOW ALARM NE/NDE

- NE-NORMALY ENERGIZED
- NDE-NORMALY DEENERGIZED

AUX ALARM NE/NDE

- NE-NORMALY ENERGIZED
- NDE-NORMALY DEENERGIZED

MODE SELECT

- HART DEVICE
- PIR9400
- C706X
- 505
- NTMOS
- CGS
- GENERIC DEVICE

HART OPTION

TAG	XXXXX
DESCRIPTOR	XXXXX
DATE	DD/MMM/YYYY
MESSAGE	XXXXX
FINAL ASSY NUM	XXXXX

RTC

DISPLAYED	Y/N
SECONDS	XX
MINUTES	XX
HOURS	XX
DAY	XX
MONTH	XX
YEAR	XX

RS485

- BAUD RATE →
- PARITY →
- POLL ADDRESS XXXX

BAUD RATE

- 1200
- 2400
- 4800
- 9600
- 19.2K

PARITY

- NONE
- EVEN
- ODD

OUTPUT MODE

- STANDARD
- REPLICATE

BACKLIGHT CTRL

- OFF
- ON
- AUTOMATIC

WRITE PROTECT

- CHANGE STATE
- CHANGE PASSWORD
- WRITE PROTECT XXXX

OP FEEDBACK FLT

- OFF
- ON

GENERAL INFO

MANUFACTURER	→
MODEL	UD-10
TAG	XXXXX
DESCRIPTOR	XXXXX
DATE	DD/MMM/YYYY
MESSAGE	XXXXX
FINAL ASSY NUM	XXXXX
DEVICE ID	XXXXX

DET-TRONICS

6901 WEST 110TH STREET
MINNEAPOLIS, MN 55438
USA

FAULT/STATUS

OP MODE	XXXXX
FAULT	Y/N
STATUS	Y/N

FAULT

LOW CAL LINE	ON/OFF
EE FAULT	ON/OFF
ADC FAULT	ON/OFF
24V FAULT	ON/OFF
FLASH FAULT	ON/OFF
RAM FAULT	ON/OFF
WDT FAULT	ON/OFF
12V FAULT	ON/OFF
5V FAULT	ON/OFF
1.25V FAULT	ON/OFF
O/P LOOP FAULT	ON/OFF
INPUT LOOP FAULT	ON/OFF
0V FAULT	ON/OFF
ADC REF FAULT	ON/OFF

STATUS

ANY FAULT	ON/OFF
CAL ACTIVE	ON/OFF
WARM UP	ON/OFF
LOW RELAY ACTIVE	ON/OFF
HI RELAY ACTIVE	ON/OFF
AUX RELAY ACTIVE	ON/OFF
CURRENT FIXED	ON/OFF
MB WRITE PROTECT	ON/OFF
HART SELF TEST	ON/OFF
LON ATTACHED	ON/OFF
RESPONSE TEST	ON/OFF
MANUAL SELF TEST	ON/OFF
INPUT HART	ON/OFF

HISTORY

- DISPLAY HISTORY →
- EVENT LOG →

DISPLAY HISTORY

RUNNING HOURS	XXXX
MAX TEMP	XX.XX C
MAX TEMP TIME	XX:XX:XX
MIN TEMP	XX.XX C
MIN TEMP TIME	XX:XX:XX
RESET MAX MIN	→
MAX RESET TEMP	XX.XX C
MAX RESET TIME	XX:XX:XX
MIN RESET TEMP	XX.XX C
MIN RESET TIME	XX:XX:XX

EVENT LOG

EVENT	XXXXX
DATE	DD/MMM/YYYY
TIME	HH:MM:SS

DISPLAY INFO

RTC	→
SERIAL NUMBER	XXXXX
I/O BOARD ID	XXX
MFG DATE	DD/MM/YYYY
F/W REV	XXXXX
UNIVERSAL REV	XXXXX
FIELD DEV REV	XXXXX
RUNNING HOURS	XXXXX
TEMPERATURE	XX.XX C
HEATER CTRL	AUTO/ON/OFF
BACKLIGHT CTRL	AUTO/ON/OFF
INPUT VOLTAGE	XX.XX

RTC

DISPLAYED	Y/N
SECONDS	XX
MINUTES	XX
HOURS	XX
DAY	XX
MONTH	XX
YEAR	XX

RS485

BAUD RATE	XXXXX
PARITY	XXXXX
POLL ADDRESS	XXXXX

DEBUG MENU

HART ERRORS	XXXXX
MODBUS ERRORS	XXXXX
OUTPUT READBACK	XX.XX MA
ANALOG INPUT	XX.XX MA

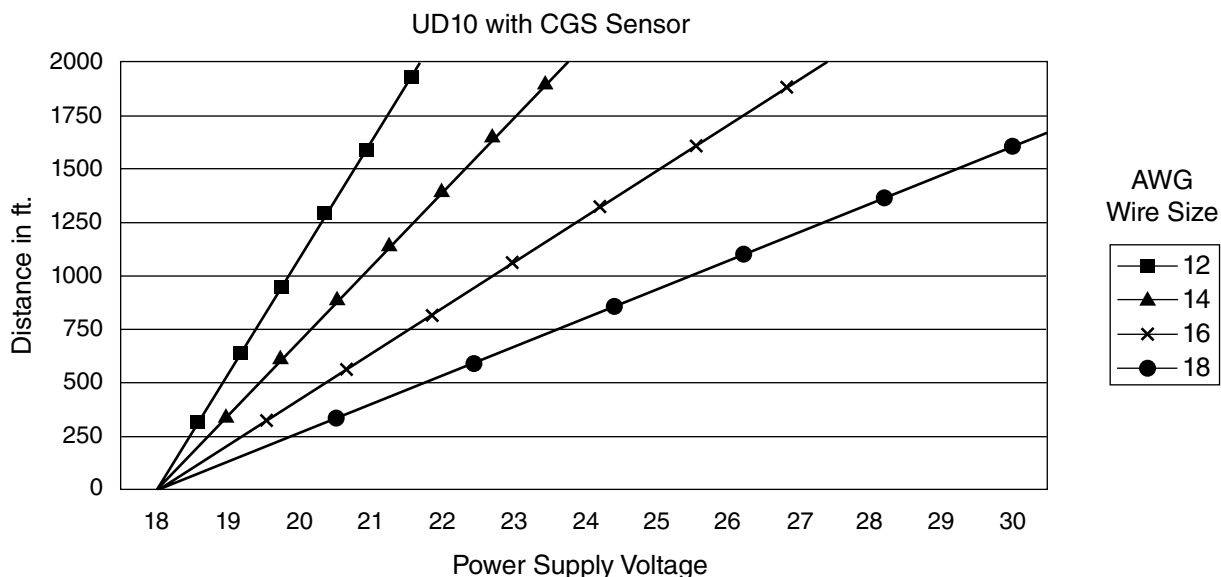
Detector Electronics

C706X	20-Feb-13	4.21
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APPENDIX M

UD10 with MODEL CGS COMBUSTIBLE GAS SENSOR

WIRING



Notes: Maximum cable length from power source to UD10 is 2000 feet.
Maximum cable length from UD10 to CGS sensor is 500 feet
(using 16 AWG cable minimum).

IMPORTANT NOTES

NOTE

The UD10 with CGS Interface option and CGS sensor is certified as a "Gas Detector" and performance approved to standards FM6310/6320, ATEX 60079-29-1, and IEC 60079-29-1.

NOTE

Only Constant Current type CGS sensors may be used with the UD10.

CAUTION

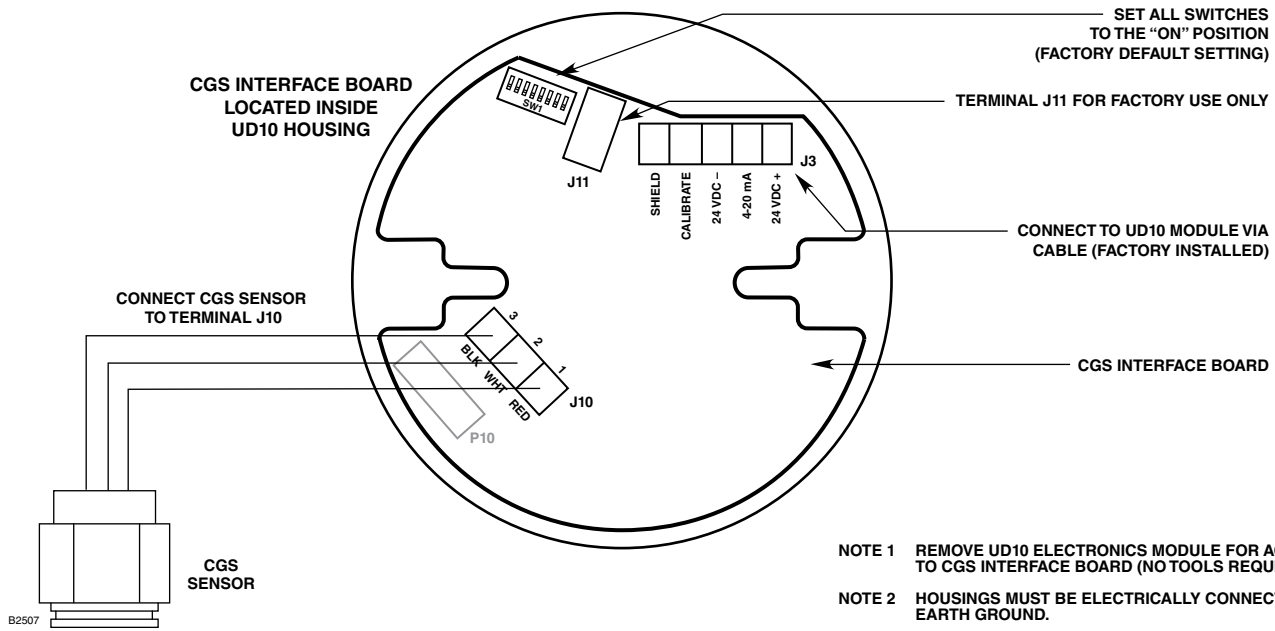
The sintered metal flame arrestor is an integral part of the combustible gas sensor. DO NOT operate the gas detector if the flame arrestor is damaged or missing, since the exposed element is a potential ignition source.

CAUTION

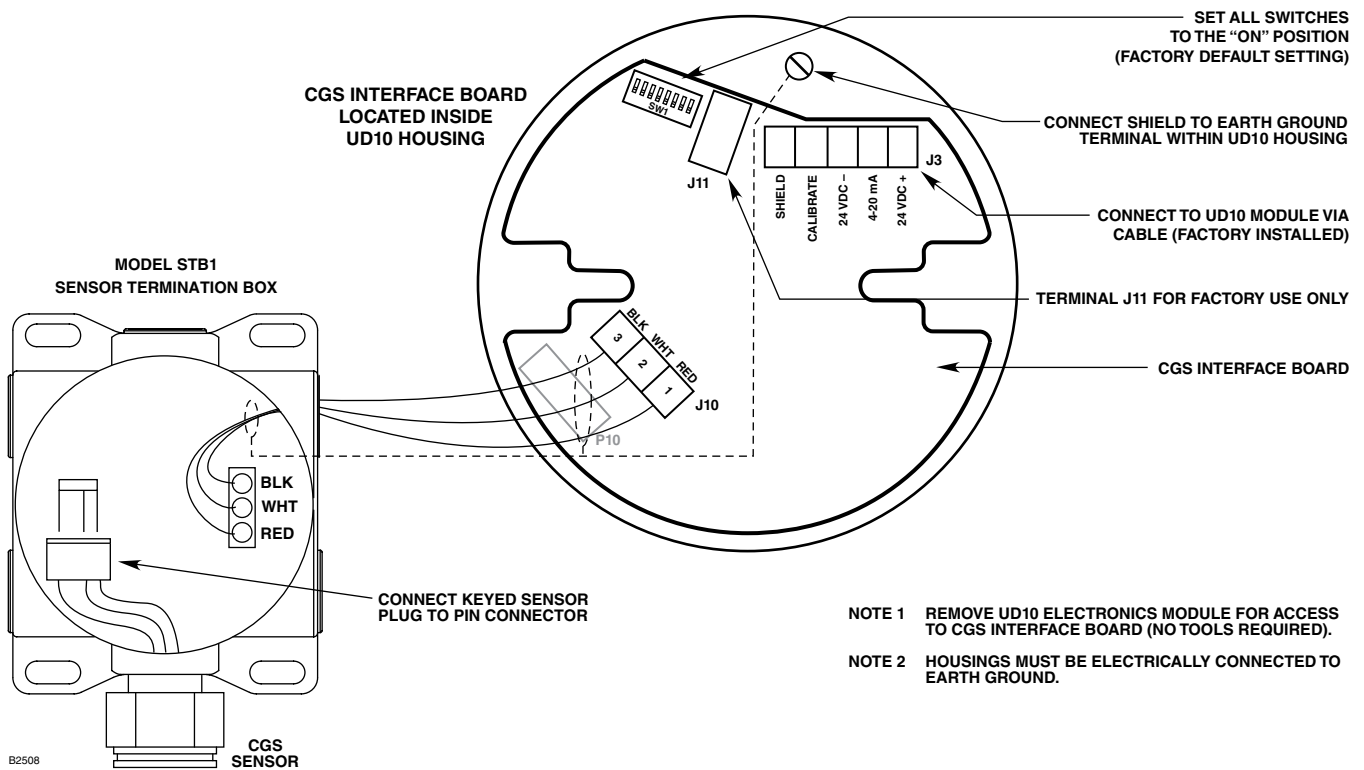
Silicone based lubricants must never be used on or near the CGS sensor, since this can result in irreversible damage to the sensing element.

CAUTION

When used as a stand alone device, the high alarm must always be programmed for latching operation. When used in conjunction with a Control Unit and configured for a non-latching high alarm, the control unit must always latch and require a deliberate manual action to clear a high gas alarm.



CGS Sensor Wired Directly to UD10



UD10 Wired to CGS Sensor with STB Termination Box

INSTALLATION

WIRING REQUIREMENTS

The simplest installation involves installing the sensor into one of the UD10 openings and connecting the wiring directly to the CGS interface board.

Sensor Separation

If the installation requires separation of the CGS sensor and the UD10 Display, the sensor can be connected to a model STB1 sensor termination box, and the CGS/STB combination wired to the UD10.

In this case, shielded cable is recommended to help protect against interference caused by extraneous electrical “noise.”

In applications where the cable is installed in conduit, the conduit should not be used for wiring to other electrical equipment whenever possible. If other equipment power wiring is run in the same conduit, the cabling **must** be shielded.

The maximum allowable distance between the CGS sensor and UD10 Display Unit is 500 feet, with connecting cable 16 AWG minimum.

INSTALLATION AND WIRING PROCEDURE

1. Determine the best mounting locations for the detectors.
2. Install the CGS sensor within the proper opening in the UD10 or STB junction box. Mount the device with the sensor oriented vertically and the opening pointing down. All junction boxes should be electrically connected to earth ground.
3. Terminate all wiring at the proper terminals. Refer to the appropriate illustration for details.
4. Double check that all wiring is the proper size and type and has been installed correctly. Check for correct operating voltage at the device.

NOTE

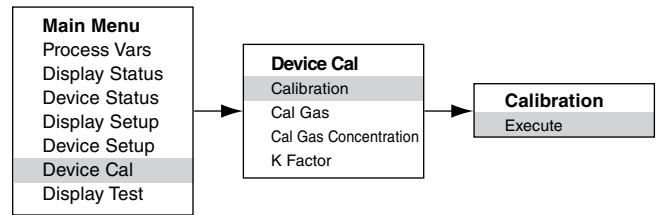
Do not apply power to the system with the junction box cover removed unless the area has been de-classified.

5. Proceed with startup and calibration.

CALIBRATION

To initiate calibration of the CGS sensor from the UD10 Display:

1. Using the magnet to activate the switches on the UD10 display, navigate to the “Calibrate” menu.



2. Activate “Execute” (Enter/Select) to start calibration.
3. The UD10 will display “Waiting for Zero” on the main display screen as it performs zero calibration.
4. When zero calibration is complete, the UD10 will display “Waiting for Gas” on the screen.
5. Apply calibration gas to the sensor.
6. The UD10 will display “Waiting for Span” on the screen while the span calibration is being performed.
7. When the UD10 shows “Remove Cal Gas” on the screen, remove the calibration gas from the sensor.
8. The UD10 automatically exits the Calibrate mode and returns to normal operating mode upon completion of a successful calibration.

UD10 mA Output During Calibration (UD10 with CGS)		
UD10 Display Reading	Standard Mode	Replicate Mode
Apply Zero Gas	3.8	2.2
Waiting for Gas	3.8	3.8
Waiting for Span	3.8	3.8
Remove Cal Gas	3.8	3.8
Back to Normal	4.0	4.0

Determining Sensor Life Remaining

At the time of calibration, the UD10 logs the sensor mV signal. This value can be used for determining the approximate sensor life remaining.

To view all the recorded mV signal values for the sensor, from the Main Menu, navigate to:

Device Status > Calibration Log > Span.

To view the mV signal from the most recent calibration only, from the Main Menu, navigate to:

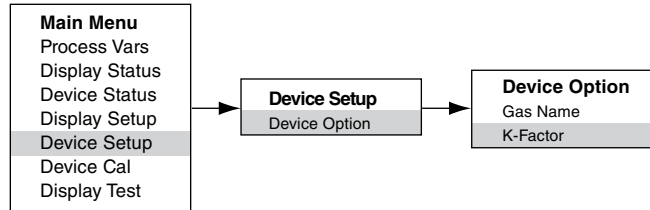
Device Status > Device Info > Response.

A typical new sensor reads between 45 and 55 mV.

- At 21-55 mV, "Cal OK" is recorded in the Cal Log, along with the Span value.
- At 15-20 mV, "Cal OK" is recorded in the Cal Log, along with the Span value. In addition, "Weak Sensor" is shown on the UD10 display for about 20 seconds. After 20 seconds, the "Weak Sensor" message is no longer seen, but a "Weak Sensor" status is recorded (Device Status > Fault/Status > Status).
- At 14 mV or less, "Weak Sensor" is shown on the UD10 display for about 20 seconds, then a Cal Fault is shown. The Cal Log shows "Cal Fail" with a Span value of 0.00 mV.

K FACTOR

If the system will be detecting a gas/vapor other than the gas used in the actual calibration process, a conversion K-Factor must be used. The K-Factor can be entered prior to calibration by navigating to the "Device Option" menu, then selecting "K-Factor". Enter the desired K-Factor and activate the "Enter" button. The new K-Factor will be applied when the sensor is calibrated.



The UD10 communicates the K-Factor to the CGS Interface Board during the calibration process, where the proper correction is made to ensure accurate calibration.

The actual effect of the K-Factor can be observed as the span portion of the calibration is completed. For example, suppose a K-Factor of 0.865 has been programmed. When calibration is performed, the UD10 will display 50% as span is accepted. It will then apply the K-Factor, and the displayed value will change to 43.3% LFL.

For additional information regarding K-Factors, including a list of K-Factors for many common gases, refer to Technical Bulletin number 76-1017.

MENU STRUCTURE

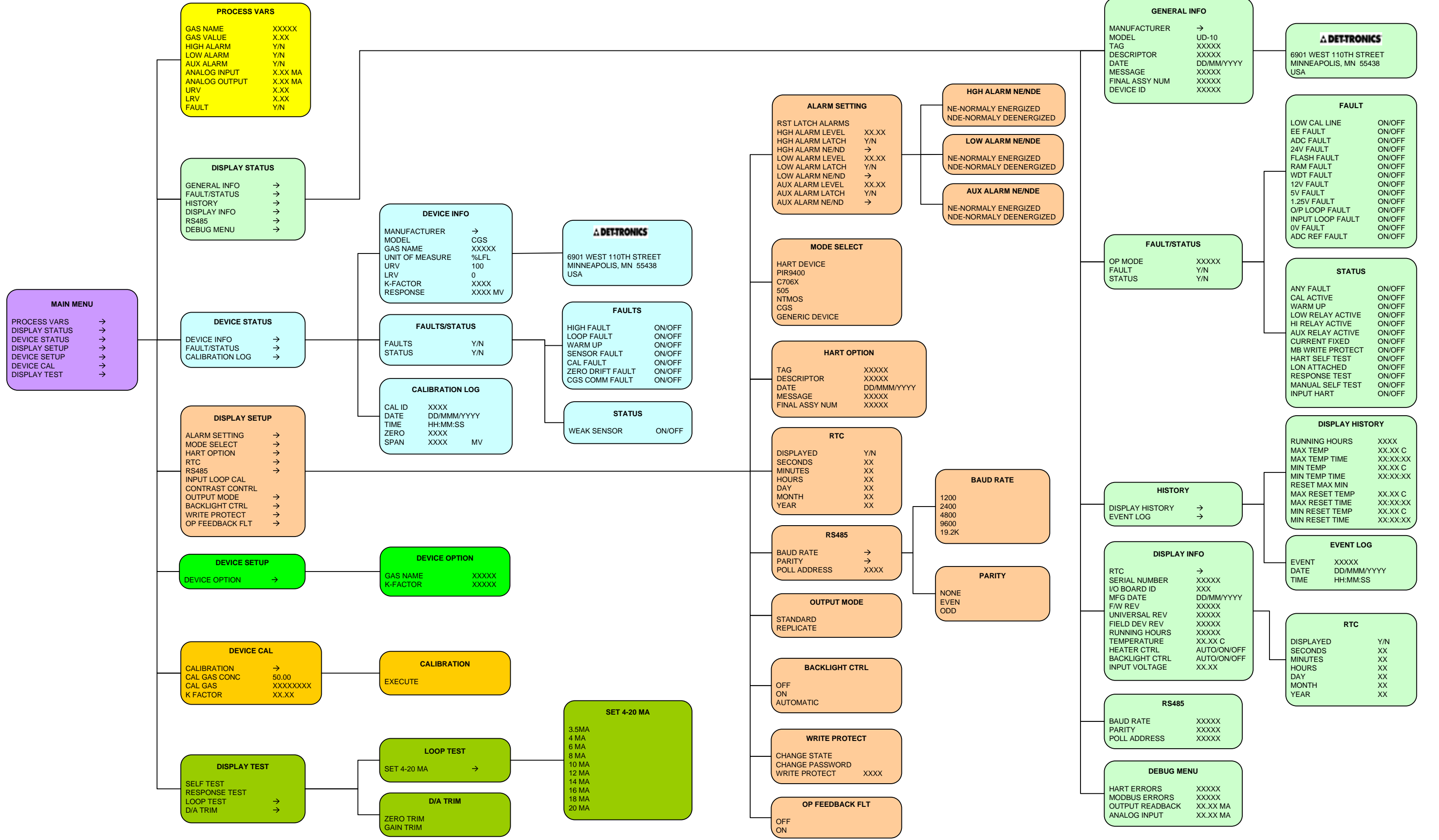
UD10 with CGS Series Sensor

Refer to the following menu when using the UD10's LCD display and internal magnetic switches.

When connecting a HART Communicator to the UD10's 4-20 mA output, refer to the "UD10 HART" menu in Appendix E.

MENU HELP

*Status menus only allow the user to view the data.
The Setup menus allow the user to both view and edit the data.*



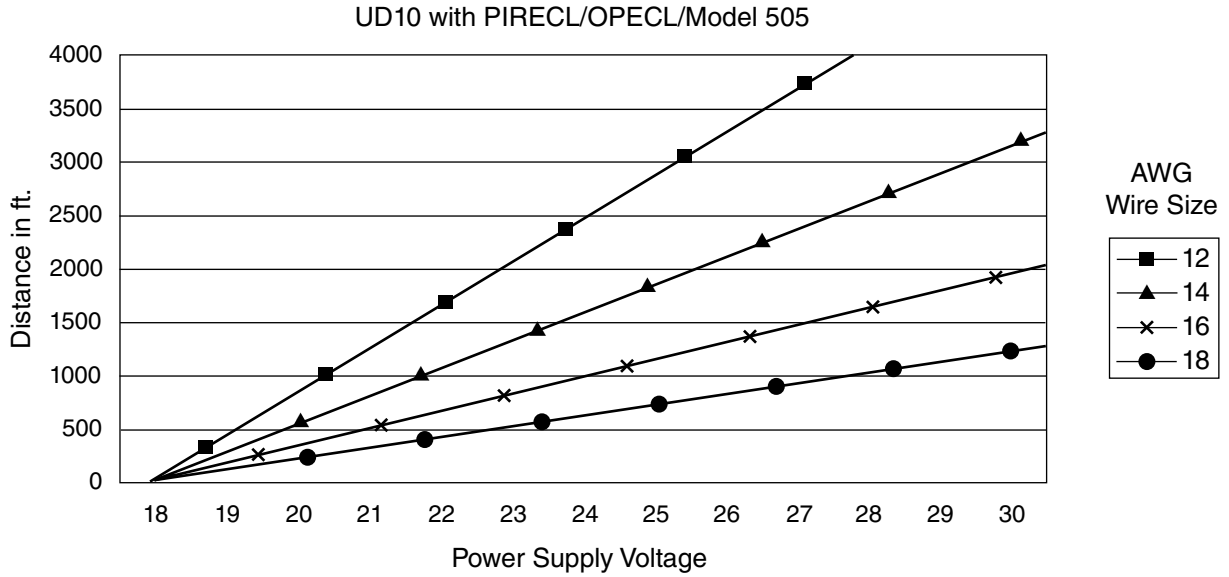
APPENDIX N

UD10 with MODEL 505 TRANSMITTER / CGS SENSOR

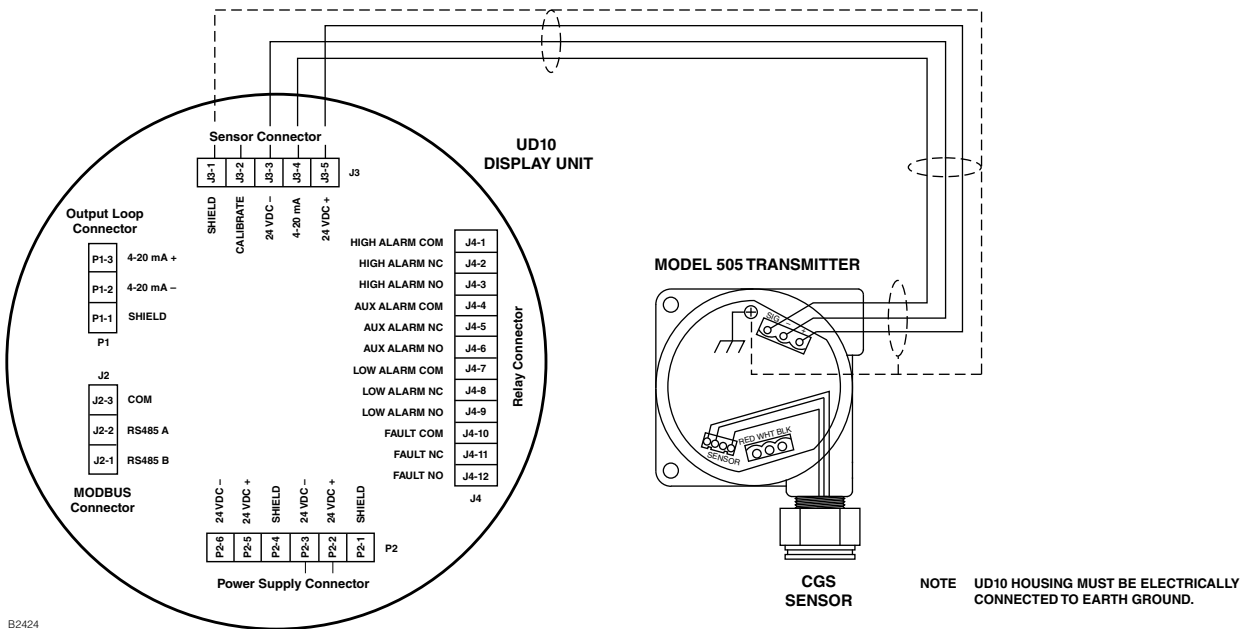
NOTE

For complete information regarding the Model 505 Transmitter, refer to instruction manual 95-8472.

WIRING

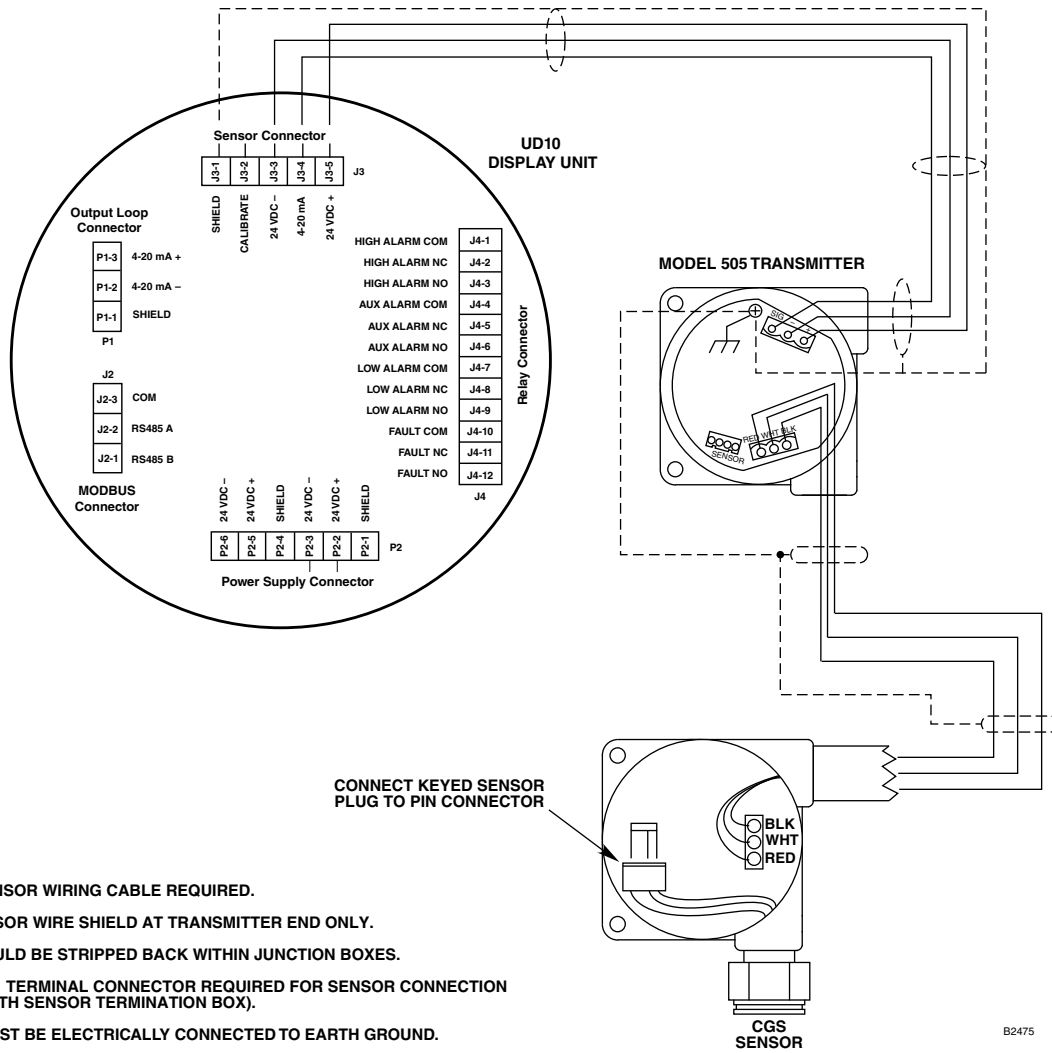


Notes: Maximum cable length from power source to UD10 is 2000 feet.
Maximum cable length from UD10 to sensor/STB termination box is 2000 feet.



B2424

UD10 Wired to Model 505 Transmitter/CGS Sensor



UD10 Wired to Model 505 Transmitter/CGS Sensor Using Sensor Separation Termination Box

INSTALLATION

Refer to the Model 505 Instruction Manual (number 95-8472) for complete information regarding proper installation of the Model 505 with combustible gas sensor.

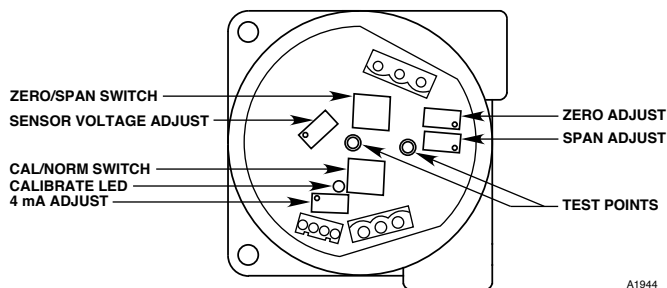
ORIENTATION

The Model 505/CGS must be mounted with the CGS sensor opening pointing down.

CALIBRATION

Model 505

The Model 505/CGS must be calibrated when the system is commissioned as well as when the CGS sensor is replaced. Calibration is performed at the Model 505 using the following procedure. Calibration at the UD10 is not supported.



A1944

WARNING		
<i>Before removing the junction box cover, verify that no dangerous levels of gas are present.</i>		
Step	Switch Position	Operator Action
1	CAL/NORM switch in the CAL position.	<ol style="list-style-type: none"> 1. LED turns on. 2. Connect a digital voltmeter to the transmitter test jacks. 3. Set the meter range to 2 Vdc.
2	ZERO/SPAN switch in the ZERO position.	<ol style="list-style-type: none"> 1. Adjust the ZERO potentiometer to read 0.000 Vdc on the voltmeter. See Note 3 below.
3	ZERO/SPAN switch in the SPAN position.	<ol style="list-style-type: none"> 1. Adjust the 4 mA potentiometer to read 0.167 Vdc on the voltmeter. 2. Apply the 50% LFL calibration gas to the sensor. When the output has stabilized, adjust the SPAN potentiometer for a reading of 0.500 on the voltmeter.
4	ZERO/SPAN switch in the ZERO position.	<ol style="list-style-type: none"> 1. Sensitivity test. The meter must read greater than 0.015 Vdc. See Note 4 below. 2. Remove the calibration gas. 3. When the meter reads 0.002 Vdc or less, remove the test probes.
5	CAL/NORM switch in NORM position.	<ol style="list-style-type: none"> 1. The LED turns off. 2. The calibration is complete. 3. Replace the junction box cover.

NOTES:

1. When the CAL/NORM switch is in the CAL position, the yellow LED turns on and the 4-20 mA output signal goes to 3.4 mA.
2. The voltmeter must be suitable for use in a hazardous location.
3. If the possibility of background gases exists, purge the sensor with clean air prior to the zero adjustment to assure accurate calibration.
4. A typical sensitivity reading with 50% LFL gas applied to the sensor is 35 to 50 millivolts for a new sensor. Sensor replacement is recommended when the sensitivity reading is less than 15 millivolts.
5. If a dust cover or splash shield is used, inspect it to be sure that it is not dirty or plugged. A plugged dust cover can restrict the flow of gas to the sensing element, seriously reducing its effectiveness. For optimum performance, sensor covers/filters should be replaced frequently to ensure that they are not degraded or plugged.

MENU STRUCTURE

UD10 with Model 505 / CGS Sensor

Refer to the following menu when using the UD10's LCD display and internal magnetic switches.

When connecting a HART Communicator to the UD10's 4-20 mA output, refer to the "UD10 HART" menu in Appendix E.

MENU HELP

Status menus only allow the user to view the data.

The Setup menus allow the user to both view and edit the data.

MAIN MENU

- PROCESS VARS →
- DISPLAY STATUS →
- DEVICE STATUS →
- DISPLAY SETUP →
- DEVICE CAL →
- DISPLAY TEST →

PROCESS VARS

GAS NAME	XXXXXX
GAS VALUE	X.XX
HIGH ALARM	Y/N
LOW ALARM	Y/N
AUX ALARM	Y/N
ANALOG INPUT	X.XX MA
ANALOG OUTPUT	X.XX MA
URV	X.XX
LRV	X.XX
FAULT	Y/N

DISPLAY STATUS

- GENERAL INFO →
- FAULT/STATUS →
- HISTORY →
- DISPLAY INFO →
- RS485 →
- DEBUG MENU →

DEVICE STATUS

- FAULT/STATUS →
- CALIBRATION LOG →

DISPLAY SETUP

- ALARM SETTING →
- MODE SELECT →
- HART OPTION →
- RTC →
- RS485 →
- INPUT LOOP CAL →
- CONTRAST CONTRL →
- OUTPUT MODE →
- BACKLIGHT CTRL →
- WRITE PROTECT →
- OP FEEDBACK FLT →

DEVICE SETUP

GAS NAME	XXXX
DETECTOR TYPE	→

DETECTOR TYPE

505 CH4 100 %LFL

DEVICE CAL

CALIBRATION	→
CAL GAS CONC	XXX.XX

CALIBRATION

EXECUTE
ABORT

DISPLAY TEST

- SELF TEST →
- RESPONSE TEST →
- LOOP TEST →
- D/A TRIM →

LOOP TEST

SET 4-20 MA →

D/A TRIM

ZERO TRIM
GAIN TRIM

SET 4-20 MA

3.5 MA
4 MA
6 MA
8 MA
10 MA
12 MA
14 MA
16 MA
18 MA
20 MA

FAULTS/ STATUS

FAULTS Y/N

FAULTS

HIGH FAULT ON/OFF
LOW FAULT ON/OFF

CALIBRATION LOG

CAL ID	XXXX
DATE	DD/MMM/YYYY
TIME	HH:MM:SS
ZERO	XXXX
SPAN	XXXX

ALARM SETTING

RST LATCH ALARMS	
HGH ALARM LEVEL	XX.XX
HGH ALARM LATCH	Y/N
HGH ALARM NE/ND	→
LOW ALARM LEVEL	XX.XX
LOW ALARM LATCH	Y/N
LOW ALARM NE/ND	→
AUX ALARM LEVEL	XX.XX
AUX ALARM LATCH	Y/N
AUX ALARM NE/ND	→

HGH ALARM NE/NDE

NE-NORMALY ENERGIZED
NDE-NORMALY DEENERGIZED

LOW ALARM NE/NDE

NE-NORMALY ENERGIZED
NDE-NORMALY DEENERGIZED

AUX ALARM NE/NDE

NE-NORMALY ENERGIZED
NDE-NORMALY DEENERGIZED

MODE SELECT

HART DEVICE
PIR9400
C706X
505
NTMOS
CGS
GENERIC DEVICE

HART OPTION

TAG	XXXXX
DESCRIPTOR	XXXXX
DATE	DD/MMM/YYYY
MESSAGE	XXXXX
FINAL ASSY NUM	XXXXX

RTC

DISPLAYED	Y/N
SECONDS	XX
MINUTES	XX
HOURS	XX
DAY	XX
MONTH	XX
YEAR	XX

BAUD RATE

1200
2400
4800
9600
19.2K

PARITY

NONE
EVEN
ODD

RS485

BAUD RATE	→
PARITY	→
POLL ADDRESS	XXXX

OUTPUT MODE

STANDARD
REPLICATE

BACKLIGHT CTRL

OFF
ON
AUTOMATIC

WRITE PROTECT

CHANGE STATE	
CHANGE PASSWORD	
WRITE PROTECT	XXXX

OP FEEDBACK FLT

OFF
ON

GENERAL INFO

MANUFACTURER	→
MODEL	UD-10
TAG	XXXXX
DESCRIPTOR	XXXXX
DATE	DD/MMM/YYYY
MESSAGE	XXXX
FINAL ASSY NUM	XXXXX
DEVICE ID	XXXXX

DETTRONICS

6901 WEST 110TH STREET
MINNEAPOLIS, MN 55438
USA

FAULT/STATUS

OP MODE	XXXXX
FAULT	Y/N
STATUS	Y/N

FAULT

LOW CAL LINE	ON/OFF
EE FAULT	ON/OFF
ADC FAULT	ON/OFF
24V FAULT	ON/OFF
FLASH FAULT	ON/OFF
RAM FAULT	ON/OFF
WDT FAULT	ON/OFF
12V FAULT	ON/OFF
5V FAULT	ON/OFF
1.25V FAULT	ON/OFF
O/P LOOP FAULT	ON/OFF
INPUT LOOP FAULT	ON/OFF
0V FAULT	ON/OFF
ADC REF FAULT	ON/OFF

STATUS

ANY FAULT	ON/OFF
CAL ACTIVE	ON/OFF
WARM UP	ON/OFF
LOW RELAY ACTIVE	ON/OFF
HI RELAY ACTIVE	ON/OFF
AUX RELAY ACTIVE	ON/OFF
CURRENT FIXED	ON/OFF
MB WRITE PROTECT	ON/OFF
HART SELF TEST	ON/OFF
LON ATTACHED	ON/OFF
RESPONSE TEST	ON/OFF
MANUAL SELF TEST	ON/OFF
INPUT HART	ON/OFF

HISTORY

- DISPLAY HISTORY →
- EVENT LOG →

DISPLAY HISTORY

RUNNING HOURS	XXXX
MAX TEMP	XX.XX C
MAX TEMP TIME	XX:XX:XX
MIN TEMP	XX.XX C
MIN TEMP TIME	XX:XX:XX
RESET MAX MIN	
MAX RESET TEMP	XX.XX C
MAX RESET TIME	XX:XX:XX
MIN RESET TEMP	XX.XX C
MIN RESET TIME	XX:XX:XX

EVENT LOG

EVENT	XXXXX
DATE	DD/MMM/YYYY
TIME	HH:MM:SS

DISPLAY INFO

- RTC →

SERIAL NUMBER	XXXXXX
I/O BOARD ID	XXX
MFG DATE	DD/MM/YYYY
F/W REV	XXXXX
UNIVERSAL REV	XXXXX
FIELD DEV REV	XXXXX
RUNNING HOURS	XXXXX
TEMPERATURE	XX.XX C
HEATER CTRL	AUTO/ON/OFF
BACKLIGHT CTRL	AUTO/ON/OFF
INPUT VOLTAGE	XX.XX

RTC

DISPLAYED	Y/N
SECONDS	XX
MINUTES	XX
HOURS	XX
DAY	XX
MONTH	XX
YEAR	XX

RS485

BAUD RATE	XXXXXX
PARITY	XXXXXX
POLL ADDRESS	XXXXXX

DEBUG MENU

HART ERRORS	XXXXXX
MODBUS ERRORS	XXXXXX
OUTPUT READBACK	XX.XX MA
ANALOG INPUT	XX.XX MA

Detector Electronics

505	20-Feb-13	4.21
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APPENDIX O

UD10 with GENERIC 4-20 mA SENSORS

NOTE

For complete information regarding installation, wiring, and calibration of the sensor, refer to the instruction manual provided by the sensor manufacturer.

OPERATION

The UD10 can be used with generic sensors that generate a calibrated linear 4-20 mA signal, with or without HART. The UD10 allows the operator to select the upper and lower range values and unit of measurement. The UD10 then analyzes the 4-20 mA input signal from the sensor and displays the value with the designated measurement unit, and also controls the alarm outputs.

UPPER AND LOWER RANGE VALUES

The upper range value (URV) and lower range value (LRV) are selected using the magnetic tool and the UD10's menu system (Main Menu > Device Setup). The URV corresponds to the 20 mA signal while the LRV corresponds to 4 mA. The default values are 0 for the LRV and 100 for the URV. When the generic detector supports HART communication, the URV and LRV come from the attached detector.

MEASUREMENT UNIT TEXT

The operator can select the appropriate measurement unit from a pre-entered list: % (default), PPM, LFL, or PPB, or he can enter his own custom 4-character string. Measurement unit text is displayed on the main screen with the process variable. When the generic detector supports HART communication, the unit text comes from the attached detector.

LOW FAULT THRESHOLD

The operator can enter a low input fault threshold in the range of 0.5 to 4 mA (default is 3.5 mA). When the input signal is at or below this point, an "Out of Range Low Fault" is annunciated. This feature can be enabled/disabled as desired.

HIGH FAULT THRESHOLD

The operator can enter a high input fault threshold in the range of 20 to 27 mA (default is 21 mA). When the input signal is at or above this point, an "Out of Range High Fault" is annunciated. This feature can be enabled/disabled as desired.

ALARMS

The Low, High and Auxiliary alarm levels are independently field adjustable. Alarm levels are set and displayed with the selected measurement units. All alarm levels must be within the LRV to URV range.

ALARM LATCHING

Latching or non-latching function is independently selectable for each alarm. The default setting is non-latching. Latched alarms can be reset with a "Reset Latched Alarms" command from the menu system or a power cycle.

SENSOR CALIBRATION

The UD10 does not support generic sensor calibration. Generic sensors must be pre-calibrated following the procedure described in the instruction manual provided by the sensor manufacturer.

4-20 MA OUTPUT READING

While in Generic mode, the UD10 displays values below the 4 mA level to allow the use of 0-20 mA sensors.

MENU STRUCTURE

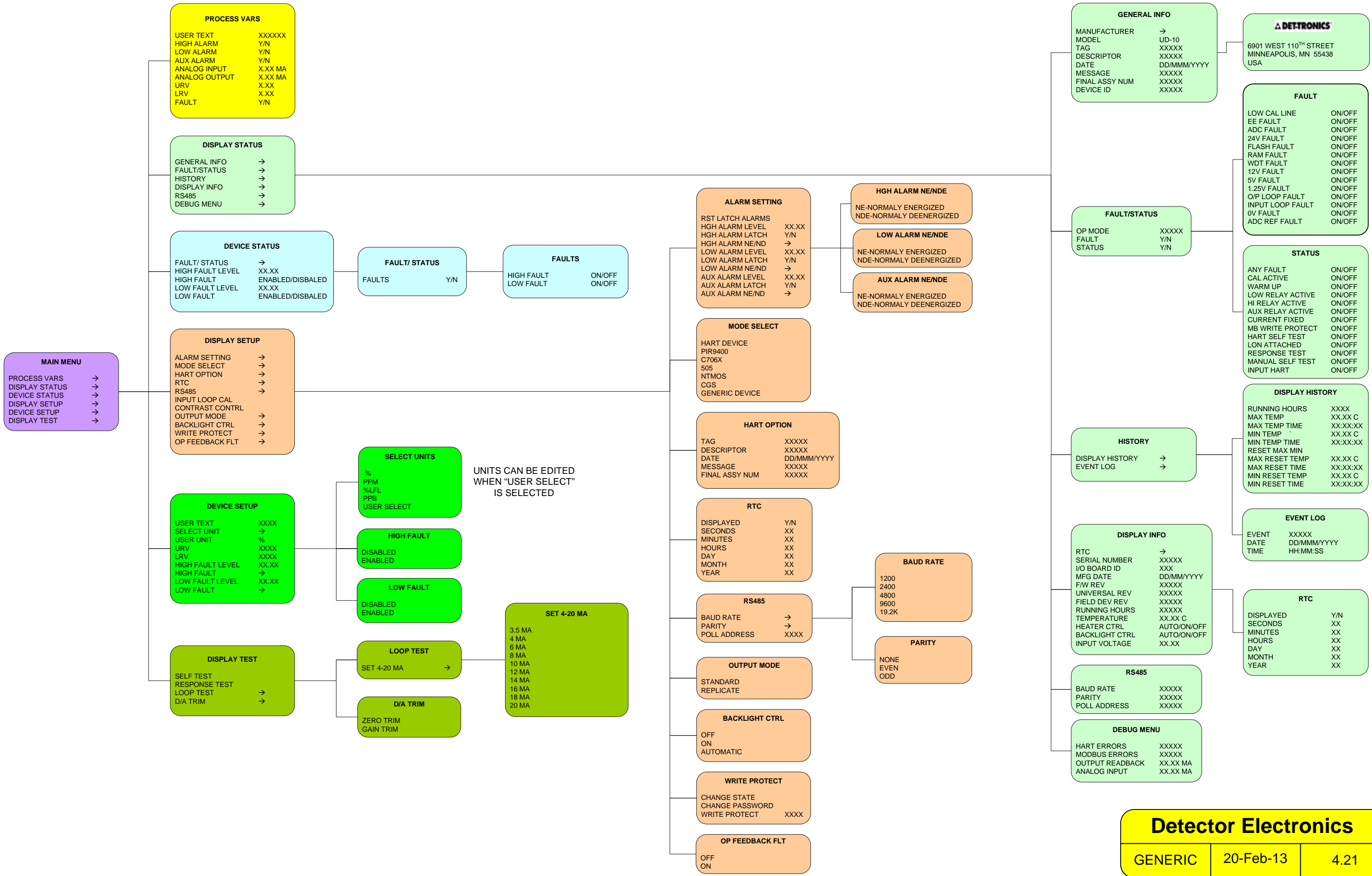
UD10 with Generic 4-20 mA Sensors

Refer to the following menus when using the UD10's LCD display and internal magnetic switches. Two different menus are provided to accommodate sensors with or without HART communication.

When connecting a HART Communicator to the UD10's 4-20 mA output, refer to the "UD10 HART" menu in Appendix E.

MENU HELP

Status menus only allow the user to view the data. The Setup menus allow the user to both view and edit the data.



MAIN MENU

- PROCESS VARS →
- DISPLAY STATUS →
- DEVICE STATUS →
- DISPLAY SETUP →
- DEVICE SETUP →
- DISPLAY TEST →

PROCESS VARS

USER TEXT	XXXXXX
HIGH ALARM	Y/N
LOW ALARM	Y/N
AUX ALARM	Y/N
ANALOG INPUT	X.XX MA
ANALOG OUTPUT	X.XX MA
URV	X.XX
LRV	X.XX
FAULT	Y/N

DISPLAY STATUS

- GENERAL INFO →
- FAULT/STATUS →
- HISTORY →
- DISPLAY INFO →
- RS485 →
- DEBUG MENU →

DEVICE STATUS

- FAULT/STATUS →
- HIGH FAULT LEVEL XX.XX
- HIGH FAULT ENABLED/DISBALED
- LOW FAULT LEVEL XX.XX
- LOW FAULT ENABLED/DISBALED

FAULT/STATUS

FAULTS Y/N

FAULTS

HIGH FAULT ON/OFF

LOW FAULT ON/OFF

DISPLAY SETUP

- ALARM SETTING →
- MODE SELECT →
- HART OPTION →
- RTC →
- RS485 →
- INPUT LOOP CAL
- CONTRAST CONTRL →
- OUTPUT MODE →
- BACKLIGHT CTRL →
- WRITE PROTECT →
- OP FEEDBACK FLT →

DEVICE SETUP

- USER TEXT XXXX
- SELECT UNIT →
- USER UNIT %
- URV XXXX
- LRV XXXX
- HIGH FAULT LEVEL XX.XX
- HIGH FAULT →
- LOW FAULT LEVEL XX.XX
- LOW FAULT →

DISPLAY TEST

- SELF TEST
- RESPONSE TEST
- LOOP TEST →
- D/A TRIM →

SELECT UNITS

- %
- PPM
- %LFL
- PPB
- USER SELECT

UNITS CAN BE EDITED WHEN "USER SELECT" IS SELECTED

HIGH FAULT

DISABLED
ENABLED

LOW FAULT

DISABLED
ENABLED

LOOP TEST

SET 4-20 MA →

D/A TRIM

ZERO TRIM
GAIN TRIM

SET 4-20 MA

- 3.5 MA
- 4 MA
- 6 MA
- 8 MA
- 10 MA
- 12 MA
- 14 MA
- 16 MA
- 18 MA
- 20 MA

ALARM SETTING

RST LATCH ALARMS	XX.XX
HGH ALARM LEVEL	Y/N
HGH ALARM LATCH	→
LOW ALARM LEVEL	XX.XX
LOW ALARM LATCH	Y/N
LOW ALARM NE/ND	→
AUX ALARM LEVEL	XX.XX
AUX ALARM LATCH	Y/N
AUX ALARM NE/ND	→

HGH ALARM NE/NDE

NE-NORMALY ENERGIZED
NDE-NORMALY DEENERGIZED

LOW ALARM NE/NDE

NE-NORMALY ENERGIZED
NDE-NORMALY DEENERGIZED

AUX ALARM NE/NDE

NE-NORMALY ENERGIZED
NDE-NORMALY DEENERGIZED

MODE SELECT

- HART DEVICE
- PIR9400
- C706X
- 505
- NTMOS
- CGS
- GENERIC DEVICE

HART OPTION

TAG	XXXXX
DESCRIPTOR	XXXXX
DATE	DD/MMM/YYYY
MESSAGE	XXXXX
FINAL ASSY NUM	XXXXX

RTC

DISPLAYED	Y/N
SECONDS	XX
MINUTES	XX
HOURS	XX
DAY	XX
MONTH	XX
YEAR	XX

RS485

- BAUD RATE →
- PARITY →
- POLL ADDRESS XXXX

BAUD RATE

- 1200
- 2400
- 4800
- 9600
- 19.2K

PARITY

- NONE
- EVEN
- ODD

OUTPUT MODE

- STANDARD
- REPLICATE

BACKLIGHT CTRL

- OFF
- ON
- AUTOMATIC

WRITE PROTECT

- CHANGE STATE
- CHANGE PASSWORD
- WRITE PROTECT XXXX

OP FEEDBACK FLT

- OFF
- ON

GENERAL INFO

MANUFACTURER	→
MODEL	UD-10
TAG	XXXXX
DESCRIPTOR	XXXXX
DATE	DD/MMM/YYYY
MESSAGE	XXXXX
FINAL ASSY NUM	XXXXX
DEVICE ID	XXXXX

DET-TRONICS

6901 WEST 110TH STREET
MINNEAPOLIS, MN 55438
USA

FAULT/STATUS

OP MODE	XXXXX
FAULT	Y/N
STATUS	Y/N

FAULT

LOW CAL LINE	ON/OFF
EE FAULT	ON/OFF
ADC FAULT	ON/OFF
24V FAULT	ON/OFF
FLASH FAULT	ON/OFF
RAM FAULT	ON/OFF
WDT FAULT	ON/OFF
12V FAULT	ON/OFF
5V FAULT	ON/OFF
1.25V FAULT	ON/OFF
O/P LOOP FAULT	ON/OFF
INPUT LOOP FAULT	ON/OFF
0V FAULT	ON/OFF
ADC REF FAULT	ON/OFF

STATUS

ANY FAULT	ON/OFF
CAL ACTIVE	ON/OFF
WARM UP	ON/OFF
LOW RELAY ACTIVE	ON/OFF
HI RELAY ACTIVE	ON/OFF
AUX RELAY ACTIVE	ON/OFF
CURRENT FIXED	ON/OFF
MB WRITE PROTECT	ON/OFF
HART SELF TEST	ON/OFF
LON ATTACHED	ON/OFF
RESPONSE TEST	ON/OFF
MANUAL SELF TEST	ON/OFF
INPUT HART	ON/OFF

HISTORY

- DISPLAY HISTORY →
- EVENT LOG →

DISPLAY HISTORY

RUNNING HOURS	XXXX
MAX TEMP	XX.XX C
MAX TEMP TIME	XX:XX:XX
MIN TEMP	XX.XX C
MIN TEMP TIME	XX:XX:XX
RESET MAX MIN	
MAX RESET TEMP	XX.XX C
MAX RESET TIME	XX:XX:XX
MIN RESET TEMP	XX.XX C
MIN RESET TIME	XX:XX:XX

EVENT LOG

EVENT	XXXXX
DATE	DD/MMM/YYYY
TIME	HH:MM:SS

DISPLAY INFO

RTC	→
SERIAL NUMBER	XXXXX
I/O BOARD ID	XXX
MFG DATE	DD/MM/YYYY
F/W REV	XXXXX
UNIVERSAL REV	XXXXX
FIELD DEV REV	XXXXX
RUNNING HOURS	XXXXX
TEMPERATURE	XX.XX C
HEATER CTRL	AUTO/ON/OFF
BACKLIGHT CTRL	AUTO/ON/OFF
INPUT VOLTAGE	XX.XX

RTC

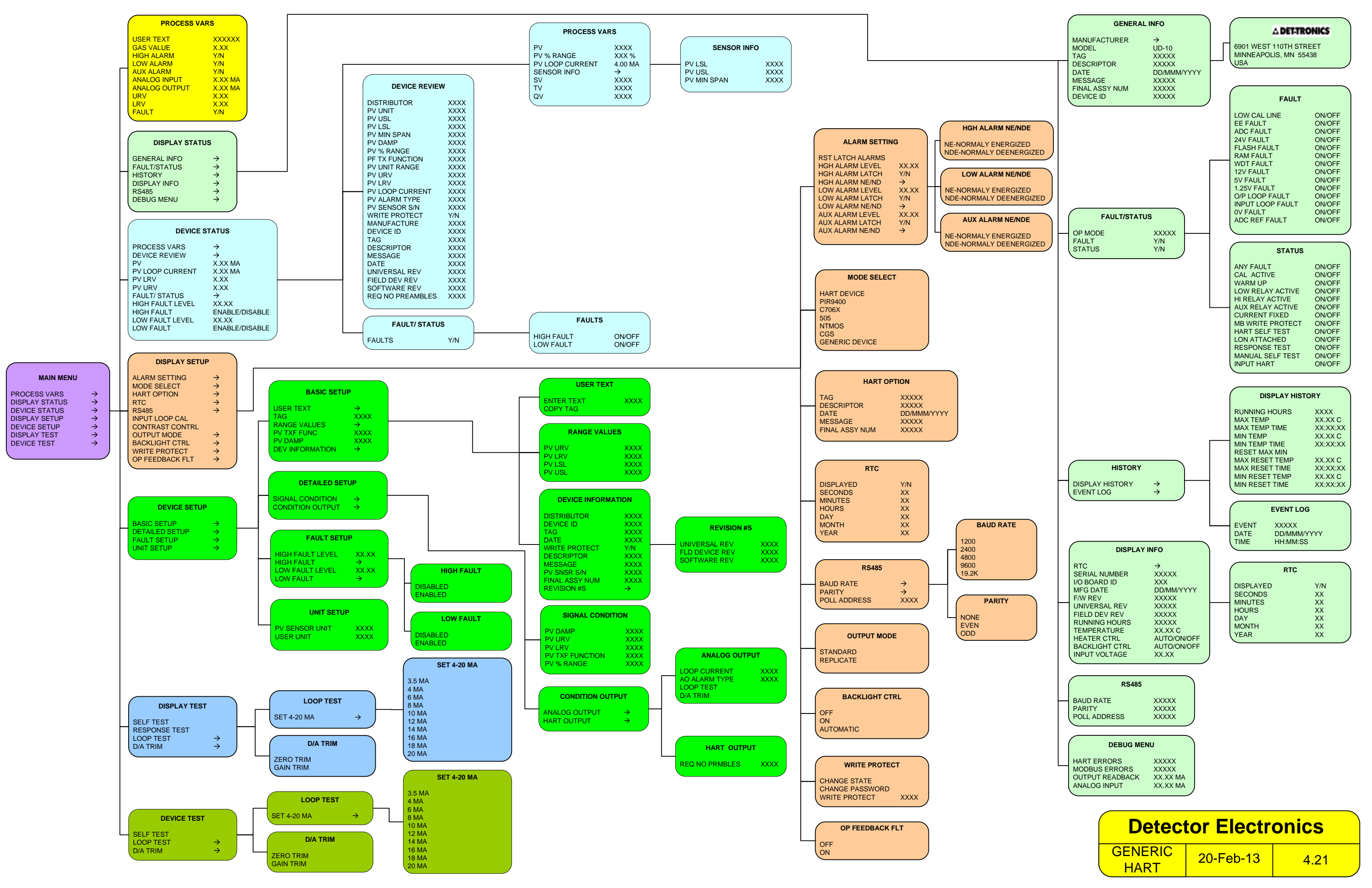
DISPLAYED	Y/N
SECONDS	XX
MINUTES	XX
HOURS	XX
DAY	XX
MONTH	XX
YEAR	XX

RS485

BAUD RATE	XXXXX
PARITY	XXXXX
POLL ADDRESS	XXXXX

DEBUG MENU

HART ERRORS	XXXXX
MODBUS ERRORS	XXXXX
OUTPUT READBACK	XX.XX MA
ANALOG INPUT	XX.XX MA



PROCESS VARS	
USER TEXT	XXXXXX
GAS VALUE	X.XX
HIGH ALARM	Y/N
LOW ALARM	Y/N
AUX ALARM	Y/N
ANALOG INPUT	X.XX MA
ANALOG OUTPUT	X.XX MA
URV	X.XX
LRV	X.XX
FAULT	Y/N

DISPLAY STATUS	
GENERAL INFO	→
FAULT/STATUS	→
HISTORY	→
DISPLAY INFO	→
RS485	→
DEBUG MENU	→

DEVICE STATUS	
PROCESS VARS	→
DEVICE REVIEW	→
PV	X.XX MA
PV LOOP CURRENT	X.XX MA
PV LRV	X.XX
PV URV	X.XX
FAULT/STATUS	→
HIGH FAULT LEVEL	XX.XX
HIGH FAULT	ENABLE/DISABLE
LOW FAULT LEVEL	XX.XX
LOW FAULT	ENABLE/DISABLE

DISPLAY SETUP	
ALARM SETTING	→
MODE SELECT	→
HART OPTION	→
RTC	→
RS485	→
INPUT LOOP CAL	→
CONTRAST CONTRL	→
OUTPUT MODE	→
BACKLIGHT CTRL	→
WRITE PROTECT	→
OP FEEDBACK FLT	→

DEVICE SETUP	
BASIC SETUP	→
DETAILED SETUP	→
FAULT SETUP	→
UNIT SETUP	→

DISPLAY TEST	
SELF TEST	→
RESPONSE TEST	→
LOOP TEST	→
D/A TRIM	→

DEVICE TEST	
SELF TEST	→
LOOP TEST	→
D/A TRIM	→

DEVICE REVIEW	
DISTRIBUTOR	XXXX
PV UNIT	XXXX
PV USL	XXXX
PV LSL	XXXX
PV MIN SPAN	XXXX
PV DAMP	XXXX
PV % RANGE	XXXX
PF TX FUNCTION	XXXX
PV UNIT RANGE	XXXX
PV URV	XXXX
PV LRV	XXXX
PV LOOP CURRENT	XXXX
PV ALARM TYPE	XXXX
PV SENSOR S/N	XXXX
WRITE PROTECT	Y/N
MANUFACTURE	XXXX
DEVICE ID	XXXX
TAG	XXXX
DESCRIPTOR	XXXX
MESSAGE	XXXX
DATE	XXXX
UNIVERSAL REV	XXXX
FIELD DEV REV	XXXX
SOFTWARE REV	XXXX
REQ NO PREAMBLES	XXXX

FAULT/STATUS	
FAULTS	Y/N

PROCESS VARS	
PV	XXXX
PV % RANGE	XXX %
PV LOOP CURRENT	4.00 MA
SENSOR INFO	→
SV	XXXX
TV	XXXX
QV	XXXX

SENSOR INFO	
PV LSL	XXXX
PV USL	XXXX
PV MIN SPAN	XXXX

FAULTS	
HIGH FAULT	ON/OFF
LOW FAULT	ON/OFF

USER TEXT	
ENTER TEXT	XXXX
COPY TAG	XXXX

RANGE VALUES	
PV URV	XXXX
PV LRV	XXXX
PV LSL	XXXX
PV USL	XXXX

DEVICE INFORMATION	
DISTRIBUTOR	XXXX
DEVICE ID	XXXX
TAG	XXXX
DATE	XXXX
WRITE PROTECT	Y/N
DESCRIPTOR	XXXX
MESSAGE	XXXX
PV SNSR S/N	XXXX
FINAL ASSY NUM	XXXX
REVISION #S	→

REVISION #S	
UNIVERSAL REV	XXXX
FLD DEVICE REV	XXXX
SOFTWARE REV	XXXX

SIGNAL CONDITION	
PV DAMP	XXXX
PV URV	XXXX
PV LRV	XXXX
PV TXF FUNCTION	XXXX
PV % RANGE	XXXX

CONDITION OUTPUT	
ANALOG OUTPUT	→
HART OUTPUT	→

ANALOG OUTPUT	
LOOP CURRENT	XXXX
AO ALARM TYPE	XXXX
LOOP TEST	→
D/A TRIM	→

HART OUTPUT	
REQ NO PRMBLES	XXXX

ALARM SETTING	
RST LATCH ALARMS	→
HGH ALARM LEVEL	XX.XX
HGH ALARM LATCH	Y/N
HGH ALARM NE/ND	→
LOW ALARM LEVEL	XX.XX
LOW ALARM LATCH	Y/N
LOW ALARM NE/ND	→
AUX ALARM LEVEL	XX.XX
AUX ALARM LATCH	Y/N
AUX ALARM NE/ND	→

HGH ALARM NE/NDE	
NE-NORMALLY ENERGIZED	→
NDE-NORMALLY DEENERGIZED	→

LOW ALARM NE/NDE	
NE-NORMALLY ENERGIZED	→
NDE-NORMALLY DEENERGIZED	→

AUX ALARM NE/NDE	
NE-NORMALLY ENERGIZED	→
NDE-NORMALLY DEENERGIZED	→

MODE SELECT	
HART DEVICE	→
PIR9400	→
C706X	→
505	→
NTMOS	→
CGS	→
GENERIC DEVICE	→

HART OPTION	
TAG	XXXXX
DESCRIPTOR	XXXXX
DATE	DD/MM/YYYY
MESSAGE	XXXXX
FINAL ASSY NUM	XXXXX

RTC	
DISPLAYED	Y/N
SECONDS	XX
MINUTES	XX
HOURS	XX
DAY	XX
MONTH	XX
YEAR	XX

BAUD RATE	
1200	→
2400	→
4800	→
9600	→
19.2K	→

PARITY	
NONE	→
EVEN	→
ODD	→

RS485	
BAUD RATE	→
PARITY	→
POLL ADDRESS	XXXX

OUTPUT MODE	
STANDARD	→
REPLICATE	→

BACKLIGHT CTRL	
OFF	→
ON	→
AUTOMATIC	→

WRITE PROTECT	
CHANGE STATE	→
CHANGE PASSWORD	→
WRITE PROTECT	XXXX

OP FEEDBACK FLT	
OFF	→
ON	→

GENERAL INFO	
MANUFACTURER	→
MODEL	UD-10
TAG	XXXXX
DESCRIPTOR	XXXXX
DATE	DD/MM/YYYY
MESSAGE	XXXXX
FINAL ASSY NUM	XXXXX
DEVICE ID	XXXXX

DETTRONICS	
6901 WEST 110TH STREET	
MINNEAPOLIS, MN 55438	
USA	

FAULT	
LOW CAL LINE	ON/OFF
EE FAULT	ON/OFF
ADC FAULT	ON/OFF
24V FAULT	ON/OFF
FLASH FAULT	ON/OFF
RAM FAULT	ON/OFF
WDT FAULT	ON/OFF
12V FAULT	ON/OFF
5V FAULT	ON/OFF
1.25V FAULT	ON/OFF
O/P LOOP FAULT	ON/OFF
INPUT LOOP FAULT	ON/OFF
0V FAULT	ON/OFF
ADC REF FAULT	ON/OFF

FAULT/STATUS	
OP MODE	XXXXX
FAULT	Y/N
STATUS	Y/N

STATUS	
ANY FAULT	ON/OFF
CAL ACTIVE	ON/OFF
WARM UP	ON/OFF
LOW RELAY ACTIVE	ON/OFF
HI RELAY ACTIVE	ON/OFF
AUX RELAY ACTIVE	ON/OFF
CURRENT FIXED	ON/OFF
MB WRITE PROTECT	ON/OFF
HART SELF TEST	ON/OFF
LON ATTACHED	ON/OFF
RESPONSE TEST	ON/OFF
MANUAL SELF TEST	ON/OFF
INPUT HART	ON/OFF

DISPLAY HISTORY	
RUNNING HOURS	XXXX
MAX TEMP	XX.XX C
MAX TEMP TIME	XX:XX:XX
MIN TEMP	XX.XX C
MIN TEMP TIME	XX:XX:XX
RESET MAX MIN	→
MAX RESET TEMP	XX.XX C
MAX RESET TIME	XX:XX:XX
MIN RESET TEMP	XX.XX C
MIN RESET TIME	XX:XX:XX

HISTORY	
DISPLAY HISTORY	→
EVENT LOG	→

EVENT LOG	
EVENT	XXXXX
DATE	DD/MM/YYYY
TIME	HH:MM:SS

DISPLAY INFO	
RTC	→
SERIAL NUMBER	XXXXXX
I/O BOARD ID	XXX
MFG DATE	DD/MM/YYYY
F/W REV	XXXXX
UNIVERSAL REV	XXXXX
FIELD DEV REV	XXXXX
RUNNING HOURS	XXXXX
TEMPERATURE	XX.XX C
HEATER CTRL	AUTO/ON/OFF
BACKLIGHT CTRL	AUTO/ON/OFF
INPUT VOLTAGE	XX.XX

RTC	
DISPLAYED	Y/N
SECONDS	XX
MINUTES	XX
HOURS	XX
DAY	XX
MONTH	XX
YEAR	XX

RS485	
BAUD RATE	XXXXX
PARITY	XXXXX
POLL ADDRESS	XXXXX

DEBUG MENU	
HART ERRORS	XXXXXX
MODBUS ERRORS	XXXXXX
OUTPUT READBACK	XX.XX MA
ANALOG INPUT	XX.XX MA

Detector Electronics		
GENERIC HART	20-Feb-13	4.21



95-8661



X3301 Multispectrum
IR Flame Detector



PointWatch Eclipse®
IR Combustible Gas Detector



FlexVu® Universal Display
w/ GT3000 Toxic Gas Detector



Eagle Quantum Premier®
Safety System

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GENTEX CORPORATION

8000 SERIES

PHOTOELECTRIC TYPE OPEN AREA SYSTEM DETECTORS

Installation Instructions - Owner's Information

INTRODUCTION 8000 SERIES

The 8000 Series Smoke Detector is an open area photoelectric system detector, engineered to provide reliable early warning against smoke. Each detector is provided with a standard Form A/Form C relay for alarm and auxiliary functions.

Supplied with each detector is a quick-disconnect wiring harness and universal mounting bracket.

MODELS AVAILABLE:

8240/8243.....24 VDC
8100/8103.....120 VAC, 60 HZ

OPTIONS, SELECTIONS:

- ** P - BUILT-IN EVACUATION HORN
- T - INTEGRAL 135°F THERMAL SENSOR
- * H - ISOLATED 135°F THERMAL SENSOR
- Y - NON-LATCHING/SELF-CLEARING

- * The H Series 135°F Normally Open Isolated Thermal is not wired into the detection circuit. It is for remote connection to the auxiliary annunciation circuit. The "H" Thermal is supervised with two wires in and two wires out.

- ** Model numbers ending with a 3 with the P option have a temporal horn output.

All detectors with the horn option include smoke detector reverse polarity horn activation. Relay contacts are not activated with the application of reverse polarity power.

HOW IT WORKS

The 8000 Series Smoke Detector operates on the photoelectric light scatter principle. The unit's sensing chamber houses a light source and a light sensor.

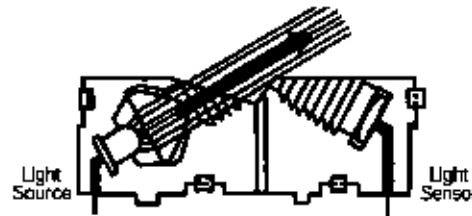
The darkened sensing chamber is exposed to the atmosphere and designed to permit optimum smoke entry from any direction while rejecting light from outside the detector.

The light source is an infrared (invisible) LED which pulses every 4 to 8 seconds. The light sensor is a photodiode matched to the light frequency of the LED light source.

Under normal conditions, the light generated by the pulsing infrared LED is not seen by the light beam. When smoke enters the sensing chamber, light from the pulsing LED light source is reflected by the smoke particles onto the photodiode light sensor. At the first sighting of smoke, the detector is put into a pre-alarm mode. This is indicated by a rapidly flashing LED on the face of the detector.

Once the light sensor confirms smoke for 2 consecutive pulses inside the chamber, the light sensor produces the signal necessary to trigger the alarm.

This technique of verifying the smoke condition, combined with a 5-to-1 signal-to-noise ratio, substantially reduces the possibility of nuisance alarms.



LOCATION

This smoke detection alarm can be mounted on a ceiling or wall with equal efficiency in either location.

- Ceiling location - detector should be mounted as close as possible to the center of a hallway or room. If this is not possible, the edge of the detector should be at least 12 inches from any wall.
- Wall location - locate the top of the detector at least 4 inches and not more than 12 inches from the ceiling. Observe detector for proper top/bottom orientation (test knob is near the bottom of unit).

Each detector and spacing shall be determined by an evaluation based on engineering judgment supplemented, if possible, by field tests and NFPA 72. For additional information on Detector Location and Spacing, contact: National Fire Protection Association, Batterymarch Park, Quincy, MA 02269, and request a copy of NFPA 72, Standard on Automatic Fire Detectors.

INSTALLATION - GENERAL

CAUTION - New Construction: DO NOT attach detector head until AFTER sanding, insulation, painting, and other dust creating situations are finished.

COMMERCIAL OR INDUSTRIAL USE
 Recommendation according to
 NFPA Standard 72

LOCATION	SPACING RECOMMENDATION
Smooth ceiling	Spacing of 30 feet between detectors may be used.
Joisted ceiling	Joists 8" or less may be considered as a smooth ceiling.
Sloped ceiling	Within 3 feet of peak, measured horizontally. Additional detectors based on horizontal projection of ceiling.
High ceiling	If air temperature near ceiling is high enough to cause loss of thermal lift (smoke stops rising and stratifies), install detectors at alternate levels: half at ceiling level, half 3 feet below ceiling. Typical structure where stratification may occur is a warehouse with metal roof.
Beam ceiling	Beams less than 8" may be considered as a smooth ceiling. Beams more than 8" and less than 18" thick require reduced spacing for detectors. Beams 18" or larger spaced on 8-foot centers - each bay shall be treated as a separate area requiring at least one detector.

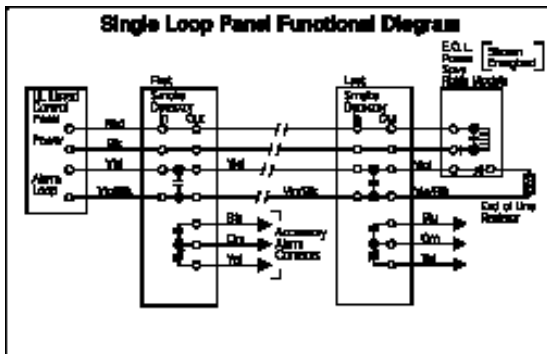
MOUNT ROUGH-IN BOX & RUN WIRING

IMPORTANT: INSURE THAT ALL FLUORESCENT LIGHTING FIXTURES ARE PROPERLY GROUNDED.

- Use a 2" x 3" switch box or a 4" square or octagon junction box. Mount a box for each detector and run the system fire detection circuit plus the power circuit to all smoke detector locations. See Wiring Diagrams, Figures A and B, for Latching Models, and Figures C and D for Self Clearing Models.

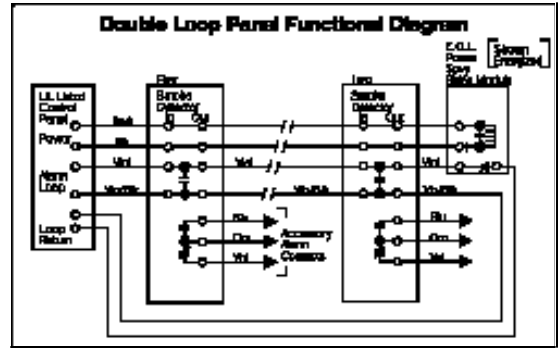
CAUTION: Break wire runs to provide supervision for connections made to each wire pair.

FIG. A



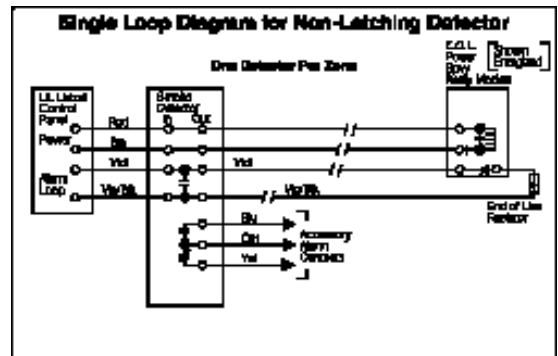
Class B Panel Wiring Diagram

FIG. B



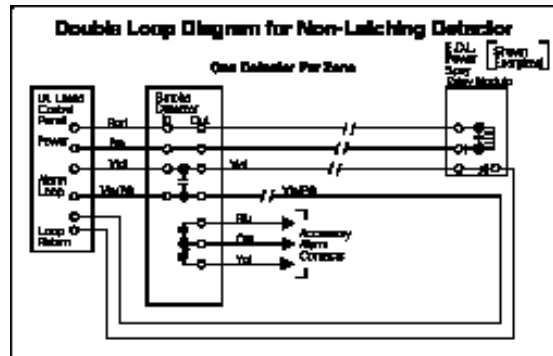
Class A Panel Wiring Diagram

FIG. C



Class B Panel Wiring Diagram
 One Detector Per Zone

FIG. D



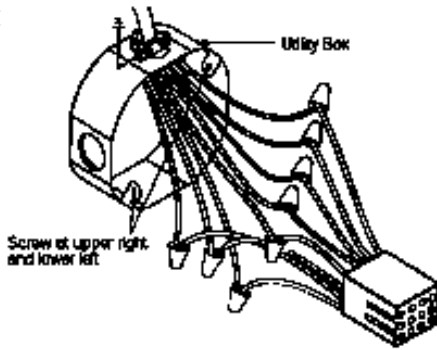
Class A Panel Wiring Diagram
 One Detector Per Zone

NOTE: Non-Latching/Self Clearing Detector Models, Figures C and D, are only UL Listed with the following Control Panels:

MANUFACTURER	PART #
FCI	SBP-4
SIMPLEX	4001
	4002
FARADAY	19000A

- If wall mounting is desired, be sure the box screws are oriented to upper right and lower left corners, Figure E. The volume of the box is determined by the number of conductors entering and exiting the box. Use 1-3/4 cubic inches per conductor (#16 AWG).

FIG. E

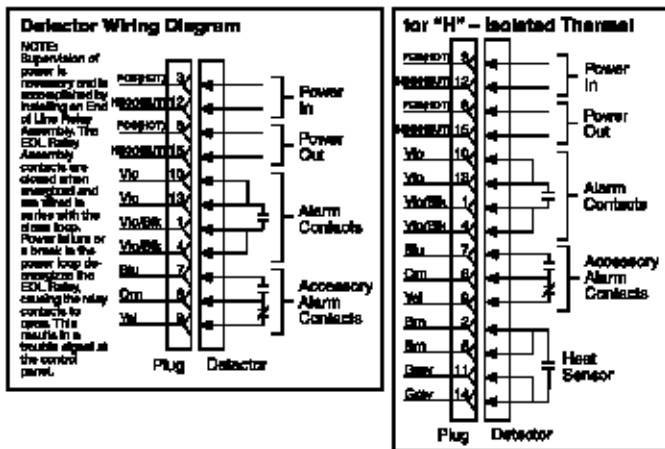


INSTALL MOUNTING PLATE & CONNECT WIRES

1. Remove the plug and wire assembly from the shipping container and wire it in junction box as follows:
2. Major Circuits (power in, power out, and alarm contacts) have two wires, one for the incoming circuit and one for the outgoing circuit. Auxiliary relay contacts are single wire circuits. Make connections as detailed on wiring diagrams, Figure F.
3. Lace the connector through the provided mounting plate cover and secure the plate to the junction box.

NOTE: For trouble areas where there can be a large volume of air blowing out through the electrical junction box. You must first insert the cardboard shield packaged with your smoke detector to the backside of detector before securing it to mounting plate.

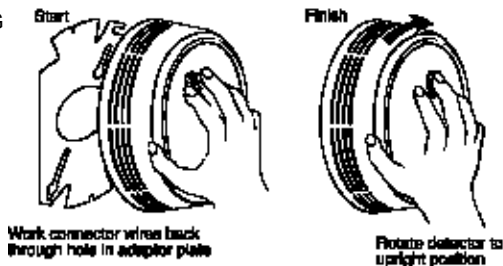
FIG. F



SECURE DETECTOR TO MOUNTING PLATE

1. Plug the wire connector into the detector base.
2. Place the detector up to the mounting plate, rotating it clockwise until detector firmly snap locks into place. Keep the detector parallel to the mounting plate so upper and lower tabs on plate seat correctly into detector, Figure G.

FIG. G



CHECKOUT & TROUBLESHOOTING

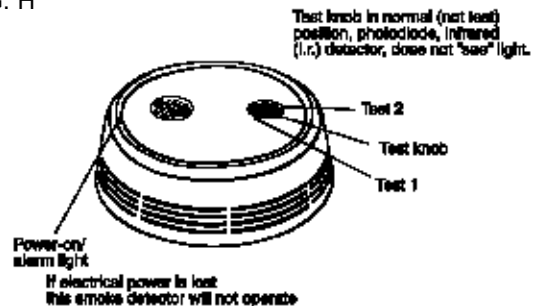
1. Turn test knob on each unit to the NORMAL position and supply power to the system Control Unit.
 - a. If the fire alarm sounds, one or more smoke detector connections to the fire detection circuit may be reversed. Check wire color codes and trace.
 - b. If the trouble buzzer sounds, the fire detection circuit may be reversed or disconnected at the Control Unit.
2. Turn the test knob on the front of the unit to TEST 1 position (counter-clockwise). See Figure H. The alarm should sound in less than 20 seconds. To reset the system, return the knob to its NORMAL position and use the reset switch on the system Control Panel. Hold in reset for 5 or more seconds.

To test detector for high sensitivity, rotate test knob clockwise to the TEST 2 position. Alarm should remain silent. Return test knob to normal position.

If your detector alarmed during TEST 2 the detector's sensitivity has become too high and may cause false alarms. This may mean your detector is dirty and should be cleaned as described in the below maintenance procedure. If your detector still alarms in TEST 2 position following washing and recommended drying time then return it to Gentex Corp. for service.

The test knob actually tests the sensitivity of the unit by using the same principle involved as when smoke enters the detector. When you turn the test knob to the TEST 1 position, you are scattering the detector's LED light to the equivalent of 3.4% actual smoke. TEST 2 position is equivalent to 0.85%.

FIG. H



The test knob is not an electrical switch, nor is it connected in any way to the alarm horn. Therefore, when you test with the test knob, you are simulating the smoke condition in the detector and testing all elements of the smoke detector that are necessary for the detection of actual smoke.

To check for proper smoke entry into your detector's sensing chamber, Gentex recommends using the **Home Safeguard Smoke Detector spray**.

This test should be performed once a year and should be sprayed from a distance no closer than 12 inches from smoke detector (refer to NFPA 72 for details).

3. A trouble buzzer will sound if any detector is removed from its socket in supervised circuits. CAUTION: When a smoke detector is removed it may cause other detectors to have a loss of power and become inoperative. If this happens, reconnect the detector until a replacement can be installed, or use a jumper plug which can be ordered separately from the factory.
4. Power-On - Alarm Light. The LED on the face of the detector blinks every 15-30 seconds, indicating electrical power is being supplied. See Figure H. If the smoke (or test knob) persists for about 20 seconds, the LED will be on continuously for latching models or flash rapidly for non-latching models to indicate the alarm condition of the detector. It will stay on until the system is reset.

MAINTENANCE

After your detector has been in operation for a period of time or if it was installed prior to the completion of all building construction, your detector may have become more sensitive due to dirt build-up in the detector's optic sensing chamber. This could cause nuisance alarms or cause the alarm to activate from small amounts of smoke build-up.

For further information regarding frequency of maintenance and testing, refer to NFPA 72, NFPA, Batterymarch Park, Quincy, MA 02269.

If this should occur, following this simple washing procedure will restore your smoke detector back to its original condition.

IMPORTANT: Failure to follow full cleaning instructions could result in damage to this smoke detector.

1. Turn off electrical power to the detector.
2. Twist the detector counter-clockwise to remove it from its mounting plate. **WARNING:** The fire alarm system shall remain active during all maintenance. Therefore, while servicing one detector, either use a replacement detector or jumper plug to keep the fire alarm system operative. Contact your local Gentex distributor for the proper jumper plugs to use with your fire system.
3. Unplug the connector from the back of the detector. Do not remove the wire connection; leave the connector for your replacement detector or jumper plug.
4. Select three (3) standard size wash buckets and fill them each with one gallon of normal tap water (**distilled or de-ionized treated water is recommended as a final rinse if water is extremely hard in your area.**)
5. Add 1/8 cup of Ivory dishwashing liquid to the first bucket of water and allow it to mix thoroughly, then place dirty detector in the soap water mixture until it becomes completely covered or submerged. **NOTE:** If the detectors are exceptionally dirty, you may wish to first wipe off any excess dirt before washing detector so as not to dirty the wash water too quickly.
WARNING: ONLY IVORY DISWASHING LIQUID IS TO BE USED. OTHER BRANDS ARE NOT RECOMMENDED AND MAY CAUSE YOUR DETECTOR TO MALFUNCTION.
6. Allow detector to soak for approximately 10 minutes (longer if extremely dirty). Then agitate for 5 or 10 seconds to flush out any remaining dirt left inside detector's housing.
7. Remove detector from wash water and transfer directly to one of the first rinse buckets containing clear water. Again, allowing detector to become completely submerged, agitate once more for 5 or 10 seconds to remove soap residue.
8. Finally, transfer detector to your second and final rinse bucket, repeating method found in Step 7, then remove detector to a clean dry area for a period of 48 hours to allow it to thoroughly dry.

WARNING: SMOKE DETECTORS ARE TO AIR DRY ONLY. DO NOT PLACE DETECTOR IN OVEN OR USE A HOT AIR BLOWER TO ACCELERATE DRYING TIME. THIS COULD RESULT IN DAMAGE TO YOUR SMOKE DETECTOR.

IMPORTANT: IT IS RECOMMENDED TO CHANGE WASH AND RINSE WATER AFTER FIVE (5) DETECTORS. IF YOUR DETECTORS ARE EXTREMELY DIRTY, WATER SHOULD BE CHANGED MORE FREQUENTLY.

In the event you experience difficulty in the cleaning of your smoke detectors or if you have any questions, please contact Gentex Corporation or your local Gentex distributor.

TO RETURN A DETECTOR

Should you experience problems with your smoke detector, proceed as follows:

1. Turn off electrical power to the detector.
2. Push-n-turn the detector counter-clockwise to remove it from its mounting plate.
3. Unplug the connector from the back of the detector. Do not remove the wire connection; leave the connector for your replacement detector. If the system is to remain active while the detector is removed, a jumper plug must be installed. Contact factory for part.
4. Carefully pack (the manufacturer cannot be responsible for consequential damage) and return to the manufacturer. Include complete details as to exact nature of difficulties being experienced and date of installation.
5. Return to: Gentex Corporation, 10985 Chicago Drive, Zeeland, Michigan 49464. Prior to returning, call 1-800-436-8391 for a RMA number.

ELECTRICAL SPECIFICATIONS

MODEL NUMBERS	8240	8100
Operating Voltage		
Nominal:	24VDC	120VAC
Range	Min:	18VDC 110VAC
	Max:	30VDC 120VAC
Frequency	-----	60HZ.
Current consumption at Normal Operating Voltage		
	Standby	6mA 70mA
	Alarm	60mA 70mA

NOTE: For "P" Option (horn), alarm current consumption is unchanged. Reverse polarity current is 15mA.

Alarm Relay Contacts-1 Form A.....Rated Load (Resistive)
1 Amp at 24 Volt DC
0.5 Amp at 120 Volt AC

Auxiliary Relay Contact-1 Form C.....Rated Load (Resistive)
1 Amp at 24 Volt DC
0.5 Amp at 120 Volt AC

Temperature.....40°F-100°F(4.4°C-37.8°C)

Humidity.....10%-93% Relative Humidity

Size.....5.7"W x 5.7"H x 2.8"D

E.O.L. RELAY MODULES MUST BE U.L. LISTED. APPROVED TYPES AND MANUFACTURER ARE LISTED AS FOLLOWS:

MANUFACTURER	PART #	DET. MODEL#
FCI	2040-120	8100
269 GROVE ST. NEWTON, MA 02166	2040-24	8240

LIMITED WARRANTY

For a period of 24 months from the date of purchase, or a maximum of 20 months from the date of manufacture, Gentex warrants to you, the original consumer purchaser, that your Smoke Detector will be free from defects in workmanship, materials, and construction under normal use and service. If a defect in workmanship, materials, or construction should cause your Smoke Detector to become inoperable within the warranty period, Gentex will repair your Smoke Detector or furnish you with a new or rebuilt replacement Smoke Detector without charge to you except for postage required to return the Smoke Detector to us. Your repaired or replacement Smoke Detector will be returned to you free of charge and it will be covered under this warranty for the balance of the warranty period.

This warranty is void if our inspection of your Smoke Detector shows that the damage or failure was caused by abuse, misuse, abnormal usage, faulty installation, improper maintenance, or repairs other than those performed by us. ANY WARRANTIES IMPLIED UNDER ANY STATE LAW, INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, APPLY ONLY FOR THE WARRANTY PERIOD SPECIFIED ABOVE. PLEASE NOTE THAT SOME STATES DO NOT ALLOW LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY LASTS, SO THE ABOVE EXCLUSION MAY NOT APPLY TO YOU.

GENTEX WILL NOT BE LIABLE FOR ANY LOSS, DAMAGE, INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY KIND ARISING IN CONNECTION WITH THE SALES, USE OR REPAIR OF THIS SMOKE DETECTOR. PLEASE NOTE THAT SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE EXCLUSION MAY NOT APPLY TO YOU.

If a defect in workmanship, materials, or construction should cause your Smoke Detector to become inoperable within the warranty period, you must return the Smoke Detector to Gentex postage prepaid. You must also pack the Smoke Detector to minimize the risk of it being damaged in transit. You must also enclose a return address. Smoke Detectors returned for warranty service should be sent to: Gentex Corporation, 10985 Chicago Drive, Zeeland, MI 49464.

If we receive a Smoke Detector in a damaged condition as the result of shipping, we will notify you and you must file a claim with the Shipper.

THIS LIMITED WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS. YOU MAY ALSO HAVE OTHER RIGHTS WHICH VARY FROM STATE TO STATE.



SelecTone® Hazardous Location Audible Signaling Device

Model 302GCX

DESIGNED FOR USE IN HAZARDOUS LOCATIONS

- Available in 24VAC/DC, 120VAC and 240VAC
- Reliable, solid-state circuitry
- Digital signal amplification
- Fused input and output
- Built-in gain control, adjustable between 0dBA to 114dBA @ 10' (0dBA to 124dBA @ 1m)
- Type 4X enclosure
- External mounting tabs
- Indoor/outdoor use
- UL 1480 and CSFM Approved
- UL and cUL Listed

Federal Signal's Model 302GCX SelecTone® Speaker Amplifier is designed to produce tones, digital voice messages and live public address in harsh environments with high ambient noise levels.

The rugged speaker cone and projector are constructed of spun aluminum. The amplification circuitry, tone module, and gain control are contained in a housing constructed of die-cast aluminum. All surfaces are sealed with powder-coat paint. Dust- and moisture-proof gaskets provide protection from the elements.

The 302GCX is UL Listed for Class I, Division 2, Groups A, B, C and D; Class II, Division 2, Groups F & G, and Class III. It has been tested and approved for use in Type 4X applications.

Internal gain control allows output adjustment from 0dBA to a maximum of 114dBA at 10 feet.

SelecTone Speaker Amplifiers are used individually or as part of a plant-wide emergency notification system. The Model UTM Universal Tone Module, with 32 tones, or the TM33 Custom Tone Module is plugged into a single SelecTone Speaker Amplifier for stand-alone use or into a SelecTone Command Unit for plant-wide signaling.

For plant-wide signaling, a Connector Kit is installed into each SelecTone Speaker Amplifier and wired to a central controller, SelecTone Command Unit or CommCenter® Digital Message Center. Command Units and CommCenters broadcast tones, voice messages, melodies and live public address to an unlimited number of SelecTone Speaker Amplifiers.

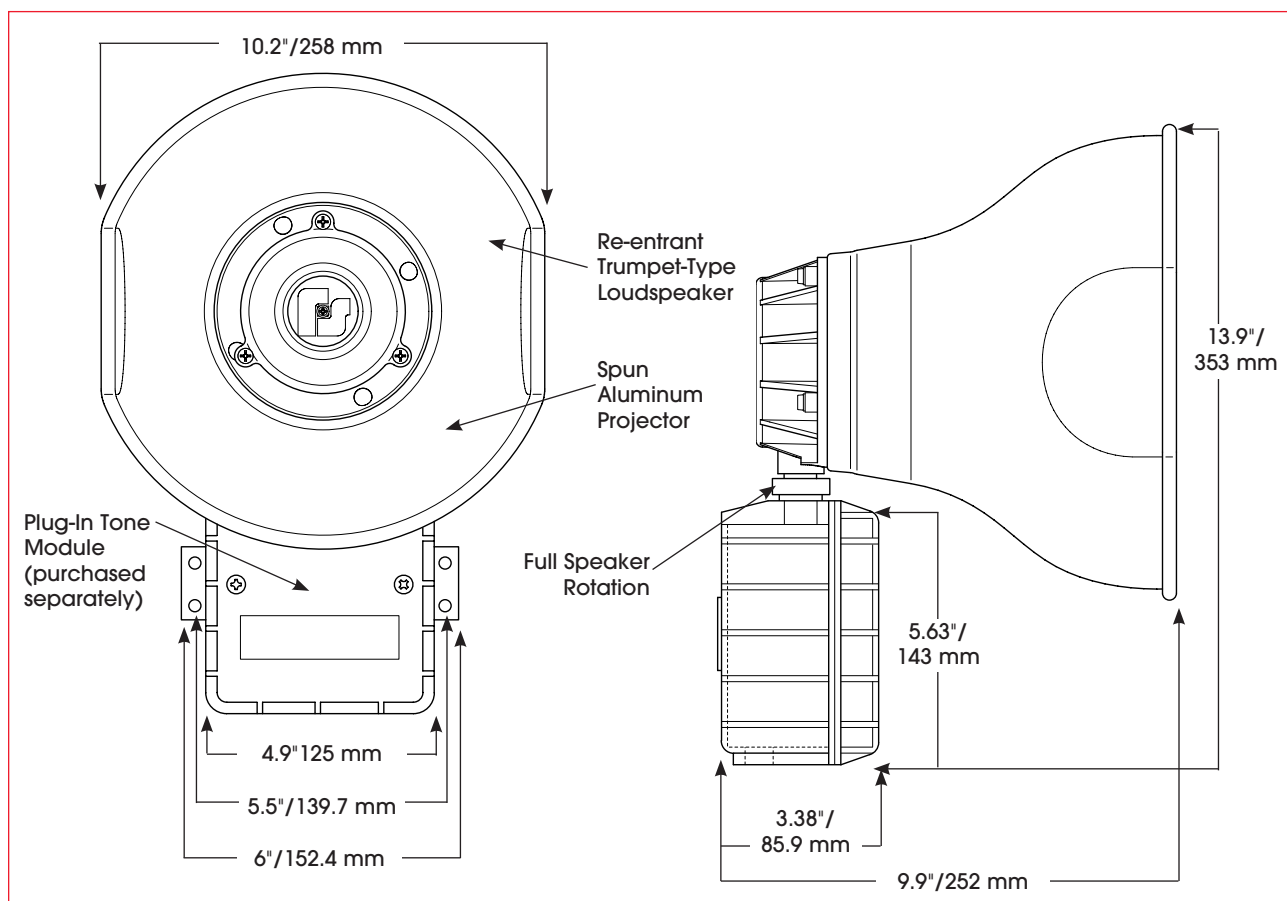
Applications for SelecTone include emergency warning, evacuation, start/dismissal, public address, and process control signaling.

Model	Voltage	Operating Current	Standby Current	Decibels @		T-Code ¹
				10'	1m	
302GCX-024	24VDC	1 amps	50 mA	114	124	T6
302GCX-024	24VAC 50/60Hz	1.40 amps	100 mA	114	124	T6
302GCX-120	120VAC 50/60Hz	0.30 amps	50 mA	114	124	T6
302GCX-240	240VAC 50/60Hz	0.15 amps	35 mA	114	124	T6

¹ T-Code in Class 1 Division 2 A,B,C,D



HAZARDOUS LOCATION AUDIBLE SIGNALING DEVICE (302GCX)



SPECIFICATIONS

Operating Temperature:	-67°F to 150°F	-55°C to 66°C
Net Weight:		
24VAC/DC	7.9 lbs.	3.6 kg
120/240VAC	7.9 lbs.	3.6 kg
Shipping Weight:		
24VAC/DC	7.9 lbs.	3.6 kg
120/240VAC	9.3 lbs.	4.2 kg
Height:	13.9"	353.0 mm
Width:	10.2"	258.0 mm
Depth:	9.9"	252.0 mm

HOW TO ORDER

- Specify model number and voltage
- Specify Tone Module for stand alone operation
 - Universal Tone Module (UTM)
 - Custom Tone Module (TM33)
- Specify Connector Kit for use in systems (Call factory for system design assistance)
 - 25 Vrms Connector Kit (AM25CK)
 - 70 Vrms Connector Kit (AM70CK)

REPLACEMENT PARTS

Description	Part Number
Amplifier Assembly, 24VAC/DC	K2005502A-02
Transformer, 120VAC	K120846A
Transformer, 240VAC	K120856A
Voice Coil, Series C	K8590246A
Speaker Assembly	K8593103A



FEDERAL SIGNAL

Safety and Security Systems / **Industrial**

Advancing security and well being

Model 191XL Series Beacon for Use in Hazardous Conditions



Installation and Maintenance Manual

2561421G
REV. G 912
Printed in U.S.A.



Warranty – Seller warrants all goods for five years on parts and 2-1/2 years on labor, under the following conditions and exceptions: Seller warrants that all goods of Seller's manufacture will conform to any descriptions thereof for specifications which are expressly made a part of this sales contract and at the time of sale by Seller such goods shall be commercially free from defects in material or workmanship. Seller reserves the right at the Seller's discretion to "Repair and Return" or "Replace" any item deemed defective during the warranty period. This warranty does not cover travel expenses, the cost of specialized equipment for gaining access to the product, or labor charges for removal and reinstallation of the product. This warranty shall be ineffective and shall not apply to goods that have been subjected to misuse, neglect, accident, damage, improper maintenance, or to goods altered or repaired by anyone other than Seller or its authorized representative, or if five years have elapsed from the date of shipment of the goods by Seller with the following exceptions: lamps and strobe tubes are not covered under this warranty. Outdoor warning sirens and controllers manufactured by Federal Warning Systems are warranted for two years on parts and one year on labor. No agent, employee, representative or distributor of Seller has any authority to bind the Seller to any representation, affirmation, or warranty concerning the goods and any such representation, affirmation or warranty shall not be deemed to have become a part of the basics of the sales contract and shall be unenforceable. THE FOREGOING WARRANTIES ARE EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES OR MERCHANTABILITY, FITNESS FOR PURPOSE AND OF ANY OTHER TYPE, WHETHER EXPRESS OR IMPLIED. These warranties shall not apply unless Seller shall be given reasonable opportunity to investigate all claims for allegedly defective goods. Upon Seller's instruction a sample only of allegedly defective goods shall be returned to Seller for its inspection and approval. The basis of all claims for alleged defects in the goods not discoverable upon reasonable inspection thereof pursuant to paragraph 8 hereof must be fully explained in writing and received by Seller within thirty days after Buyer learns of the defect or such claim shall be deemed waived.



Industrial Systems
2645 Federal Signal Drive • University Park, IL 60484-3167
Tel: 1-877-289-3246 • Fax: 708-534-4852
www.federal-signal-indust.com • www.fs-isys.com

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Safety Messages to Installers

⚠ WARNING

It is important to follow all instructions shipped with this product. This device is to be installed by a trained electrician who is thoroughly familiar with the National Electrical Code and/or Canadian Electrical Code and will follow the NEC and/or CEC Guidelines as well as all local codes. This beacon should be considered a part of the warning system and not the entire warning system.

The selection of the mounting location for the beacon, its controls and the routing of the wiring are to be accomplished under the direction of the facilities engineer and the safety engineer. In addition, listed below are some other important safety instructions and precautions you should follow:

- Read and understand all instructions before installing or operating this beacon.
- Do not connect this beacon to the system when power is on.
- Do not disconnect the beacon while circuit is live or unless the area is known to be free of ignitable concentrations. Keep the beacon tightly closed when in operation.
- After installation, make sure that all set screws and threaded joints are properly tightened.
- Never alter the unit in any manner. Safety in hazardous locations may be endangered if additional openings or other alterations are made in units specifically designed for use in these locations.
- To be an effective warning device, this product produces bright beacon that can be hazardous to your eyesight when viewed at a close range. Do not stare directly into this lighting product at a close range or permanent damage to your eyesight may occur.

Installation and Service Instructions

- After installation, test the beacon to make sure that it is operating properly.
- Keep the unit tightly closed when in operation.
- After testing is complete; provide a copy of this instruction booklet to all personnel.
- Establish a procedure to routinely check the beacon for proper activation and operation.

Failure to follow all safety precautions and instructions may result in property damage, serious injury, or death.

An Overview of the 191XL Series

This equipment is suitable for use in Class I, Division 2, Groups A, B, C and D; Class II, Division 1, Groups E, F & G; Class III OR non-hazardous locations only.

This strobe light can be mounted to a Federal Signal Model LHWB bracket. If installed in this way, the entire assembled device is suitable only for Class I, Div. 2, Groups A, B, C, and D; Class II, Div. 2, Groups F and G; Class III locations.

The Model 191XL LED Beacon is a UL listed visual signal for operation in harsh environments and hazardous locations and has been investigated by UL as meeting Type 4X and IP66 enclosure requirements. The unit is rated for operation on 100Vac to 265 Vac, 50/60 Hz, 0.21 A, 277 Vac, 50/60 Hz, 0.13A, or 24 Vdc/ac 50/60 Hz, 0.38 A. The 191XL can be supplied with colors of red, amber, green, blue, and clear. The 191XL is factory-set to operate 60 flashes/minute. There is an option to operate the LED Beacon in Steady Mode. (See “Changing from Flash Mode to Steady Mode” on page 13). Models are available for pipe mounting (191XL) or surface mounting (191XL-S).

These devices are intended for permanent installation and operation in accordance with Title 46, Code of Federal Regulations, Parts 110–113, or Title 33, Code of Federal Regulations, Part 183, Sub-part I, Section 183.410, and the

applicable requirements of the American Boat and Yacht Council, Inc., and/or ANSI/NFPA 302, “Fire Protection Standard for Pleasure and Commercial Motor Craft.”

Unpacking the Beacon

⚠ WARNING

EXPLOSION HAZARD—Damaged domes can lead to explosions that could result in serious injury or death.

After unpacking the beacon, examine it for damage that may have occurred in transit. If the beacon has been damaged, do not attempt to install or operate it. File a claim immediately with the carrier, stating the extent of the damage. Carefully check all envelopes, shipping labels, and tags before removing or discarding them. Disposal of all shipping materials must be carried out in accordance with national and local codes and standards. If any parts are missing, please call Federal Signal Customer Support at 708-534-4756.

Table 1 Electrical ratings

Operating Voltage:	24 Vdc/ac	100–265, 277 Vac	277 Vac
Flashes/Minute:	60 FPM	60 FPM	60 FPM
Maximum Operating Current:	380 mA	210 mA	130 mA
Frequency:	DC/50/60	50/60	50/60
DC In-Rush Current:	1.75 A at 24 Vdc for 5 ms.		
AC In-Rush Current:	2.0 A at 85 Vac and 1.5 A at 265 and 277 Vac for 0.25 ms.		

Table 2 Installation Environment Ratings

Ambient Storage Rating: –55 °C to +70 °C
Ambient Operating Rating: –50 °C to +66 °C
Type 4X (water-tight and corrosion resistant) and indoor/outdoor use
IP66 (dust-tight and protection against heavy seas) and outside type (saltwater)

Table 3 Ambient and Operating Temperature Range

	Temperature Code or Maximum Temperature, °C								
	40 °C Ambient			55 °C Ambient			66 °C Ambient		
Hazardous Locations	24 V	100–265 Vac	277 Vac	24 V	100–265 Vac	277 Vac	24 V	100–265 Vac	277 Vac
Class I, Div 2, Groups A, B, C, and D	T6	T6	T5	T5	T5	T5	T4A	T4A	T5
Class II, Div 1, Groups E, F, and G	T6	T6	T6	T6	T6	T6	T6	T6	T6
Class III	T6	T6	T6	T6	T6	T6	T6	T6	T6

Pipe-Mounting the Beacon (191XL)

⚠ WARNING

EXPLOSION HAZARD— *To reduce the risk of fire or explosion, do not install the beacon in a hazardous location if the operating temperature exceeds the hazardous atmosphere’s ignition temperature. Before proceeding, consult the product nameplate and determine the operating temperature of the beacon.*

NOTE: To comply with NEC Section 300-14, which requires a minimum of 6 inches (15.25 cm) of free conductor at a junction, when mounting the Model 191XL, the mounting pipe used to join the unit to a splice box should be no longer than 10 inches (25.4 cm).

The Model 191XL has provisions for mounting a 3/4" pipe and can be mounted in any position.

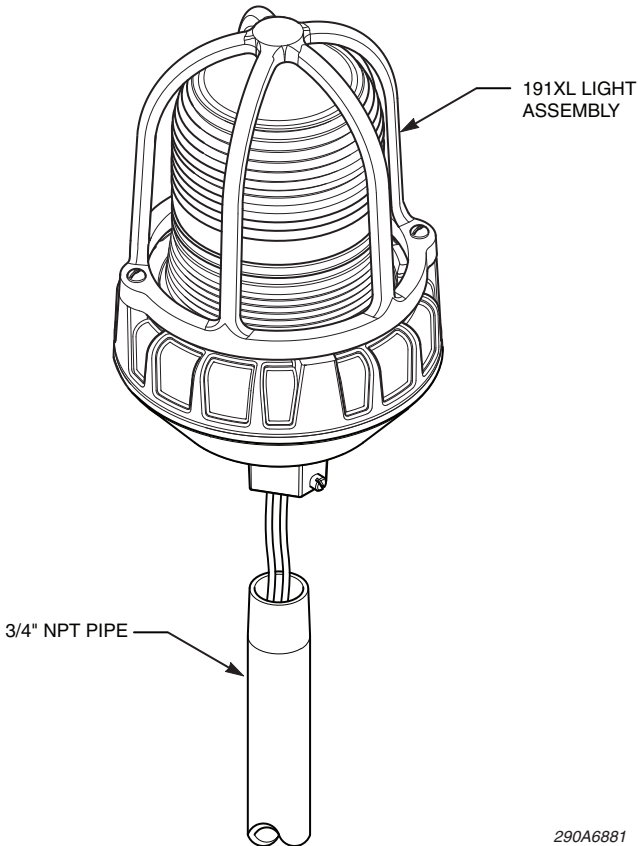
1. Before mounting the beacon, ensure that the mating threads are clean.
2. To prevent the ingress of water and dust, apply conductive sealant to the conduit threads prior to mounting. If non-conductive sealant is used, the enclosure must be earthed via the provided internal grounding wire/grounding screw to ensure proper grounding continuity.

3. In high-humidity environments when units are mounted dome down, condensation may occur in the conduit system. Use properly rated conduit seals/drains to prevent moisture from entering the fixture.

IMPORTANT: To prevent the connection from loosening, tighten the fixture to a MINIMUM torque of 5 ft-lb (6.8 N·m) after threading it onto the pipe.

4. Thread the fixture onto the 3/4" pipe and secure it with the set screw.

Figure 1 Pipe-mounted beacon



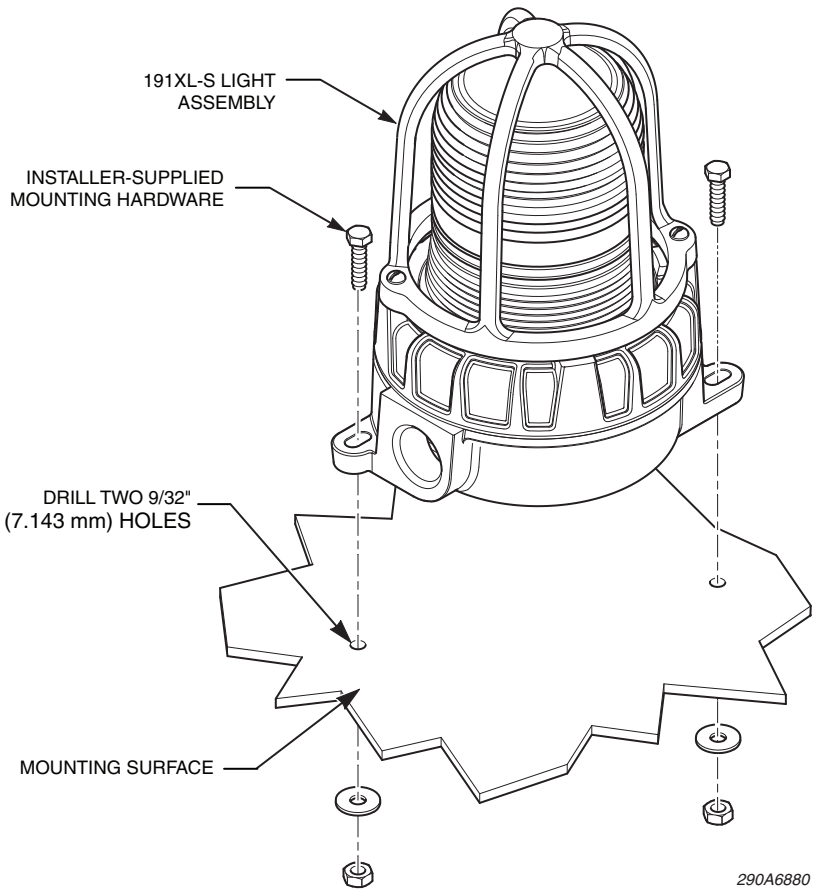
290A6881

Surface-Mounting the Beacon (191XL-S)

To surface mount the beacon:

1. Use the mounting base as a template to mark the location of the two mounting holes.
2. Drill a 9/32 inch (7.143 mm) hole at each mark.
3. Secure the beacon to the mounting surface with installer supplied hardware.

Figure 2 Surface-mounted beacon



Wiring the Beacon

⚠ WARNING

SHOCK HAZARD

To avoid electrical shock hazards, do not connect wires while power is applied.

⚠ WARNING

EXPLOSION HAZARD

Do not disconnect the beacon while the circuit is live or unless the area is known to be free of ignitable concentrations. Keep the beacon tightly closed when in operation.

Wiring must comply with the National Electrical Code or Canadian Electrical Code and the local authority having jurisdiction.

The Model 191XL Series LED Beacon should be installed per the NEC or CEC, STATE and LOCAL CODES. Alternate installation locations and/or orientations should only be performed with the approval of the authority having jurisdiction. In addition, the unit can be mounted using an optional ceiling mount or optional wall mount.

⚠ WARNING

SHOCK HAZARD—*To avoid electrical shock hazards, do not connect wires while power is applied.*

NOTE: Model 191XL that are 24 V models are designed to operate on AC and DC supply voltages. The 120–240 Vac model is designed to operate 100 Vac to 265 Vac at 50/60 Hz. See Table 1 on page 7 for electrical ratings.

NOTICE

REVERSE POLARITY/MISWIRING—*The 191XL is not polarity sensitive, but MAY BE DAMAGED by incorrect electrical hookup. Damage will result if the voltage rating of the particular model is exceeded.*

Installation and Service Instructions

NOTE: Field terminations made inside of the surface mount enclosure will require the printed circuit board (PCB) assembly to be removed from the housing. See Figure 3 on page 15 and follow steps 1–4 and 6–8 of “Changing from Flash Mode to Steady Mode” on page 13 for the PCB removal and installation process.

The surface mount enclosure is not suitable for feed-through branch-circuit conductors.

Wiring 120-240, 277 Vac Models

The 120-240, 277 Vac models are supplied with three 24-inch leads: white, black, and green/yellow. Connect the black lead to the phase (hot) side of the power source and the white lead to the common (neutral) side of the power source. If required, the green/yellow lead in the housing is provided for connection to an earth ground.

Wiring 24 Vac/dc Models

The 24 Vac/dc models are supplied with two 24" leads, one red and one black. Connect the red (+) lead to the positive or phase (hot) side of the power source and the black (–) lead to the negative or common (neutral) side of power source.

Safety Message to Maintenance Personnel

WARNING

Listed below are some important safety instructions and precautions you should follow:

- Read and understand all instructions before operating this system.
- Any maintenance to the light system must be done with power turned off.
- Any maintenance to the light system must be performed by a trained electrician who is thoroughly familiar with all applicable national and local codes in the country of use.
- Do not connect this beacon to the system when power is on.

- Do not disconnect the beacon while circuit is live or unless the area is known to be free of ignitable concentrations. Keep the beacon tightly closed when in operation.
- Never alter the unit in any manner. Safety of the unit may be affected if additional openings or other alterations are made to the internal components or housing.
- The nameplate should NOT be obscured, as it contains cautionary and/or other information of importance to maintenance personnel. Ensure the nameplate remains readable if the housing exterior is painted.
- If the dome is damaged in any way, it MUST be replaced.
- After performing any maintenance, test the light system to ensure that it is operating properly.

Failure to follow all safety precautions and instructions may result in property damage, serious injury, or death to you or others.

Changing from Flash Mode to Steady Mode

WARNING

EXPLOSION HAZARD—To prevent ignition of hazardous atmospheres, disconnect the fixture from the supply circuit before opening it.

WARNING

***EXPLOSION HAZARD
Do not disconnect the beacon while circuit is live or unless the area is known to be free of ignitable concentrations. Keep the beacon tightly closed when in operation.***

WARNING

EXPLOSION HAZARD—To maintain the vapor-tight enclosure, do not damage the dome or threads while disassembling or reassembling the unit. Lubricated threaded joints exposed for long periods of time may attract small particles of dirt or other foreign materials. Housing and cover joints should be reassembled immediately, with all the threads fully engaged.

Installation and Service Instructions

To change from the default Steady Mode to Flashing Mode.

1. Disconnect power to the device.
2. See Figure 3 on page 15. Remove the threaded dome assembly by twisting it counterclockwise.
3. Using a No. 2 Phillips screwdriver, remove two #8-32 pan-head screws holding the printed circuit board assembly to the die-cast housing. Be sure to retain the two nylon screw bushings isolating the bracket from the screws.
4. Gently lift the printed circuit board (PCB) assembly from the housing and turn the assembly over to access the component side of the printed circuit board.
5. See Figure 4 on page 16. Locate jumper J3 and lift the jumper to remove it from “Flash” setting. Re-seat the jumper over the pins labeled “Steady.”
6. Place the printed circuit board assembly back into housing, making sure that four insulating pads are seated between the metal bracket and die-cast housing. The bracket must be oriented so that the notch in the bracket is aligned with the ground screw in the die-cast housing. This step must be carefully followed to prevent arcing and dielectric failure.
7. Slide two #8-32 pan-head screws into the screw bushings and tighten screws to secure the printed circuit board assembly to the die-cast housing.
8. Thread the dome assembly back onto the housing by turning it clock-wise to tighten.

⚠ WARNING

SHOCK HAZARD

To avoid electrical shock hazards, do not connect wires while power is applied.

9. Reconnect the beacon to power.

10. Test the device by applying power and verifying the steady operation of the LED lamp.

Figure 3 PCB removed from housing

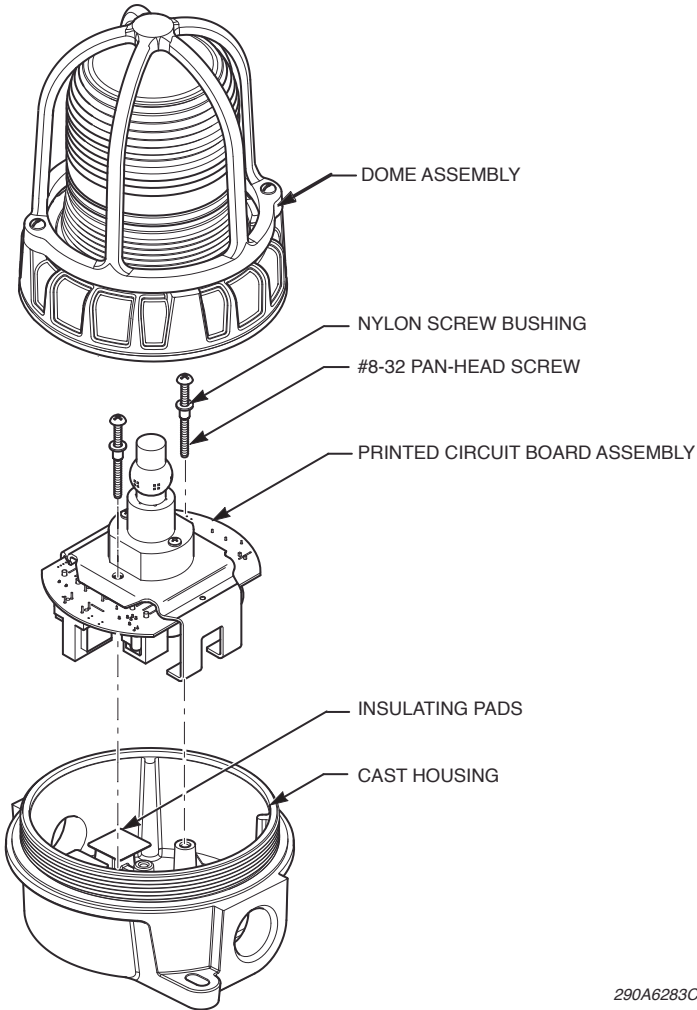
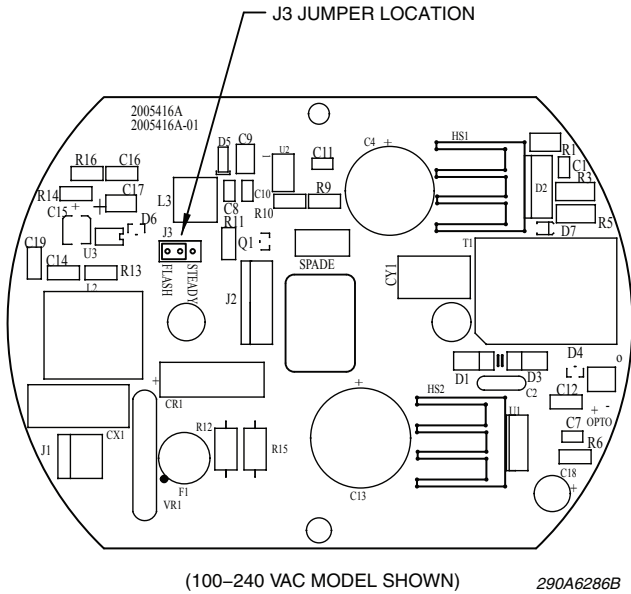


Figure 4 Location of jumper J3 on PCB



Cleaning the Fixture

⚠ WARNING

EXPLOSION HAZARD—Never use an abrasive material or file to remove corrosive materials from threaded surfaces. In extremely corrosive locations, equipment should be periodically inspected to guard against unusual deterioration and possible porosity, since this may weaken the enclosure structurally.

Maintenance procedures sometimes require fixtures to be hosed down for good housekeeping. The circuit should be turned off prior to hosing down the fixture.

The fixture should be cleaned periodically to maintain maximum light output. Only mild, non-abrasive cleaning agents should be used. The glass dome should be regularly inspected for scratches and chips, and if damaged, MUST be replaced.

Lubricating the Threaded Joint

The threaded joint on the cover should be kept well lubricated with a corrosion inhibiting grease such a petrolatum or soap-thickened mineral oil. If corrosive materials have accumulated on the threaded joints and cannot be removed with solvents, the parts should be discarded and replaced.

Getting Service, Assistance, and Parts

Please call 1-877-289-3246 for service, assistance and replacement parts. For instruction manuals and information about related products, please go to <http://www.federsignal-indust.com>.

⚠ WARNING

EXPLOSION HAZARD—Substitution of components may impair suitability for Class I, Division 2.

Typical spare parts are listed below. Due to certification, certain component parts are not available for field replacement. Units with this type of damage must be either replaced entirely or returned to Federal Signal for service.

Table 4 Replacement parts

Description	Part Number
Dome Assy., Red	K8449078
Dome Assy., Amber	K8449078-01
Dome Assy., Clear	K8449078-04
Dome Assy., Blue	K8449078-06
Dome Assy., Green	K8449078-07
Gasket	K8449080
Grease, 8 oz Tube	KR81-05-01
Dome Guard	K8449090
LED Emitter, Amber	K147169-06
LED Emitter, Blue	K147169-07
LED Emitter, Green	K147169-08
LED Emitter, Red	K147169-09
LED Emitter, Clear	K147169-10

Returning the Product for Credit

Product returns for credit require a return authorization from your local distributor prior to returning the product to Federal Signal. Please contact your distributor for assistance.

A product is qualified to be returned for credit when the following conditions are met:

- Product is resalable and in the original cartons
- Product has not been previously installed
- Product is the current revision
- Product has not been previously repaired
- Product is a standard product
- Product is not a service part

All returns are subject to a re-stock fee.

Defective products that are returned within the warranty period will be repaired or replaced at Federal Signal's sole discretion. Defective products do not include those products with lamp failure.

Circumstances other than those listed above will be addressed on a case-by-case basis.



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Industrial Systems

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Order Number	
	7376019
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Quote Expires On 12/31/2015

Bill To:

SHELL CANADA ENERGY
PO BOX 548 STATION 100
CALGARY, AB T2P 2J2
CA

Ship To:

SHELL CANADA ENERGY
P.O. BOX 480, STATION 100
CALGARY, AB T2P 2J1
CA

7809923878

Customer ID: 344594

PO Number	Ship Route	Taker	SalesRep
Rec Spares		ARLENE.RODGER	House Calgary

Quantities					Item ID Item Description	Pricing UOM Unit Size	Unit Price	Extended Price
Ordered	Allocated	Remaining	UOM Unit Size	D				

1.000	0.000	1.000	EA	(001) JON JPMG-336-CE-R ELEMENT	EA	1,491.2800	1,491.28
			1.0	GAS COALESCENT FILTER	1.0		

Order Line Notes: REC SPARES FOR: GAS COALESCER VESSEL
MODEL JVC - 3 - 8 - 1440 - 1 - 336 - STD

SOLD ONLY IN A BOX OF 4

QTY'S NEEDED ARE PER EACH UNIT:

START UP = 1 BOX
2 YEARS = 2 BOXES

1.000	0.000	1.000	EA	(002) AGS B906080008101121	EA	37.6200	37.62
			1.0	8" GASKET, FLEX CGI 600#	1.0		

Order Line Notes: REC SPARES FOR: GAS COALESCER VESSEL
MODEL JVC - 3 - 8 - 1440 - 1 - 336 - STD

QTY'S NEEDED ARE PER EACH UNIT:

START UP = 1
2 YEARS = 2

2.000	0.000	2.000	EA	(003) SPACO SCALE	EA	296.0000	592.00
			1.0	MAGTECH REPLACEMENT SCALE	1.0		

Order Line Notes: REC SPARES FOR: MAGTECH LEVEL GAUGE
S/N 24301N / 24302N

QTY'S NEEDED ARE PER EACH UNIT:

2 YEARS = 2

2.000	0.000	2.000	EA	(004) SPACO VISUAL INDICATOR	EA	862.0000	1,724.00
			1.0	MAGTECH REPLACEMENT VISUAL INDICATOR	1.0		

Order Line Notes: REC SPARES FOR: MAGTECH LEVEL GAUGE
S/N 24301N / 24302N

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Quantities					Item ID Item Description	Pricing UOM Unit Size	Unit Price	Extended Price
Ordered	Allocated	Remaining	UOM Unit Size	D				

QTY'S NEEDED ARE PER EACH UNIT:

2 YEARS = 2

1.000	0.000	1.000	EA	(005) SPACO FLOAT	EA	7,570.0000	7,570.00
			1.0	MAGTECH REPLACEMENT FLOAT	1.0		

Order Line Notes: REC SPARES FOR: MAGTECH LEVEL GAUGE
CAT # F063ADT - 1T/8B TITANIUM BALL FLOAT
LENGTH - 18"

QTY'S NEEDED ARE PER EACH UNIT:

2 YEARS = 1

1.000	0.000	1.000	EA	(006) SPACO FLOAT	EA	5,046.0000	5,046.00
			1.0	MAGTECH REPLACEMENT FLOAT	1.0		

Order Line Notes: REC SPARES FOR: MAGTECH LEVEL GAUGE
CAT # F088ADT - 1T/4B TITANIUM BALL FLOAT
LENGTH - 12"

QTY'S NEEDED ARE PER EACH UNIT:

2 YEARS = 1

1.000	0.000	1.000	EA	(007) SPACO RD4XNACE232	EA	1,356.0800	1,356.08
			1.0	2" D4 1/2" PORT NACE TRIM PARTS	1.0		

Order Line Notes: REC SPARES FOR: FISHER D4E CONTROL VALVE W/ EASY-DRIVE
TAG: PCV - 08064A, PCV - 08064D

QTY'S NEEDED ARE PER EACH UNIT:

2 YEARS = 1

1.000	0.000	1.000	EA	(008) SPACO RD4X0000022	EA	523.0600	523.06
			1.0	KIT, REPAIR, D4, ACTUATOR, PTFE PACKING	1.0		

Order Line Notes: REC SPARES FOR: FISHER D4E CONTROL VALVE W/ EASY-DRIVE
TAG: PCV - 08064A, PCV - 08064D

QTY'S NEEDED ARE PER EACH UNIT:

2 YEARS = 1

1.000	0.000	1.000	EA	(009) SPACO RD4XNACE242	EA	1,342.2200	1,342.22
			1.0	2" D3 3/4" PORT NACE TRIM PARTS	1.0		

Order Line Notes: REC SPARES FOR: FISHER D4E CONTROL VALVE W/ EASY-DRIVE
TAG: PCV - 08064B, PCV - 08064E

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Quantities					Item ID Item Description	Pricing UOM Unit Size	Unit Price	Extended Price
Ordered	Allocated	Remaining	UOM Unit Size	D				

QTY'S NEEDED ARE PER EACH UNIT:

2 YEARS = 1

1.000	0.000	1.000	EA		(010) SPACO RD4X0000022	EA	523.0600	523.06
-------	-------	-------	----	--	-------------------------	----	----------	--------

1.0 KIT, REPAIR, D4, ACTUATOR, PTFE PACKING 1.0

Order Line Notes: REC SPARES FOR: FISHER D4E CONTROL VALVE W/ EASY-DRIVE
TAG: PCV - 08064B, PCV - 08064E

QTY'S NEEDED ARE PER EACH UNIT:

2 YEARS = 1

1.000	0.000	1.000	EA		(011) SPACO RD4XNACE252	EA	1,352.2200	1,352.22
-------	-------	-------	----	--	-------------------------	----	------------	----------

1.0 2" D4 1" PORT NACE TRIM PARTS 1.0

Order Line Notes: REC SPARES FOR: FISHER D4E CONTROL VALVE W/ EASY-DRIVE
TAG: PCV - 08064C, PCV - 08064F

QTY'S NEEDED ARE PER EACH UNIT:

2 YEARS = 1

1.000	0.000	1.000	EA		(012) SPACO RD4X0000022	EA	523.0600	523.06
-------	-------	-------	----	--	-------------------------	----	----------	--------

1.0 KIT, REPAIR, D4, ACTUATOR, PTFE PACKING 1.0

Order Line Notes: REC SPARES FOR: FISHER D4E CONTROL VALVE W/ EASY-DRIVE
TAG: PCV - 08064C, PCV - 08064F

QTY'S NEEDED ARE PER EACH UNIT:

2 YEARS = 1

1.000	0.000	1.000	EA		(013) SPACO 4KG26A34S	EA	219.0800	219.08
-------	-------	-------	----	--	-----------------------	----	----------	--------

1.0 2600 GASKET KIT 1.0

Order Line Notes: REC SPARES FOR: 3" 150 RF X 4" 150 RF FARRIS RELIEF VALVE
TAG: PSV-08064B

QTY'S NEEDED ARE PER EACH UNIT:

2 YEARS = 1

1.000	0.000	1.000	EA		(014) SPACO 301218X9-010	EA	1,095.3600	1,095.36
-------	-------	-------	----	--	--------------------------	----	------------	----------

1.0 DISC L 1.0

Order Line Notes: REC SPARES FOR: 3" 150 RF X 4" 150 RF FARRIS RELIEF VALVE
TAG: PSV-08064B

QTY'S NEEDED ARE PER EACH UNIT:

2 YEARS = 1

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Quantities					Item ID Item Description	Pricing UOM Unit Size	Unit Price	Extended Price
Ordered	Allocated	Remaining	UOM Unit Size	D				
1.000	0.000	1.000	EA		(015) SPACO 4KG26A3S 2600 GASKET KIT	EA	127.8000	127.80
			1.0					
Order Line Notes:					REC SPARES FOR: 1 1/2" CL900 RF X 2" CL300 RF FARRIS RELIEF VALVE TAG: PSV-08064A			
					QTY'S NEEDED ARE PER EACH UNIT:			
					2 YEARS = 1			
1.000	0.000	1.000	EA		(016) SPACO 308482X5-010 DISC D	EA	472.2200	472.22
			1.0					
Order Line Notes:					REC SPARES FOR: 1 1/2" CL900 RF X 2" CL300 RF FARRIS RELIEF VALVE TAG: PSV-08064A			
					QTY'S NEEDED ARE PER EACH UNIT:			
					2 YEARS = 1			
1.000	0.000	1.000	EA		(017) SPACO 4KG26A1S 2600 GASKET KIT	EA	127.8000	127.80
			1.0					
Order Line Notes:					REC SPARES FOR: 600RFX2 150RF FARRIS RELIEF VALVE TYPE 2600 PSV MODEL 26DA13-120L/C SET @ 9930 KPAG 1" 600 RF X 2" 150 RF TAG: PSV-08063A			
					QTY'S NEEDED ARE PER EACH UNIT:			
					2 YEARS = 1			
1.000	0.000	1.000	EA		(018) SPACO 308482X5-010 DISC D	EA	472.2200	472.22
			1.0					
Order Line Notes:					REC SPARES FOR: 600RFX2 150RF FARRIS RELIEF VALVE TYPE 2600 PSV MODEL 26DA13-120L/C SET @ 9930 KPAG 1" 600 RF X 2" 150 RF TAG: PSV-08063A			
					QTY'S NEEDED ARE PER EACH UNIT:			
					2 YEARS = 1			
1.000	0.000	1.000	EA		(019) SPACO 4KG26A1S 2600 GASKET KIT	EA	127.8000	127.80
			1.0					
Order Line Notes:					REC SPARES FOR: 600RFX2 150RF FARRIS RELIEF VALVE TYPE 2600 PSV MODEL 26DA10-120L/C			

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Quantities					Item ID Item Description	Pricing UOM Unit Size	Unit Price	Extended Price
Ordered	Allocated	Remaining	UOM Unit Size	D				
					SET @ 9930 KPAG 1" 600 RF X 2" 150 RF TAG: PSV-08115A			
					QTY'S NEEDED ARE PER EACH UNIT: 2 YEARS = 1			
1.000	0.000	1.000	EA 1.0		(020) SPACO 308482X5-010 DISC D	EA 1.0	472.2200	472.22
1.000	0.000	1.000	EA 1.0		(021) EXH 041167.01.EL ELEMENT	EA 1.0	3,122.1400	3,122.14
					Order Line Notes: REC SPARES FOR: 230KW EXE CLASS A DIV.2 ELECTRICAL HEATER			
					QTY'S NEEDED ARE PER EACH UNIT: 2 YEARS = 10			
3.000	0.000	3.000	EA 1.0		(022) EXH 041167.01.STUDBOLTS STUDBOLT	EA 1.0	280.1400	840.42
					Order Line Notes: REC SPARES FOR: 230KW EXE CLASS A DIV.2 ELECTRICAL HEATER			
					QTY'S NEEDED ARE PER EACH UNIT: 2 YEARS = 3			
1.000	0.000	1.000	EA 1.0		(023) EXH S9090205000003 RTD	EA 1.0	1,514.3800	1,514.38
					Order Line Notes: REC SPARES FOR: 230KW EXE CLASS A DIV.2 ELECTRICAL HEATER			
					QTY'S NEEDED ARE PER EACH UNIT: 2 YEARS = 1			
1.000	0.000	1.000	EA 1.0		(024) EXH S9090245000003 RTD	EA 1.0	1,148.0000	1,148.00
					Order Line Notes: REC SPARES FOR: 230KW EXE CLASS A DIV.2 ELECTRICAL HEATER			
					QTY'S NEEDED ARE PER EACH UNIT: START UP = 0 2 YEARS = 1			

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Quantities					Item ID Item Description	Pricing UOM Unit Size	Unit Price	Extended Price
Ordered	Allocated	Remaining	UOM Unit Size	D				
1.000	0.000	1.000	EA		(025) EXH S0230200100004 1.0 GASKET	EA	824.1800	824.18
					Order Line Notes: REC SPARES FOR: 230KW EXE CLASS A DIV.2 ELECTRICAL HEATER			
					QTY'S NEEDED ARE PER EACH UNIT:			
					START UP = 1 2 YEARS = 1			
1.000	0.000	1.000	EA		(026) EXH S03702000500199 1.0 ACH	EA	987.5200	987.52
					Order Line Notes: REC SPARES FOR: 230KW EXE CLASS A DIV.2 ELECTRICAL HEATER			
					QTY'S NEEDED ARE PER EACH UNIT:			
					START UP = 0 2 YEARS = 1			
1.000	0.000	1.000	EA		(027) END 71097759 1.0 KIT P.S.B. 40/8X 24V REX330	EA	1,735.6090	1,735.61
					Order Line Notes: REC SPARES FOR: 7F2B50-19R3/0 & 7F2B2H-13J8/0			
					7F2B50-C3CCCD1AASK+EBJALALDZ & 7F2B2H-C3BCCD1AASK+EBJALALDZ1			
					PROV IRL F 200, 7F2B50, DN59 2" VORTEX FLOWMETER			
					QTY'S NEEDED ARE PER EACH UNIT:			
					2 YEARS = 1			
1.000	0.000	1.000	EA		(028) END 50094003 1.0 KIT 10 FUSES 250 VAX T 2A00	EA	321.8000	321.80
					Order Line Notes: REC SPARES FOR: 7F2B50-19R3/0 & 7F2B2H-13J8/0			
					7F2B50-C3CCCD1AASK+EBJALALDZ & 7F2B2H-C3BCCD1AASK+EBJALALDZ1			
					PROV IRL F 200, 7F2B50, DN59 2" VORTEX FLOWMETER			
					QTY'S NEEDED ARE PER EACH UNIT:			
					2 YEARS = 1			

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Quantities					Item ID Item Description	Pricing UOM Unit Size	Unit Price	Extended Price
Ordered	Allocated	Remaining	UOM Unit Size	D				
1.000	0.000	1.000	EA		(029) END 50106097	EA	2,666.6000	2,666.60
			1.0		KIT MEAS.AMPLIFIER PROMASS 83/8ME WEA	1.0		
					Order Line Notes: REC SPARES FOR: 7F2B50-19R3/0 & 7F2B2H-13J8/0			
					7F2B50-C3CCCD1AASK+EBJALALDZ & 7F2B2H-C3BCCD1AASK+EBJALALDZ1			
					PROV IRL F 200, 7F2B50, DN59 2" VORTEX FLOWMETER			
					QTY'S NEEDED ARE PER EACH UNIT: 2 YEARS = 1			
1.000	0.000	1.000	EA		(030) END 50098301	EA	2,930.5400	2,930.54
			1.0		KIT COM 53/55/83/93 CURR./FREQ.OUT EX	1.0		
					Order Line Notes: REC SPARES FOR: 7F2B50-19R3/0 & 7F2B2H-13J8/0			
					7F2B50-C3CCCD1AASK+EBJALALDZ & 7F2B2H-C3BCCD1AASK+EBJALALDZ1			
					PROV IRL F 200, 7F2B50, DN59 2" VORTEX FLOWMETER			
					QTY'S NEEDED ARE PER EACH UNIT: 2 YEARS = 1			
1.000	0.000	1.000	EA		(031) END 50096754	EA	1,298.7200	1,298.72
			1.0		KIT DISPLAY MODULE	1.0		
					Order Line Notes: REC SPARES FOR: 7F2B50-19R3/0 & 7F2B2H-13J8/0			
					7F2B50-C3CCCD1AASK+EBJALALDZ & 7F2B2H-C3BCCD1AASK+EBJALALDZ1			
					PROV IRL F 200, 7F2B50, DN59 2" VORTEX FLOWMETER			
					QTY'S NEEDED ARE PER EACH UNIT: 2 YEARS = 1			

Total Lines: 31

SUB-TOTAL: 42,585.01
TAX: 2,129.24
AMOUNT DUE: 44,714.25



Start-Up & Operating Instruction Manual

- Natural Gas Pressure Reduction Skid Package

Rev.0

August 2015

Manufactured For: Shell Carmon Creek Project (CMT)

Section I - System Description

This package is used to reduce pressure and meter the natural gas for the construction CMT at Carmon Creek Field Facilities. The process is to use a series of pressure regulators to reduce the gas pressure from the package inlet pressure down to the required outlet pressure while maintaining a set outlet gas temperature at a measurable flow rate.

Natural gas for the construction CMT will be supplied by a 2" inch natural gas pipeline; the system is designed to supply natural gas at Max. Flow rate 1540 m³/day at the desired pressure and temperature, the minimum flow rate can be as low as 10% of the Max. Flow rate (See P&ID & PFD'S and Heat Mass Balance for base cases).

The package consists of coalescer filter with isolation valves & bypass in the piping system, natural gas electrical heater, condensate storage tank with truck out and enviro box, mercaptan odorizer, pressure reduction system (1 stream, 1 x 100% operating, with three pressure regulators to satisfy various process conditions and isolation valves), coriolis flow meter, high - integrity pressure protection system, pressure relief valves, associated piping, fittings and instrumentation (pressure transmitter, pressure gauge, temperature transmitter and temperature gauge, etc.).

Electrical Room:

Process and Safety Control is performed by three Control Panels found in the Electrical Room. The natural gas heater is controlled by CP-21603. Safety Shutdowns are performed by SIL rated trip alarms and relay modules located in CP-21602. A PLC located in CP-21601 controls the automated process, as well as monitors both CP-21602 and CP-21603. An HMI located on CP-21601 allows the operator to view the status of all three panels, as well as control over the skid process, based on user level. Critical building alarms are sent from CP-21601 to the control room through the remote PLC inside TER-202. The control room can remote trip the natural gas skid through CP-21602.

Building, HVAC and Miscellaneous

The natural gas pressure reduction package has a self-framing building with HVAC system.

HVAC is sized and based on heat gain from equipment; Six (6) Air Changes per Hour (ACH) shall be maintained at a positive pressure during normal operating conditions. This is achieved by one fan in each room operating all the time (C-08169 for the electrical room and C-08165 for the process room). Also the shelter shall maintain minimum temperature of 10 °C in winter and maximum temperature of 35 °C in summer. The minimum temperature is maintained by a thermostat and heater in each room (TS-08170 and H-08170 in the electrical room and TS-08167 and H-08167 in the process room). The maximum temperature is controlled by a thermostat and fan in each room (TS-08166 and C-08166 in the electrical room and TS-08168 and C-08168 in the Process Room). C-08168 can also be activated by confirmed LEL detection in the process room (see cause and effects diagrams).

Normal operation has the hand switches for the fans (SW-08166 and SW-08169 in the electrical room and SW-085174 and SW-08165 in the process room) on (closed contact) at all times.

HVAC CP-21604 sends a common alarm XI-21601A1 to control room (see Cause and Effects for more details). A building low temperature alarm (XI-21601B1) is provided by TT-21601A is sent to the control room.

Inlet Section:

The ESDV is used to isolate the skid from the upstream gas line in the case of an emergency. The ESDV is open in normal operation but will close when the skid trips from CP-21602. See the Cause and Effects diagrams for more details on what causes the skid to trip.

Coalescer Filter:

Natural Gas Filter Coalescer Unit is installed to remove the entrained liquids and solid particles from the gas stream down to less than 0.5 microns. Coalesced particles and liquids greater than 0.5 microns will be collected in the vessel. These particles and liquids can be drained manually using choke valves into the truck out storage tank (V-08092). Manual *draindown* of the coalescer filter should be done when the liquid level in LI-08070B reaches $\frac{1}{2}$ to $\frac{3}{4}$ of the level gauge. Note: Operator to be aware that when draining down liquid level there is a possibility for gas blow through. Relief valve PSV 08070A has been designed for fire case on the coalescer filter.

Initial pressure drop across the filter (PDI-08070A) should be low and typically not exceed 7 to 10 kPag with clean and dry condition; once the element are wetted, the clean pressure drop may reach 14 kPag. The filter is replaceable, and in normal service, the recommended element change out interval is once every 12 months or earlier. If excessive solids are present, this may necessitate a more frequent change-out based on differential pressure of 70 -83 kPag. Periodic checks will be required to monitor the pressure drop across the filter.

Condensate Storage Tank:

The collected fluid will be stored in a condensate tank and will be emptied through a truck-out connection complete with enviro box and will be trucked out when necessary (typically the liquid content reaches to $\frac{1}{2}$ – $\frac{3}{4}$ volume of the tank), the level gauge indicator is mounted on the top of the tank and shows the liquid level of the tank in eighths of a tank on one side, and quarters of a tank on the other side.

Condensate storage tank is vented to atmosphere (outside the skid) and may have hydrocarbon release when draining down the coalescer filter to tank.

Natural Gas Electric Heater:

Natural Gas Heater is installed to avoid the formation of hydrates, liquid hydrocarbons, and liquid/solid water as a result of pressure reduction. The gas heater is designed to raise the temperature of the gas so that after pressure reduction, the temperature meets the outlet gas temperature set-point of 25°C.

Pressure Control Valves:

The pressure regulators control the outlet gas pressure to a normal operating pressure of 160 kPag at the skid limit through a three valve let-down stream.

Downstream of the control valves PZT-08071D will protect the piping by tripping the skid (See cause and effects diagrams) at 563 kPag. In addition there are two PSVs, one located upstream of the PRVs and one downstream that will protect the piping in the case of overpressure due to fire around the natural gas heater (upstream PSV) and PRV failure (downstream PSV). See the P&ID for more details.

Flow Measurement section:

The gas flow is measured using a Coriolis Meter (FT-08071A1) with a volumetric output in standard meters cubed per day. There is a totalizer built into the local PLC that will record the daily gas usage. Previous day, present day, and running totals are available on the HMI on CP-21601.

Mercaptan Odorizer:

The Natural Gas from the pipeline is odorless, so for use around human occupancy it is required to introduce mercaptan into the gas stream to provide a smell. This is accomplished by diverting a portion of un-odorized natural gas through the mercaptan odorizer vessel V-08116 where it picks up some of the mercaptan before returning to the main gas line. Factory technicians would provide the service on initial setup including the valve adjustment to the proper volume of the by-passed gas through the odorizer. During operation, the refill interval is based on the usage; its range could be as low as one refill every ten years (minimum flow case of 150 Sm³/day) or be as high as one refill every two years (Max flow case of 1540 Sm³/day). The level gauge LI-08116A on the top of the odorizer is required to check the level of the

mercaptan and should be monitored periodically to determine when the refill will be required. The factory provided refill services are to meet the CSA standard Z662-11 for oil and gas pipeline systems. Detailed info. for the odorizer including details on initial set-up can be found in its IOM (See Hardware, Software and Firmware Manuals).

A PSV is located downstream of V-08116 for the fire case.

Section II - Start-Up and Operating

Factory Acceptance Test (FAT) has been performed in the shop prior to shipping to site. Instrumentation and control systems have been tested and calibrated to ensure proper operation, the electrical power and control panel has been pre-set to a “ready to run” status as well. The gas heater and its control panel were unable to be tested due to the possibility of damaging the heater with no gas flowing through it. Commissioning to thoroughly check the gas heater and its control panel prior to start-up and ensure any other outstanding items from the FAT are closed out prior to start-up. See the factory acceptance test report for more details.

Caution:

Ensure the source natural gas to the package inlet has been fully shut off before the starting the following procedure.

Ensure all external connections to skid are complete.

Electrical Hookup and pre-check before unit start.

Confirm all ESD, Fire, and LEL alarms have been cleared.

Check to ensure the coalescing filter is in position, refer to filter vessel IOM.

Check the hydraulic oil is in the correct level in the reservoir on ESDV valve, refer to ESDV IOM.

Check the odorizer has been properly filled, refer to odorizer IOM.

Ensure to close all the drain/vent valves on the equipment and piping, refer to PID.

Ensure to close the process bypass valves, refer to PID.

Ensure to open the all the process valve including those isolating valves for the equipment and instruments, refer to PID.

Ensure to close the outlet drain valve after the condensate storage tank, refer to PID.

Confirm all Control Loop Auto Set points and ensure pressure control parameters are set.

Once the above steps have been properly finished, the package can be pressurized to operation by gradually opening the site natural gas supply.

Plan valve line-up to allow for slow and controlled pressure-up of skid checking for gas leaks as pressure increases.

Caution:

Observe to see if the package is in a steady condition.

If any abnormal condition appears, SHUT OFF the natural gas supplies immediately and Recheck the unit.

Reference Document Table

	Document description	Shell Document #
1	P & ID drawing	CCK-4512109130-0735-C01-00001-001
2	Bill and Materials drawing	CCK-4512109130-0735-C04-00001-000
3	General Arrangement drawing	CCK-4512109130-0735-B01-00001-001
4	Cause and Effect Diagram - Process	CCK-4512109130-0735-C14-00001-000
5	Cause and Effect Diagram – Fire and Gas	CCK-4512109130-0735-C14-00002-000
6	Factory Acceptance Test Report	CCK-4512109130-0735-K05--00002-000
7	Control Philos. and Block Logic Diagrams	CCK-4512109130-0735-C15-00001-000
8	Erection and installation Procedure	CCK-4512109130-0735-G01-00001-000
9	PFD'S and Heat Mass Balance	CCK-4512109130-0735-C13-00001-000
10	Startup and Shutdown Flowcharts	CCK-4512109130-0735-J01-00001-000
11	Hardware, Software and Firmware Manuals	CCK-4512109130-0735-J01-00003-000

SECTION 3.0
QUALITY CONTROL DOCUMENTS

3.1 Testing Procedures



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1. Introduction and Certification

1.1. Purpose of Quality Assurance Management

1.1.1. Definition

Quality Management is a method for ensuring that all the activities necessary to design develop and implement a product or service are effective and efficient with respect to the system and its performance. Quality management can be considered to have three main components: quality control, quality assurance and quality improvement. Quality management is focused not only on product quality, but also the means to achieve it. Quality Assurance is the control of processes as well as products to achieve more consistent quality.

1.1.2. Certification of the Quality Management System

The quality system in place at National Process Equipment was developed under the guidelines of ISO 9001:2008 Quality System, and is accurately documented in the Quality Assurance Manual.

I certify that the system described in this manual, and in the supporting procedures and instruction, is fully implemented at:

National Process Equipment

David Zyba

Vice President Operations, National Process Equipment Inc.

1.1.3. QMS Manual Foundation and Structure

The Quality Program Manual makes reference to both higher and lower level documents in the next immediate tier. The same practice will be followed for all other quality system documents. (For example, the appropriate Quality Assurance Procedures are referenced in this manual. Detailed instructions and forms are not - they will be referenced in the applicable procedure.) This practice reduces the opportunities for error as well as improving the efficiency of the maintenance activities.

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2. Organization Table and Functional Definition and Responsibilities

2.1. Natpro Matrix Organizational Chart

2.1.1. Chief Operating Officer (COO)

The COO has complete responsibility and authority concerning all Quality Assurance matters, including but not limited to, defining and implementing Quality Assurance policies.

2.1.2. Vice President of Operations

The VP of operations will provide adequate resources to maintain the quality system and nominates as his representative the Quality Assurance Manager. The VP of Operations will conduct annual Quality Assurance Review Committee meetings and other management reviews, as required.

2.1.3. Quality Assurance Manager

The VP of Operations of National Process Equipment will appoint the Quality Assurance Manager. The Quality Assurance Manager will be responsible for the implementation and maintenance of the quality assurance system throughout the National Process Equipment organization. The Quality Assurance Manager will be responsible for:

- a) Creation of the Quality Assurance Policy Manual and all appropriate changes.
- b) Auditing or review of appropriate process notes and procedures as initiated by other teams or offices including verification of their compatibility with the Quality Assurance Policy Manual.
- c) Overseeing planning, preparation and establishment of the required internal and external quality audits.
- d) Verifying the implementation of corrective action(s) resulting from quality system audits.
- e) The functional operation of the Quality Assurance Department.
- f) QA Manager reviews and has control over our engineering practices.
- g) Annually reporting of Quality Assurance program status to the VP of Operations.

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2.1.4. Sales

The sales team will verify that technical and commercial information is provided to National Process Equipment customers.

The sales team will review customer requests for quotations and ensure that the quotation covers all aspects of the inquiry and that the requirements can be provided by National Process Equipment before a purchase order is accepted.

The sales teams will compile the quotation covering the customer's inquiry.

The sales team will review the customer contract and its specifications for compliance to the National Process Equipment quotation. Any deviations will be reported and then the necessary proposal(s) negotiated until final agreement and approval is obtained from the parties involved. Project management will provide order acceptance.

The records concerning deviation approval will be properly maintained. The Sales team will process all required documents quickly and completely to ensure compliance to contractual specifications.

2.1.5. Operations

Engineering will ensure that all goods, services, and processes meet Customer specifications, NPE standards, and industry codes.

Project Management will ensure the conformity to listed contract specifications.

Project Management will ensure the Customer is fully communicated with regarding schedule and compliance to the agreed plan.

Contract Administration will generate the required documents in a timely manner to facilitate compliance to contractual specifications.

The Production team will be responsible for producing the final product in accordance with the specifications and requirements stipulated by Project Management.

Production will be responsible for establishing internal schedules and programs for compliance to contractual requirements.

Production will verify that appropriate personnel understand the established work procedures concerning product quality.

Procurement will obtain goods and services that conform to specifications and will participate in auditing selected suppliers. (Production will acquire general consumption goods and subcontracted services.)

The Service Department will provide assistance to customers according to contractual requirements or as appropriate.

Service tasks will be performed in a professional manner to maintain customer satisfaction.

Field problems and corrective actions, including proposals for product improvements, will be documented.

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2.1.6. Accounting and Finance

The Accounting and Finance Group maintains ledgers and records needed to meet regulatory requirements according to generally accepted accounting principals.

2.1.7. Quality Assurance Review Committee

A Quality Assurance Review Committee (QMS) exists and functions to oversee compliance to policies and procedures of the quality system. The Quality Assurance Review Committee shall consist of, as a minimum, the VP of Operations, the VP of Sales, the Value Stream Managers, the Functional Managers, and the Manager of Quality Assurance.

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3. Quality System Policies

3.1. Management Responsibilities

3.1.1. Objective

National Process Equipment is committed to be the most valuable link between the manufacturers and the customers in the supply of industrial pumps, compressors and related process equipment in Canada. We will attain this by identifying and focusing on the elements of our distinctive core competencies:

- a) Building principal supplier relationships,
- b) Pre-sale, technical and sales expertise,
- c) After-market service, and
- d) Integrated logistics.

It is to this end that management directs all employees of the company to ensure that the quality of products and services supplied meet our customers' requirements. The policy statements provided in the Quality Assurance Manual are intended to direct our efforts in key areas to ensure that this goal is consistently achieved. These policies are mandatory for employees involved in the affected functions.

3.1.2. Policy

Every employee will strive to meet or exceed customer expectations in all transactions and activities through use of a planned total quality management system and observation of the following principles:

- a) Employees emphasize a pro-active work environment for prevention rather than detection and correction.
- b) Employees recognize and treat each internal or external recipient of a process or activity as interdependent process.
- c) Employees apply methods of continuous improvement in their efforts to produce quality products and customer service.
- d) Employees increase their levels of proficiency by taking advantage of training opportunities, both individually and collectively.
- e) Employees use verifiable methods to measure and control processes.
- f) Employees measure and report progress in key elements (such as timely delivery and customer service) of customer satisfaction.
- g) Employees are responsible for reporting any known product non-conformance, process failure, document error and system non-compliance to their supervisor.

Each employee of National Process Equipment is responsible for providing quality products and customer satisfaction.

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3.1.3. Commitment

The management of National Process Equipment provides the resources necessary to ensure that this quality assurance policy is understood, implemented and maintained at all levels in the organization.

3.1.4. Purpose and Scope

All personnel through proper responsibility, authority and channels according to the following descriptions and organization table shown in 3.1 will support the defined quality program of National Process Equipment. This program shall comply with general industrial norms and the ISO-9002: 1994 standard with the exception of Statistical Techniques, which are neither required nor used in National Process Equipment processes.

3.1.5. Method

The Quality Assurance department will define, document and ensure implementation of quality policies, procedures and operating instructions at all levels of the organization. Management will provide adequate resources for the attainment of quality products, services, and work environment objectives.

The authority to maintain and verify the effectiveness of the quality assurance system in accordance with the ISO-9002: 1994 will be delegated to the Quality Assurance Manager. The Quality Assurance Manager, as the management representative, has the authority to initiate actions and solutions to prevent non-conformities and to prevent the manufacture, assembly and testing of all non-conforming product(s). This Quality Assurance Policy Manual is made available to customers and employees. The Quality Assurance Manual shall be updated and controlled according to National Process Equipment Quality Assurance Procedure QAP-017 and controlled according to procedures QAP-005.

Training in the Quality Assurance Procedures shall be provided to all employees at National Process Equipment.

3.1.6. Verification Activities (Resources and Personnel)

The Sales Team identifies product requirements. These include external customer requirements, as applicable.

Project Management is responsible for establishing verification methods that will ensure customer requirements are met and documenting them on engineering drawings, quality plans, and production planning.

Project Management is responsible for auditing the test procedures to assure verification requirements are satisfied.

Production is responsible for testing the product(s) per test procedures.

Quality Assurance will schedule and maintain documentation of internal audits per the Internal Audit Procedure to assure that resources are available to complete all defined inspection, test and monitoring activities.

It is each office or groups' responsibility to assure that their employees fully understand all procedures pertaining to their area of responsibility.

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3.1.7. Management Review

The Quality Assurance Review Committee, led by the VP of Operations or their designate, shall conduct a thorough review of the entire quality system at least once a year.

This review will cover, as a minimum, the following:

- a) Evaluation of the suitability and effectiveness of the established plans, procedures and internal/external audits as defined by the Quality Assurance Policy Manual.
- b) Evaluation of the proposed process changes and financial implications as they affect quality.
- c) Customer complaints and corrective action requests concerning quality received and proposed corrective and preventive action plans.
- d) The quality objectives of the previous period shall be reviewed and quality objectives for the next period shall be established during this review..

The results of the quality system review will be documented and reported to all National Process Equipment personnel.

3.1.8. References

- a) QAP-005, Document Control Procedure
- b) QAP-017, Internal Quality System Audit Procedure
- c) QN-400, Quality Assurance Manual
- d) Special Procedures
- e) Quality Assurance Forms
- f) Quality System Review meeting agenda, minutes and task lists.
- g) ISO 9002, paragraph 4.1
- h) QMS Policy and Procedure

3.1.9. Records

The Quality Assurance Manager will maintain the Quality Assurance Manual, Special Procedures and Quality Assurance Review Committee reports.

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3.2. Quality Management System

3.2.1. Policy

In order to implement and maintain management of quality and ensure that the product requirements are clearly defined and met, National Process Equipment has created and implemented a quality system based on the ISO 9002:1994 standard.

To achieve compliance with the specified requirements, the quality system involves the following activities:

- a) Preparation of Quality Plans.
- b) Identification and acquisition of verification equipment used to meet the specified quality.
- c) Maintenance and updating of manufacturing/inspection resources.
- d) Evaluation of metrology needs.
- e) Clarification of standards of acceptability.
- f) Compatibility of all organization processes, procedures and documentation.
- g) Accurate identification and maintenance of quality records.

Effective implementation of the procedures shall be verified through internal audits. If stipulated by the original purchase order, the customer or his representative can inspect the effective implementation of the quality program.

3.2.2. Purpose and Scope

The Quality Management System establishes and maintains documented procedures ensuring that a quality system is implemented for conformance to specified requirements from quotation, to order award, through shipment of product, invoicing, financial completion, warranty support, ending with aftermarket support.

3.2.3. Responsibility

The responsibility and authority to maintain the quality management system is assigned to the Quality Assurance Manager

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3.2.4. Method

The quality system is implemented and maintained through the use of:

- a) **Quality Assurance Manual:** The Quality Assurance Manual stipulates the company's general structure, objectives and guidelines to implement the ISO 9002 standard continuously and successfully. Furthermore, the Quality Assurance Manual references procedures and other documentation applicable to the different policy requirements.
- b) **Quality Assurance Procedures:** Quality Assurance Procedures provide detailed directions in a local area, as required. The procedures are developed and maintained to provide the control of activities affecting quality and to determine responsibilities within the quality system.
- c) **Forms and Records:** Quality Assurance Forms are supporting documents which are used to distribute information and record data which is retained for possible future usage as a quality record.
- d) **Quality Plan:** A Quality Plan is "a document setting out the specific quality practices, resources and sequence of activities relevant to a particular product, project or contract." When required by contract or the scope of work, Quality Plans shall be order specific. The requirements of the operating procedures and will define the quality plan for all other products and orders.
- e) **Quality Assurance Stamps:** Quality Assurance Stamps are numbered rubber stamps registered to employees who are responsible for identifying hold and inspection points and for performing inspections. The stamp is applied according to Procedure QAP-023.

3.2.5. Documents

- a) Quality Assurance Manual (QPM)
- b) Special Procedures
- c) Forms and Records
- d) QAP-023, Quality Assurance Stamp Procedure
- e) ISO 9002, paragraph 4.2
- f) ISO 8402. Paragraph 3.1
- g) ISO/DIS 9004-5 (Reference only)
- h) QMS Policy and Procedure Document

3.2.6. Records

An index of all quality documents (policies, procedures, operating instructions and forms) is available from the Quality Assurance Manager.

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3.3. Contract Review

3.3.1. Policy

The Sales Team is responsible for reviewing and handling customers' documents according to defined guidelines. Inquiries will be evaluated for compatibility with company goals. Inquiries will be evaluated on the basis of customer, product line and feasibility.

Emphasis is placed on products manufactured by National's principal suppliers.

Inquiries will be responded to in a professional and timely manner. Responses will be well supported technically and commercially. The technical merits and benefits of products offered shall be sufficiently detailed. Literature supplied will identify National Process Equipment as the representative for that product.

In the case of inquiries in which no suitable product can be supplied by National Process Equipment, the customer will be notified of our intention not to quote in a timely and professional manner.

When a quoted inquiry results in the award of an order that accurately reflects National's quote, a unique order number shall be assigned to the contract. If the order as awarded differs from the quote, Sales shall ensure that the discrepancies are fundamentally resolved and documented prior to proceeding with the order.

Customer purchase orders for new product that is to be invoiced shall be written. They must be identified as a purchase order and may be received by mail, fax or e-mail. Work for these orders shall not proceed prior to verification of signed customer purchase order by Sales. (If a customer uses a system that does not include issue of written purchase orders, appropriate measures must be taken to ensure that both parties are in full agreement regarding the specification of product and the commercial terms. In all such cases, Project Management and Accounts Receivable must approve the order prior to commencing work.)

Communications between the customer and National Process Equipment that affect the contract shall be fully documented. Updates and coordination with the customer shall be established and maintained.

Performance may occur for field service and counter sale orders. In the case of field service, customer acceptance is signified on the applicable control document. In the case of counter sale orders, acceptance is signified through prepayment. In both cases customer acceptance is used to ensure that National Process Equipment has a clear understanding of the order requirements.

3.3.2. Purpose and Scope

The Inquiry Review process is used to evaluate the customer inquiry requirements for compatibility with the capabilities of the appropriate National Process Equipment product lines, and to ensure these are adequately documented.

Contract Review procedures ensure that National Process Equipment understand all contractual requirements of the customer's order, and to ensure these are adequately documented and passed to the appropriate functions within the organization.

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3.3.3. References

- a) Quotation
- b) Technical Literature
- c) QAP-004, Contract Review Procedure
- d) QAP-021, Contract Amendment Procedure
- e) Contract File
- f) Customer Purchase Order and change orders
- g) ISO 9002, paragraph 4.3
- h) Baan Order Processing Procedures
- i) Order Management Procedures

3.4. Design Control

In our company, we design the product according to the contracted requirements or specification. That design sometimes may change due to evolving technical improvements and/or revised design requirements.

3.4.1. Goal

We believe it is important for us to maintain control over how our products are being designed and over the possible changes in the design. This is to make sure the product not only fulfills customer requirements but also stays within contracted features.

We believe that effective design control will result in reduced costs by helping eliminate wasted effort and material due to incorrect or unauthorized design changes. It will also ultimately result in increased business due to customer satisfaction from getting expected goods and services.

3.4.2. Policy

Thus, it is the policy of this company to adhere to the ISO 9001 section 4.4 standard on Design Control.

To ensure that the contracted requirements are met, it is our policy to always maintain control of the design of the products we make and to verify that design.

It is also our policy to use and maintain procedures to control and verify the design of our product.

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3.4.3. Design and Development Planning

To effectively coordinate the design effort and avoid misdirection or areas of work not covered, it is our policy to always have plans that identify the responsibility for each design and development activity.

To maintain the management of the project, it is also our policy to always use these plans to describe or reference these activities. These plans are always updated as the design evolves.

3.4.4. Activity Assignment

To ensure the design and verification activities are done correctly, those activities are planned and assigned to qualified staff equipped with adequate resources.

3.4.5. Organizational and Technical Interfaces

To avoid poor or incomplete communications that could result in lack of design coordination and even cause mistakes, it is our policy to always identify the organizational and technical interfaces between different involved groups and to document, transmit, and regularly review the necessary information concerning these interfaces.

3.4.6. Design Input

To avoid confusion about the inputs to the design and to ensure complete understanding of what the customer wants, it is our policy to always identify, document and review the selection by our engineering staff for adequacy of the design input requirements relating to the product.

It is also our policy to always resolve incomplete, ambiguous, or conflicting requirements with those responsible for drawing up these requirements. This is done during the design review.

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3.4.7. Design Output

To ensure the design conforms to the goal of satisfying customer requirements, it is our policy to always document our design output and express it in terms of requirements, calculations, and analyses.

It is also our policy that our design output always:

1. Meets the design input requirements;
2. Contains or references acceptance criteria;
3. Conforms to appropriate regulatory requirements whether or not these have been stated in the input information;
4. Identifies those characteristics of the design that are crucial to the safe and proper functioning of the product.

3.4.8. Design Verification

To avoid careless or incomplete verification of our design, it is our policy to always plan, establish, document, and assign to competent personnel functions for verifying that design.

By design verification we mean the activity that establishes that design output meets the design-input requirement by means of design control measures such as:

1. Holding and recording design reviews;
2. Undertaking qualification tests and demonstrations;
3. Carrying out alternative calculations; and
4. Comparing the new design with a similar proven design, if available.

3.4.9. Design Changes

To avoid unauthorized, unnecessary, or incorrect changes and modifications to the design of our product, as well as to avoid the risk of losing track and control of changes, it is our policy to always have design changes and modifications identified, documented, and reviewed and approved.

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3.5. Document Control

3.5.1. Policy

Documents related to internal quality standards are approved, reviewed and updated by the originator where possible, and appropriate approval functions depending on the document type.

Technical documents related to a contract will be processed in time to prevent delays in production and delivery.

Paper documents that do not bear the appropriate status control indicator are considered to be uncontrolled, with the exception of master copies.

3.5.2. Purpose and Scope

Document control procedures ensure that:

- a) Pertinent issues of appropriate documents are available at all locations where operations essential to the effective functioning of the quality system are performed.
- b) Obsolete documents are promptly removed from all controlled points of issue or use and, if necessary, replaced by an updated document.
- c) Obsolete quality documents are maintained in the Quality Assurance office for historical reference only.

Essential documentation includes but is not limited to:

- d) the Quality Assurance Manual
- e) engineering specifications, drawings, procedures and work instructions
- f) Quality Plan
- g) special process procedures and documentation

3.5.3. References

- a) QAP-005, Document Control Procedure
- b) ISO 9002, Paragraph 4.5

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3.6. Purchasing

3.6.1. Policy

National Process Equipment ensures that purchased products conform to specified requirements by:

- a) assessing sub-contractors on the basis of their ability to meet National Process Equipment requirements, including quality requirements
- b) providing clear and detailed descriptions on purchase orders
- c) verifying that the purchased product meets the specified requirements either at source or upon receipt.

3.6.2. Purpose and Scope

This procedure ensures that the purchased product conforms and meets the specified requirements of the contract. All purchasing activities, from selection of sub-contractors to receipt of purchased product, are documented in the purchasing procedure QAP-006.

Purchasing activities include selection of sub-contractors, establishment of Approved Suppliers List, issuing of purchase orders and verifying that purchased products meet the specified requirements.

3.6.3. References

- a) QAP-006 Purchasing Procedure
- b) ISO 9002, paragraph 4.6
- c) Baan Order Processing Procedures
- d) QAP-056 Commodity Standardization Procedure

3.7. Control of Customer Supplied Product

3.7.1. Policy

Procedures for inspection, safe handling and integration of the customer's supplied materials shall be defined. Customer supplied material that is to be incorporated into the National Process Equipment or principal's scope of supply shall be inspected upon receipt. It shall be stored safely and any instructions concerning storage or maintenance shall be followed to ensure its suitability for use.

In case of damage, loss or unsuitability reported to or by Contract Administration or the Production Manager, the customer shall be notified and mutually agreeable corrective action shall be determined according to procedure.

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3.7.2. Purpose and Scope

Customer Supplied Product procedures ensure conformity of the customer supplied product and its point of incorporation into the production scheduling.

Note: verification by National Process Equipment does not absolve the customer of the responsibility to provide acceptable product.

3.7.3. References

- a) QAP-007, Customer Supplied Product Procedure
- b) QAP-010, Inspection and Testing Procedure
- c) QAP-013, Control of Non-conforming Product Procedure
- d) QAP-015, Handling, Storage, Packaging and Delivery Procedure
- e) ISO 9002, paragraph 4.7
- f) Baan Order Processing Procedures

3.8. Product Identification and Traceability

3.8.1. Policy

Established procedures and work instructions control the identification and traceability of individual parts or components.

Identification of products shall commence upon receipt of a customer purchase order an unique order identification number shall be assigned to each contract. This number shall follow the Quality Assurance System from receipt of products through to shipment of goods. This number shall be stamped, where feasible, on an identification plate and permanently attached to the equipment.

3.8.2. Purpose and Scope

Procedures are established and maintained to ensure product identification and traceability upon receipt of customer purchase order and during all stages of production, delivery and installation.

3.8.3. References

- a) QAP-008 Product Identification and Traceability Procedure
- b) QAP-010 Inspection and Testing Procedure
- c) ISO 9002, paragraph 4.8
- d) Contract File with unique order number
- e) Supplier Quality documents (such as tests and material certificates as applicable to a particular contract).

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3.9. Process Control

3.9.1. Policy

Process control procedures ensure that order processes are carried out under controlled conditions by qualified personnel using qualified process procedures, documentation, and equipment.

Controlled conditions include:

- a) Use order specific written instructions that outline production, installation and servicing details critical to the production of quality products.
- b) Compliance with reference standards/codes, inspection and test plan, and/or documented procedures.
- c) Monitoring and control of process parameters and product characteristics during production, installation and servicing.
- d) Use of properly maintained and/or calibrated equipment.
- e) Use of properly trained personnel and safe work practices.

Applicable special process needs are recognized at the contract review stage and properly identified during production planning.

3.9.2. Purpose and Scope

Production processes that directly affect quality are identified and planned to ensure that they are carried out under controlled conditions.

Fabrication and manufacturing shall be carried out in accordance with National Process Equipment Quality Assurance Procedures or contractually defined requirements. Applicable work instructions, as required, shall be available for each process activity.

In-process monitoring and control is performed at selected points during production to ensure that the product conforms to specified requirements.

3.9.3. References

- a) QAP-009, Process Control Procedure
- b) QAP-011, Inspection Measuring and Test Procedures
- c) QAP-019, Service Procedure
- d) ISO 9002, paragraph 4.9
- e) Baan Order Processing Procedures

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3.10. Inspection and Testing

3.10.1. Policy

Components manufactured by National Process Equipment are evaluated according to established inspection and testing procedures in order to verify that the specified requirements for the product are met. Special requirements for inspection, testing, and records to be established are detailed in the Quality Plan.

3.10.2. Purpose and Scope

Purchased material is verified according to the specification contained in National Process Equipment's purchase order. If final product performance test is required, it is verified for its conformance with the requirements specified in the customer purchase order and on the Quality Plan.

Inspection and testing procedures verify some or all of the following, as appropriate for each contract:

- a) Quantities
- b) Type of equipment or material
- c) Proper identification of product by subcontractor
- d) Required documentation (eg. mill certificates, test reports etc. as described on purchase order)
- e) Dimensions
- f) Performance
- g) Other special requirements specified on purchase order

3.10.3. References

- a) QAP-009, Process Control Procedure
- b) QAP-010, Inspection and Testing Procedure
- c) QAP-011, Inspection, Measuring and Test Equipment Procedure
- d) QAP-013, Control of Non-conforming Product Procedure
- e) ISO 9002, paragraph 4.10

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3.11. Control of Inspection, Measuring and Testing Equipment

3.11.1. Policy

All inspection, measuring and test equipment that is used to check product conformity shall be calibrated according to written procedures. Records of this activity shall be stored in Production. Any equipment that is on loan or supplied by the customer for a specific contract shall be calibrated. Evidence that the equipment is calibrated or in a condition acceptable to the customer shall be kept in the contract file.

Confidence in measurement is established in the following ways:

- a) The inspection, measuring and test equipment shall be adequately selected for its identified use.
- b) Equipment that establishes the product conformance shall be identified and calibrated at planned intervals or as required. Calibration shall be performed against equipment traceable to national standards.
- c) Calibration records shall be maintained and shall include the following information:
 - list of equipment with description and calibration intervals,
 - date of last calibration and estimated re-calibration,
 - allowable error reading and action status if limits are exceeded, and
 - Manufacturer's limitation and maintenance instructions shall be logged, including repairs performed by qualified persons in-house or outside the company.
- d) All test/inspection equipment shall be evaluated and selected for the accuracy and precision as required by the National Process Equipment quality system.
- e) The calibration status for each piece of equipment shall be indicated by an adhesive sticker or proper listing of those instruments with date of calibration and for re-calibration. Calibration records of the equipment shall be maintained to demonstrate continuous quality.

3.11.2. Purpose and Scope

All measuring and testing equipment is controlled, calibrated and maintained in order to produce reliable test results. This applies to all equipment that is used to verify the quality of products produced by National Process Equipment.

If required by contract, calibration data shall be made available to the client to verify the adequacy of the inspection, measuring or test equipment.

Test software is not used by National Process Equipment.

3.11.3. References

- a) ISO 9002, paragraph 4.11
- b) ISO 10012-1
- c) QAP-011, Control of Inspection, Measuring and Test Equipment Procedure

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3.12. Inspection and Test Status

3.12.1. Policy

Inspection results for partially finished products are recorded to provide information to be used as evidence in obtaining permission to continue fabrication or shipment within the required specifications.

3.12.2. Purpose and Scope

Inspection and Test Status procedures provide a positive means of knowing whether or not a product has been

- a) inspected,
- b) inspected and accepted, or
- c) inspected and rejected

so that only products that have passed the required inspections and tests are used in fabrication or shipped to client.

3.12.3. References

- a) QAP-012 Inspection and Test Status Procedure
- b) QAP-013 Control of Non-conforming Product Procedure

3.13. Control of Non-conforming Product

3.13.1. Policy

Non-conforming products and services are held and identified for evaluation. Non-conformances are resolved in a timely manner to minimize interruption of production and service.

3.13.2. Purpose and Scope

Products that do not meet quality requirements will be clearly identified to avoid being inadvertently used in the production cycle until disposition is determined.

Non-conforming products shall be defined as:

- a) Products which fail to meet specific requirements upon inspection.
- b) Products accepted at one stage, but due to a requirement change are no longer acceptable in their present condition.
- c) A supplied product or sub-assembly found unacceptable after its delivery.

Control shall provide for identification, documentation, evaluation, segregation (when practical), and disposition of nonconforming product and for notification to the functions concerned.

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3.13.3. References

- a) QAP-012 Inspection and Test Status Procedure
- b) QAP-013, Control of Non-conforming Product Procedure

3.14. Corrective and Preventive Action

3.14.1. Policy

National Process Equipment maintains documented procedures for implementing corrective and preventive action.

Any corrective or preventive action taken to eliminate the causes of actual or potential non-conformities shall be to a degree appropriate to the magnitude of problems and commensurate to the risks encountered.

Any changes in the documented procedures resulting from corrective and preventive action shall be implemented and recorded.

3.14.2. Purpose and Scope

Corrective and preventive action procedures are used to eliminate causes of non-conformities or prevent non-conformities from occurring in any National Process Equipment product, process or quality system.

3.14.3. References

- a) QAP-014A Corrective Action Procedure
- b) QAP-014B Preventive Action Procedure

3.15. Handling, Storage, Packaging and Delivery

3.15.1. Policy

Established procedures and work instructions will control the handling, storage, packaging and delivery of the final product. These instructions will be defined and will include the following.

- a) Instructions for in-house handling and storage of material.
- b) Instructions for lifting device safety in operation, training and inspection for damage or deterioration.
- c) Instructions to avoid potential damage to the final product at National Process Equipment's facility, by providing adequate storage and protection.

3.15.2. Purpose and Scope

Procedures are established and maintained to ensure that handling, storage and packaging methods meet all the requirements of National Process Equipment Quality Assurance from receipt of the product through to shipment.

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3.15.3. References

- a) QAP-010 Inspection and Testing Procedure
- b) QAP-013 Control of Non-conforming Product Procedure
- c) QAP-015 Handling, Storage, Packaging and Delivery Procedure
- d) Packing Slip

3.16. Control of Quality Records

3.16.1. Policy

Identification, collection, indexing, filing, storage and maintenance procedures for quality records will be established and maintained.

Quality records will be established and maintained to demonstrate conformance of completed products to specified requirements and compliance with specified processing procedures.

Quality records are made available to the customer representative for analysis and review.

3.16.2. Purpose and Scope

Procedure(s) will describe the way in which records used in the quality management system are identified, stored and maintained. The records will demonstrate achievement of the required quality and effective operation of the quality system.

Procedure(s) will address the following items:

- a) Identification of records required in the operation of the quality management system.
- b) Quality records include (but are not limited to) contract review results, inspection reports, performance test data, material certifications, certification of conformity, calibration results, sub-contractor assessment reports, corrective action reports, training record, internal audit reports and management review meeting minutes.
- c) Quality records are identifiable to the product or process concerned, as appropriate.
- d) Quality records are stored and maintained in a manner that provides ready access, minimizes deterioration or damage and prevents loss.
- e) Quality records are retained according to the internal retention schedule.

3.16.3. References

- a) QAP-016 Quality Record Procedure

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3.17. Internal Quality System Audit

3.17.1. Policy

Internal audits will be performed according to documented procedures to verify the effectiveness of the quality management system. Internal quality audits shall be scheduled on the basis of criticality and performance history. The frequency of audits may be altered according to audit results and approval by Quality Assurance.

Results of the quality audits are documented and are distributed to management responsible for the audited area. Actions to correct reported non-compliances will be proposed and implemented by the responsible function in a timely manner. Quality Assurance will follow up the corrective action implementation to ensure effectiveness.

Report copies will be forwarded to the President who oversees and reviews the total quality assurance of National Process Equipment.

3.17.2. Purpose and Scope

The Internal Quality System Audit procedure is used to evaluate the effectiveness and implementation of the quality system. The effectiveness and implementation of the quality system shall be evaluated as to the compliance of the final product (and its production documentation) with the contractual requirements.

3.17.3. References

- a) QAM-017 Internal Quality Audit Procedure

3.18. Training

3.18.1. Policy

On-going training is both required and encouraged at all levels in the National Process Equipment organization. Training is provided for all National Process Equipment employees to the extent necessary to ensure a high standard of product quality.

Personnel performing specific assigned tasks are qualified on the basis of appropriate education, training and experience, as required.

Qualifications and training requirements for all personnel are identified and documented in the job description for each function. The Quality Assurance department maintains records of training for each employee.

3.18.2. Purpose and Scope

Training is provided to ensure that personnel performing activities affecting quality are adequately qualified to perform those activities.

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3.18.3. References

- a) QAP-018 Training Procedure
- b) Curricula Vitae of personnel
- c) Certification of completion of training (as available)
- d) Job descriptions

3.19. Service

3.19.1. Policy

Servicing procedures are used to identify, perform, verify and report service work in order to ensure that customer requirements are met. In addition, policies and procedures are defined to ensure that records and installation data is maintained and will ensure ongoing support is available for equipment sold and serviced by National Process Equipment.

3.19.2. Purpose and Scope

Service work includes commissioning of equipment, warranty repairs, investigation and resolution of field operating problems and any other equipment repairs performed by National Process Equipment. Installation service is traceable to the order on which the installed equipment is sold. All after-sales service requests are identified with a unique order number and are subject to the appropriate contract review procedure.

- a) Field service is work that is performed, either partly or wholly, at the customers' sites. These types of orders are characterized by verbal requests by the customer and short lead times. Often, the work is initiated and completed outside normal business hours and involves only the customer maintenance personnel and a National Service Technician. Controls appropriate to this type of business are used to ensure that work is documented and accepted.
- b) Shop Service is work performed entirely in a National Process Equipment shop. Controls applied for this type of service are a hybrid of new production and field service procedures.
- c) Installation service, such as start-up of equipment, is controlled within the sale of equipment contract when part of the original order.

Service procedures include provisions for ensuring data pertinent to the operation of equipment sold and serviced by National Process Equipment is maintained and retrievable. Installation related records will include serial number specific configuration information, application data, and performance and maintenance records as applicable and available.

3.19.3. References

- a) QAP-019 Service Procedure
- b) QAP-004 Contract Review Procedure
- c) QAP-020 Customer Service Procedure
- d) Equipment Operation and Maintenance Manual

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3.20. Numerical Analysis (Not Defined)

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Inspection and Test Plan Form

PROJECT: Shell Carmon Creek Project
ITP # NPE SLS 338716

INSPECTION AND TEST PLAN
Rev. No. 3

Inspection Plan Legend: H = Hold, W = Witness, R = Review

Supplier/Sub-supplier Name: National Process Equipment	LOCATION - Address, City & Country: 5049 -74 ave SE, Calgary, AB	Purchaser P.O. # 4512109130
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Supplier/Sub-supplier Work Scope: **SLS 338716, CMT Natural Gas Pressure Reduction Skid Package (0735A-08030)**

Activity No.	Activity Description	Location	Control Procedure Ref.	Responsible Party	Acceptance Criteria	Verifying Documents	Inspection Points (Date and Signature required)			
							NPE	Customer		
1.1	Pre-Fab Meeting	NPE	Customer PO : 4512109130	S/I	Meeting Minutes	Meeting Minutes	H	H		
1.2	Purchase Order Document Review	NPE	Customer PO : 4512109130	S/I	Commercial & Technical Specification compliance between Quote & PO	SDR	H	H		
2.0	Approval Drawings and NPE Procedures									
2.1	P&ID, BOM, and GA's Drawing	Customer	Customer PO : 4512109130	S/I	Customer Approval	Returned documents with code 1 or 2 status	H	H		
2.2	Structural Skid Drawings and Calculation	Customer	Customer PO : 4512109130	S/I	Customer Approval	Returned documents with code 1 or 2 status	H	H		
2.3	Building Drawings	Customer	Customer PO : 4512109130	S/I	Customer Approval	Returned documents with code 1 or 2 status	H	H		
2.4	HAVC Drawings if applicable	Customer	Customer PO : 4512109130	S/I	Customer Approval	Returned documents with code 1 or 2 status	H	H		
2.5	Electrical Drawings	Customer	Customer PO : 4512109130	S/I	Customer Approval	Returned documents with code 1 or 2 status	H	H		
2.6	Welding Procedure (NPE) for structural skid	Customer	Customer PO : 4512109130	S/I	Customer Approval	Returned documents with code 1 or 2 status	H	H		
2.7	Welding Procedure (NPE) for piping spool	Customer	Customer PO : 4512109130	S/I	Customer Approval	Returned documents with code 1 or 2 status	H	H		
2.8	NDE Procedure (RT, MT, PT, UT, PMI, etc.)	Customer	Customer PO : 4512109130	S/I	Customer Approval	Returned documents with code 1 or 2 status	H	H		
2.9	Hydrostatic Test Procedure	Customer	Customer PO : 4512109130	S/I	Customer Approval	Returned documents with code 1 or 2 status	H	H		
2.10	Leak Test Procedure	Customer	Customer PO : 4512109130	S/I	Customer Approval	Returned documents with code 1 or 2 status	H	H		
2.11	Welder Certifications	Customer	Customer PO : 4512109130	S/I	Customer Approval	Returned documents with code 1 or 2 status	H	R		
2.12	Coating Procedure / ITP for Coating vendor	Customer	Customer PO : 4512109130	S/I	Customer Approval	Returned documents with code 1 or 2 status	H	H		
3	Receipt Manufactured Items									
3.1	Coalescer Filter	Sub-Vendor /NPE	MFG Standard	Sub-Vendor /NPE	- NPE PO to Sub-Vendor	- CRNs, Testing Report - MTRs - CSA for all electrical devices if applicable	H	R		
3.2	Natural Gas Electrical Heater	Sub-Vendor /NPE	MFG Standard	Sub-Vendor /NPE	- NPE PO to Sub-Vendor	- CRNs, Testing Report - MTRs - CSA for all electrical devices if applicable	H	R		
3.3	Mercaptan Gas Odorizer	Sub-Vendor /NPE	MFG Standard	Sub-Vendor /NPE	- NPE PO to Sub-Vendor	- CRNs, Testing Report - MTRs - CSA for all electrical devices if applicable	H	R		
3.4	Condensate Storage Tank	Sub-Vendor /NPE	MFG Standard	Sub-Vendor /NPE	- NPE PO to Sub-Vendor	- NPE PO to Sub-Vendor	H	R		
3.5	Instrumentation-PSV, CV, LG, PG, TG, LIT, PIT, TIT, etc.	Sub-Vendor /NPE	MFG Standard	Sub-Vendor /NPE	- NPE PO to Sub-Vendor	- MTRs - Calibration Certificate, Test Report if available - CRN's	R	R		
3.6	Valve	Sub-Vendor /NPE	Shell DEP and CSA Codes	Sub-Vendor /NPE	- NPE PO to Sub-Vendor	- MTRs - CRN's	R	R		
3.7	Piping Material	Sub-Vendor /NPE	Shell DEP and CSA Codes	Sub-Vendor /NPE	- NPE PO to Sub-Vendor	- MTRs	R	R		

Inspection and Test Plan Form

PROJECT: Shell Carmon Creek Project

INSPECTION AND TEST PLAN

ITP # NPE SLS 338716

Rev. No.

3

Inspection Plan Legend: H = Hold, W = Witness, R = Review

Supplier/Sub-supplier Name: National Process Equipment	LOCATION - Address, City & Country: 5049 -74 ave SE, Calgary, AB	Purchaser P.O. # 4512109130
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Supplier/Sub-supplier Work Scope: **SLS 338716, CMT Natural Gas Pressure Reduction Skid Package (0735A-08030)**

Activity No.	Activity Description	Location	Control Procedure Ref.	Responsible Party	Acceptance Criteria	Verifying Documents	Inspection Points (Date and Signature required)		
							NPE	Customer	
3.8	Structural Material	Sub-Vendor /NPE	-Shell DEP 34.28.00.31 -CSA G40.21	Sub-Vendor /NPE	-Shell DEP 34.28.00.31 -CSA G40.21	- MTRs	R	R	
3.9	Consumables	Sub-Vendor /NPE	-Shell DEP 34.28.00.31 -CSA W48.1	Sub-Vendor /NPE	-Shell DEP 34.28.00.31 -CSA W48.1	- MTRs	R	R	
4	Fabrication, Examination and Testing								
4.1	Skid (Welding)	NPE	- NPE WPS and PQR - CSA W59, CSA W47.1 - Shell DEP 34.28.00.31	NPE	- NPE WPS and PQR - CSA W59, CSA W47.1 - Shell DEP 34.28.00.31	- CSA W47.1 Certs for welders - NPE Structural Steel data book (CWB) - Fabrication Drawings	R	R,W	
4.2	Skid (NDE) - 100% Visual Inspection - 100% UT on full penetration welds - 25% MPI on all fillet welds - 100% MPI on the lifting lugs configuration.	Sub-Vendor	- NPE Sub-Vendor NDE Procedure - CSA W59 - Shell DEP 34.28.00.31 - Shell CCK-0000-CS-7880-000-0002-000	NPE	- NPE Sub-Vendor NDE Procedure - CSA W59 - Shell DEP 34.28.00.31 - Shell CCK-0000-CS-7880-000-0002-000	- Weld Maps - NDE Report - NDE Operator Qualification Record - Fabrication Drawings	R	R,W	
4.3	Skid (Coating Applications) - Sandblasted to SSPC-SP6 - Primer - Per shell spec. - Finish - Per shell spec. - Color - Per shell spec.	Sub-Vendor	- NPE and/or Sub Vendor Procedure - Surface Preparation & Painting Specification - Shell CCK-0000-CS-2408-026-0002-001	NPE	- NPE and/or Sub Vendor Procedure - Surface Preparation & Painting Specification - Shell CCK-0000-CS-2408-026-0002-001	- Painting Inspection Report - Fabrication Drawings	R	W,H,R	
4.4	Piping Spool (Welding)	NPE	- NPE WPS and PQR - ASME B31.3 - Shell DEP 34.38.01.31	NPE	- NPE WPS and PQR - ASME B31.3 - Shell DEP 34.38.01.31	- B31.3 Certs for welders - Fabrication Drawings	R	R,W	
4.5	Piping Spool (PWHT and NDE) - 100% Visual Inspection - 10% Min. RT on Butt Weld	NPE	- NPE NDE Procedure - ASME B31.3 - Shell Standard 3-1.12	NPE	- NPE NDE Procedure - ASME B31.3 - Shell Standard 3-1.12	- Weld Maps - NDE Report - NDE Operator Qualification Record - Fabrication Drawings	R	R	
4.6	Piping Hydrostatic Test	NPE	- NPE Test Procedure - ASME B31.3	NPE	- Approved drawings - ASME B31.3	- NPE Test Report - ASME B31.3	R	H	
4.7	Welder Certifications	NPE	- ASME B31.3 - CSA W47, W59 - Shell DEP 31.38.01.31	NPE	- ASME B31.3 - CSA W47, W59 - Shell DEP 31.38.01.31	Returned documents with code 1 or 2 status	R	R	
4.8	WPS Verification for Skid	NPE	- CSA W47, W59 - Shell DEP 31.28.01.31	NPE	- CSA W47, W59 - Shell DEP 31.28.01.31	Returned documents with code 1 or 2 status	R	R	
4.9	WPS Verification for Piping	NPE	- ASME B31.3 - Shell DEP 31.38.01.31	NPE	- ASME B31.3 - Shell DEP 31.38.01.31	Returned documents with code 1 or 2 status	R	R	
4.10	Filter Hydrostatic Test	NPE	- Test Procedure - ASME Vessel code V III Div.1 - Shell DEP 31.22.20.31	NPE	- Test Procedure - ASME Vessel code V III Div.1 - Shell DEP 31.22.20.31	- Test Report	R	H	
4.11	Oderizer Hydrostatic Test	NPE	- Test Procedure - ASME Vessel code V III Div.1 - Shell DEP 31.22.20.31	NPE	- Test Procedure - ASME Vessel code V III Div.1 - Shell DEP 31.22.20.31	- Test Report	R	H	
5	Assembly and Installation								
5.1	Piping Assembly and Equipment Installation	NPE	- NPE QA/QC for mechanically assembled process piping (AQP-21321) - ASME B31.3 - Manufacturer IOM - Shell DEP 31.38.01.31	NPE	- NPE QA/QC for mechanically assembled process piping (AQP-21321) - ASME B31.3 - Manufacturer IOM - Shell DEP 31.38.01.31	- Assembly drawings	R	R,W	
5.2	Building Installation	NPE	NPE and/or Sub Vendor Procedure - Alberta Building Code 2006 - Shell CCK-0000-CB-7880-000-0001-000 - Shell CCK-0000-CB-7880-000-0002-000	NPE	NPE and/or Sub Vendor Procedure - Alberta Building Code 2006 - Shell CCK-0000-CB-7880-000-0001-000 - Shell CCK-0000-CB-7880-000-0002-000	- Assembly drawings	R	R,W	
5.3	HVAC Installation if applicable	NPE	NPE and/or Sub Vendor Procedure - Shell DEP 31.76.10.11	NPE	NPE and/or Sub Vendor Procedure - Shell DEP 31.76.10.11	- Assembly drawings	R	R,W	

Inspection and Test Plan Form

PROJECT: Shell Carmon Creek Project

INSPECTION AND TEST PLAN

ITP # NPE SLS 338716

Rev. No.

3

Inspection Plan Legend: H = Hold, W = Witness, R = Review

Supplier/Sub-supplier Name: National Process Equipment	LOCATION - Address, City & Country: 5049 -74 ave SE, Calgary, AB	Purchaser P.O. # 4512109130
--	--	---------------------------------------

Supplier/Sub-supplier Work Scope: **SLS 338716, CMT Natural Gas Pressure Reduction Skid Package (0735A-08030)**

Activity No.	Activity Description	Location	Control Procedure Ref.	Responsible Party	Acceptance Criteria	Verifying Documents	Inspection Points (Date and Signature required)		
							NPE	Customer	
5.4	Electrical Installation	NPE	NPE and/or Sub Vendor Procedure - Shell DEP33.04.20.10 - Shell DEP33.04.30.30 - Shell DEP33.04.30.31	NPE	NPE and/or Sub Vendor Procedure - Shell DEP33.04.20.10 - Shell DEP33.04.30.30 - Shell DEP33.04.30.31	- Assembly drawings	R	R,W	
5.5	Piping Spool (Coating Applications) - Sandblast to SSPC-SP6 - Primer - Per shell spec. - Color - Per shell spec.	NPE	- Surface Preparation & Painting Specification - Shell DEP 30.48.00.31	NPE	- Surface Preparation & Painting Specification - Shell DEP 30.48.00.31	- Painting Inspection Report - Fabrication Drawings	R	R,W	

6 Package Testing									
6.1	Completed skid Package Leak Test - Leak test with shop air @ 25 psig	NPE	- NPE Leak Test Procedure	S/I	-Leak Test Procedure	Leak Test Certificate (Package only)	H	H	
6.2	FAT Test and CSA if applicable Electrical, Control Panel, I & C, HVAC, etc. -3 rd Party Electrical Inspection (Marex)	NPE	CSA 22.1 Customer PO : 4512109130	NPE	CSA 22.1 Customer Approval	- NPE Test Report - CSA	R	H	
7 Final Inspection									
7.1	Final Inspection	NPE	Customer PO : 4512109130	S/I	Customer PO : 4512109130	-Signed ITP - Code 1 Drawings	H	H	
7.2	Marking, Tagging, Preparation for shipment/storage	NPE	- Handling & Shipping Procedures including preservation, storage, and packing	S/I	-handling & shipping procedures including preservation, storage, and packing	- Name Plate Pic. Etc.	H	H	
7.3	- Non-conformance Report / Log (NCR) closed - Deviation Decision Requests and Index closed	NPE	- NPE QC/QA	S/I	- Non-conformance Report (NCR)	- Non-conformance Report /Log (NCR) CLOSED	H	H	
7.4	Release for Shipment - Review ABSA certification documents prior to release (including pressure vessels, PSV, piping and fittings with ABSA design registrations, ASME data reports, AB- 83/81/41, name plate photos, etc)	NPE	- Handling & Shipping Procedures including Preservation, Storage, and Packing.	S/I	Packing Slip	- Signed Inspection release	H	H	
7.5	Final Data Book (1 Month after package shipment)	NPE	Customer PO : 4512109130	NPE	Customer PO : 4512109130	Approved VDR	H	R	

Legend				S = Supplier (NPE) I = Purchaser C = Authorized Inspector E = Owner						W = Witness Point H = Hold Point R = Review					
Prepared by Supplier/Sub-supplier Rep.		Reviewed & Approved by Supplier/Sub- supplier Quality Rep.				Approved by Purchaser				Reviewed By Owner					
Print Name / Initial	Date	Print Name / Initial	Date	Print Name / Initial	Date	Print Name / Initial	Date	Print Name / Initial	Date	Print Name / Initial	Date	Print Name / Initial	Date		

DOCUMENT FRONT SHEET

PURCHASERS NAME	National Process Equipment
PURCHASE ORDER NO	PUR630251
EXHEAT REFERENCE	041168
SDR DOCUMENT NO	041168.QP
CLIENT DOCUMENT NO	
DOCUMENT TITLE	Quality Plan - Overall

Doc Num	Revision	Issue	Date	Initials	Supplier's Approval Signature	Approval By
H01	1	1	03/07/2014	RDav		17/07/2014

To be filled by the reviewer of this document prior to its return

Tick Box	Code	Status	Description
<input type="checkbox"/>	E1	Approved	Approval given, no comments, final issue.
<input type="checkbox"/>	E2	Approved to Proceed	Approval given for work to proceed with document to be submitted as Final Issue providing comments are incorporated
<input type="checkbox"/>	E3	Not Approved	Document rejected and must be re-submitted with incorporation of comments. Work may NOT proceed
<input type="checkbox"/>	E4	Information Only	No comments made or approval given, for information purposes only.
<input type="checkbox"/>	E5	As-Built	Approval given for work to proceed provided comments incorporated in As-Built revision.

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3

COMMENTS

Please be aware that EXHeat will not be held responsible for late approval of documents and will not be held liable for any liquidated damages as a consequence.

Late approval of documents by the client may impact on the contractual delivery date.

EXHEAT LTD

Threxton Road Industrial Estate, Watton, IP25 6NG

Tel: +44 (0)1953 886200, Fax: +44 (0) 1953 886222, Email: accounts@exheat.com, Web: www.exheat.com

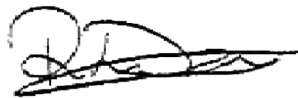
Quality Plan / Inspection & Test Plan		Document number:		041168.QP	
Customer:		Quality Process / Procedure Index			
NATIONAL PROCESS EQUIPMENT		Management responsibility		OP/01	
P.O No.:		Contract review		Sales process	
PUR630251		Design control		Design process	
		Document control		OP/04/01	
Description:		Purchasing		Purchasing process	
1 X 4.4KW ELECTRICAL HEATER		Product identification & traceability		WI/07	
TAG NO: TBA		Manufacturing control		Manufacturing process	
		Inspection & testing		Test & inspection process	
		Control of measuring & test equipment		WI/10/03	
		Inspection & test status		WI/11	
		Non-conformity		OP/12	
		Corrective action		OP/13	
		Handling, storage, marking, packing & delivery		Despatch process	
		Quality documentation & records		OP/15	
		Internal audit control		OP/16	
<p>Your acceptance of this document without inspection clearance activities indicated, shall result in Exheat manufacture & inspection (Subject to drawing approval) without further notification.</p>					
1	FIRST ISSUE	MB	HW	AE	03.07.2014
Rev	Comment	Drawn	Checked	Approved	Date

Quality Plan / Inspection & Test Plan			Document number:		041168.QP			
No	Activity description	Control documents	Acceptance criteria	Verification record	Inspection clearance ExHeat Client			
1.0	Contract review	Sales process	Quotation contract	Review sheet	H			
2.0	Design control							
2.1	Design & development planning / handover meeting	Design process	Client specification	Data sheet/prod plan	H			
2.2	Organisational & technical interfaces	Design process	N/a	Minutes of meeting	M			
2.3	Design review	Design process	Client specification	Minutes of mtg/data sheet	H			
2.4	Design input	Design process	Client specification	Data sheets	R			
2.5	Design output	Design process	Client specification	Drawings/documentation	H			
2.6	Design verification	Design process	Client specification	Design verification form	H			
3.0	Quality plan approval							
3.1	Approval of this quality plan	Manufacturing process	N/a	Endorsed quality plan	H			
3.2	Approval of vessel quality plan	Manufacturing process	N/a	Endorsed quality plan	H			
4.0	Approval of SDRL documentation by client	OP/04/01	Client specification	Client endorsed document	R			
5.0	Placement of sub-orders	WI/05/01	Approved supplier list	Purchase order	R			
		Purchasing process	Parts list/requisition	Purchase order	R			
6.0	Goods inwards							
6.1	Check all parts/materials upon receipt	WI/09/03	Purchase order	Goods received note	I			
7.0	Manufacture (heater)							
7.1	Seal elements	WI/08/01	Approved drawings	Endorsed route card	H			
7.2	Check baffle assembly	Manufacturing process	Approved drawings	Endorsed route card	I			
7.3	Elements / sensor sub assembly	Manufacturing process	Approved drawings	Endorsed route card	I			
7.4	Hydrotest - in house	Manufacturing process	Approved fat	Endorsed route card	I			IN HOUSE ONLY
7.5	Enclosure check	Manufacturing process	WI/09/130	Endorsed route card	H			
7.6	Fitting of element terminations	Manufacturing process	Approved drawings	Endorsed route card	I			
7.7	Terminal assembly, wiring and earth bonding	Manufacturing process	Approved drawings	Endorsed route card	I			
7.8	Electrical test - in house	Manufacturing process	Approved fat	Test certificate	H			IN HOUSE ONLY
7.9	Prepare for final inspection	Manufacturing process	Client specification	Design verification form	H			
8.0	Final (witness) inspection							
8.1	Electrical test final - heater	Testing & inspection process	WI/09/114	Test certificate	H			
8.2	Hydrotest - final - heater	Testing & inspection process	WI/09/110	Test certificate	H			
8.3	Data book review	Approved index	Client specification	Endorsed data book	H			
8.4	Client release	-----	Client specification	Client release note	H			
9.0	Final despatch							
9.1	Prepare for despatch	Despatch process	WI/09/130	Endorsed route card	H			
9.2	Packing & preservation	Despatch process	Endorsed packing proc	Endorsed route card	H			
9.3	Delivery	Despatch process	Client purchase order	Delivery note	H			

Inspection & surveillance codes: "I" – Inspection Codes, "H" – Hold Point, "M" – Monitor, "R" – Review, "%" – Percentage Inspection, "W" – Witness Point. "α" – Milestone Review

DOCUMENT FRONT SHEET

PURCHASERS NAME	National Process Equipment
PURCHASE ORDER NO	PUR630251
EXHEAT REFERENCE	041168
SDR DOCUMENT NO	041168.VESSQP
CLIENT DOCUMENT NO	
DOCUMENT TITLE	Vessel Quality Plan

Doc Num	Revision	Issue	Date	Initials	Supplier's Approval Signature	Approval By
H02	1	1	25/09/2014	RDav		09/10/2014

To be filled by the reviewer of this document prior to its return

Tick Box	Code	Status	Description
<input type="checkbox"/>	E1	Approved	Approval given, no comments, final issue.
<input type="checkbox"/>	E2	Approved to Proceed	Approval given for work to proceed with document to be submitted as Final Issue providing comments are incorporated
<input type="checkbox"/>	E3	Not Approved	Document rejected and must be re-submitted with incorporation of comments. Work may NOT proceed
<input type="checkbox"/>	E4	Information Only	No comments made or approval given, for information purposes only.
<input type="checkbox"/>	E5	As-Built	Approval given for work to proceed provided comments incorporated in As-Built revision.

PAGES (Including this one)

8

COMMENTS

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Quality Plan VQ0512

Customer : Exheat Ltd
 Customer Order Number : P103468
 Equipment Description : 6" 900# Shell Line Heater Vessel
 Equipment Number : TBC
 Vessco Job No. : UJ0404-1

Revision History					
Rev	Remarks	Prep	Chk'd	App'd	Date
0	Issued for Customer Approval	MVD	PT	JVD	17/09/14

Vessco Engineering Limited – Approval Signature	Date	Authorised Inspector – Approval Signature	Date

Design Code: ASME VIII Div.1 Edition 2013, Certification Mark 'U'

A.I.A.: Royal Sun Alliance

SCHEDULE OF SPECIFICATIONS, STANDARDS AND STANDARD DRAWINGS

041168.01.eds Rev 1 Exheat datasheet
CCK-0735-MS-2105-000-00001-000 Company datasheet

INTERNATIONAL AND NATIONAL CODES

ASME Boiler and Pressure Vessel Code	Section VIII, Div. 1, c/w 'U' Stamp
ASME Boiler and Pressure Vessel Code	Section IX Welding, Brazing & Fusing Qualifications
ASME Boiler and Pressure Vessel Code	Section V Non Destructive Examination
ASME Boiler and Pressure Vessel Code	Section II Part A Ferrous Material Specifications

VESSCO DOCUMENTS

Control of Documents Procedure	VQ0002
Goods Inward	VQ0006
In Works Material Traceability	VQ0022
Vessco Radiographic Examination Procedure	NDT-OPR-011
Vessco Ultrasonic Procedure	NDT-OPR-021
Vessco MPI Procedure	VQ0201-2
Hydrotest Pressure Testing	VQ0018
Handling, Storage, Packing and Delivery	VQ0007
General Assembly Drawing	VQ0510

				Inspection Points & Signatures			
				Hold (H), Witness (W), Review (R), Surveillance (S)			
No.	Description of Activities	Reference Specification	Acceptance Criteria	Vessco	Exheat	AI	Date
	PRELIMINARY						
1	Contract Review						
1.1	Review scope of work, project requirements, purchase order	- Project specifications and standards	- Order acknowledgement	R			
2	Document Review						
2.1	Document submittal & approval General arrangement drawing(s)	- VQ0002: <i>Control of Documents Procedure</i> - Reference Mechanical Datasheets (to ASME VIII Div 1 2013 c/w 'U' Stamp)	- Signed approved doc's	H	R	R	
2.2	Document submittal & approval - Quality plan	- VQ0002: <i>Control of Documents Procedure</i> - Reference Mechanical Datasheets (to ASME VIII Div 1 2013 c/w 'U' Stamp)	- Signed approved doc's	H	R	H	
2.3	Document submittal & approval Mechanical design check	- VQ0002: <i>Control of Documents Procedure</i> - Reference Mechanical Datasheets (to ASME VIII Div 1 2013 c/w 'U' Stamp)	- Signed approved doc's	H	R	R	
2.4	Document submittal & approval WPS/WPQR/WPQs	- VQ0002: <i>Control of Documents Procedure</i> - Reference Mechanical Datasheets (to ASME VIII Div 1 2013 c/w 'U' Stamp)	- Signed approved doc's	H	R	R	
2.5	Document submittal & approval NDT Procedures	- VQ0002: <i>Control of Documents Procedure</i> - Reference Mechanical Datasheets (to ASME VIII Div 1 2013 c/w 'U' Stamp)	- Signed approved doc's	H	R	R	
3	Pre Inspection Meeting (if required)			H	H		
	MATERIAL						
4	Material Procurement						
4.1	List of Materials / Sub-orders: a) Pipes b) Flanges c) Fittings d) Plates	- Purchase Orders - Project requisition - ASME II Part A - ASME VIII Div. 1	- Approved Drawings (VQ0510) - Vessco BOM	H	R	R	

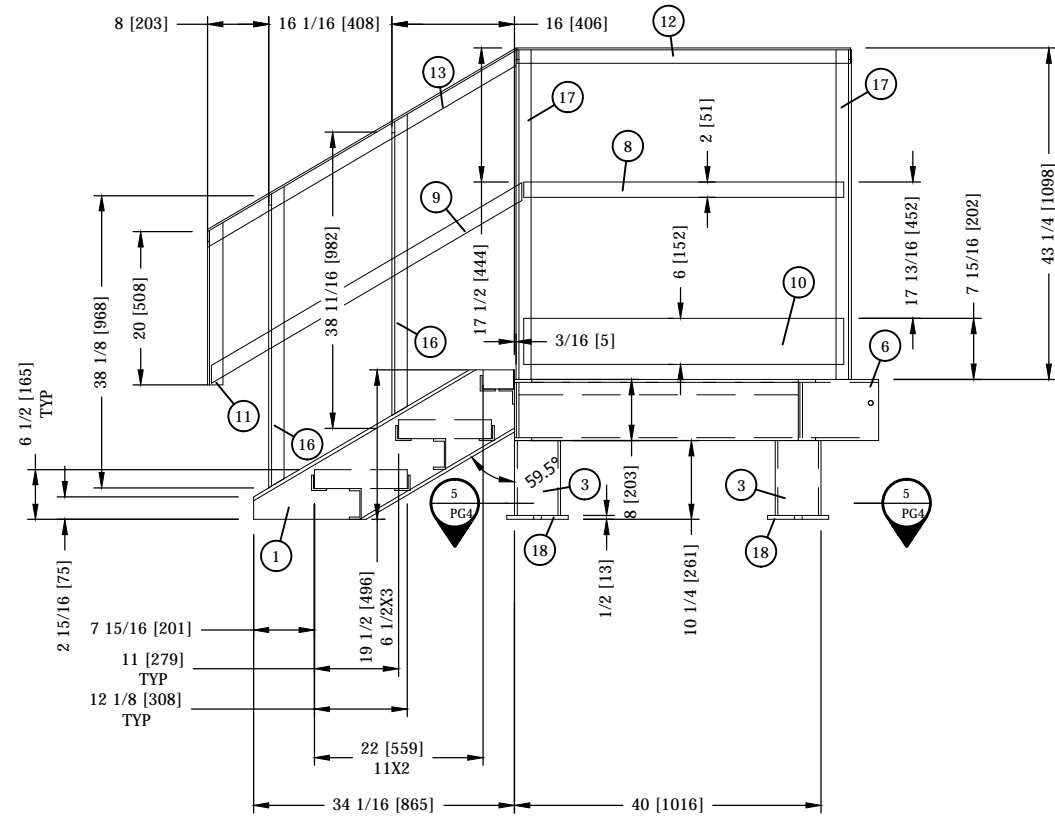
				Inspection Points & Signatures			
				Hold (H), Witness (W), Review (R), Surveillance (S)			
No.	Description of Activities	Reference Specification	Acceptance Criteria	Vessco	Exheat	AI	Date
4.2	All Pressure Retaining Materials to be certified to EN10204 3.1	-Ref ASME II part A	EN10204 3.1	R	R	R	
4.3	Incoming Goods Inspection: a) Dimensional b) Quantity c) Traceability d) Code Required Marking	- Material Goods Inwards Inspection report - Material certificates (including welding consumables) - Approved Drawing(s): VQ0510 - VQ0006: <i>Goods Inward</i>	- Pressure parts & all other materials: <i>Min requirement for material certification to be to BS EN 10204 3.1</i>	H	R	R	
4.4	Material segregation and allocation of working area / bay (In C.S. workshop)	- VQ0006: <i>Goods Inward</i>		R	R		
	PRODUCTION						
5.	Marking & Preparation						
5.1	Edge preparation Dimensional check on materials: a) Nozzle Pipes b) Flanges c) Fittings d) Plates	- Approved Drawing(s): VQ0510	- ASME VIII Div 1: UG-96: <i>Dimensional Check of Component Parts</i>	H H H H	R R R R	R R R R	
5.2	Material traceability check to ensure no. has been maintained on all items - Heat Number	- VQ0006 <i>Goods Inward Procedure</i> - MTC certificates	- ASME VIII Div 1: UG-77: <i>Material Identification</i>	H	R	R	
6	Fit-up & Assembly						
6.1	Check tack-up & alignment: a) Body flange to shell b) End cap to shell	- Approved Drawing(s): VQ0510	- ASME VIII, Div 1 2013	H H	R R	R H	
6.2	Carry out welding to approved WPS's. Ensure qualified welders are used.	Approved WPS's, WPQRs, WPQs	- ASME VIII, Div 1 2013, Section IX	R	R	R	
6.3	Check tack up and alignment of nozzles.	- Approved Drawing(s): VQ0510	- ASME VIII, Div 1 2013	H	R	R	

				Inspection Points & Signatures			
				Hold (H), Witness (W), Review (R), Surveillance (S)			
No.	Description of Activities	Reference Specification	Acceptance Criteria	Vessco	Exheat	AI	Date
6.4	Carry out welding to approved WPS's. Ensure qualified welders are used.	Approved WPS's	- ASME VIII, Div 1 2013, Section IX	R	R	R	
7	Inspection Testing & Examination						
	<u>Non-destructive examination</u>						
	Radiographic Examination 100% Radiography Examination of Type No. 1 welds (category A & B).	- Radiographic Procedure NDT-OPR-011 - Approved Drawing(s): VQ0510	- ASME VIII Div 1: UW-11: <i>Radiographic Examination (also UW-51)</i> - ASME VIII Div 1: UHA-33: <i>Radiographic Examination</i> - Radiographic report	H	R	R	
	Magnetic Particle Examination 100% MPI of all welds	-Vessco procedure VQ0201-2 - Approved Drawing(s): VQ0510	- ASME VIII Div 1 2013 - Inspection reports.	H	R	R	
	Ultrasonic Examination U.T. of nozzle to shell welds	- Ultrasonic testing procedure NDT-OPR-021 - Approved Drawing(s): VQ0510	- ASME VIII Div 1 2013 - Inspection reports.	H	R	R	
	POST PRODUCTION						
8	Inspection						
8.1	Final visual and dimensional check of fully assembled unit to ensure all dimensions are within tolerances	- Approved Drawing(s): VQ0510	-Fabrication tolerances shown on vessel GA	H	W	R	
8.2	Hydrostatic/Pneumatic testing	- VQ0018: <i>Hydrotest Pressure Testing</i>	Ensure no visible leakage and pressure drop - Gauge Calibration ASME VIII Div. 1 UG-99	H	W	H/W	
8.3	Nameplate & Application of Code Symbol Stamping (include a photocopy for the Manufacturing Data Book)	- Approved Drawing(s): VQ0510	- ASME VIII, Div 1 2013, UG-119	R	R	H/W	

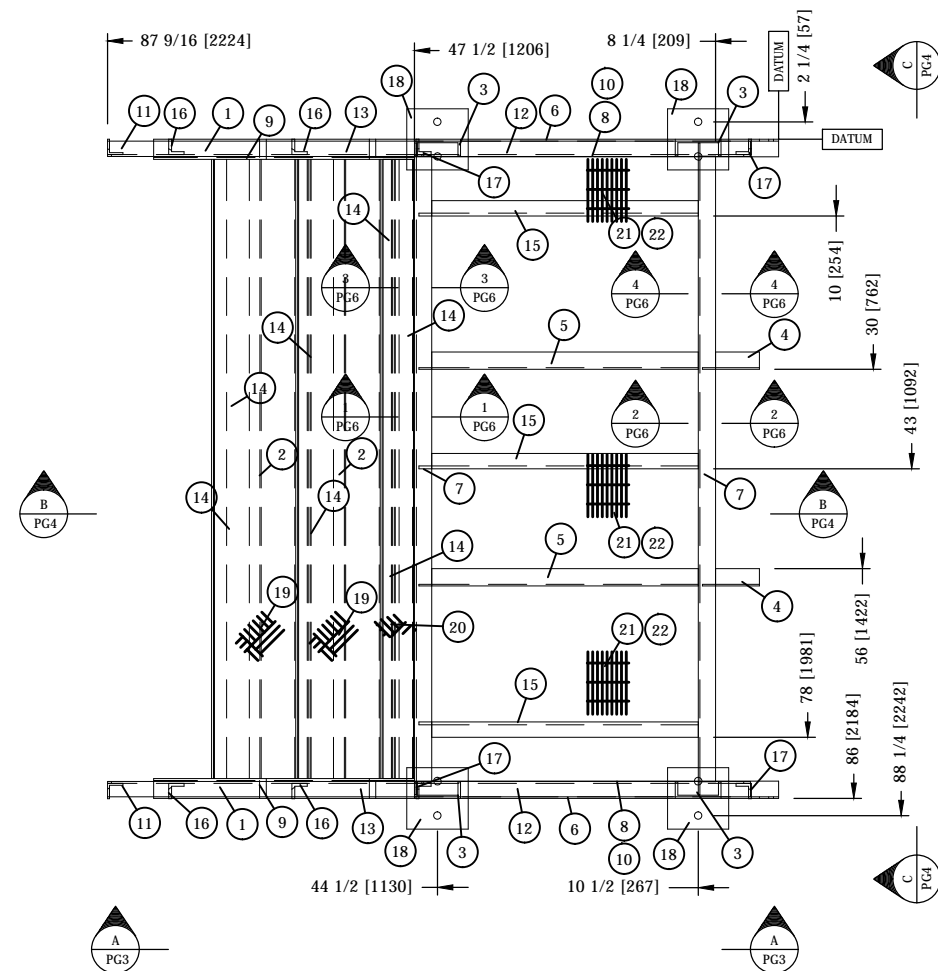
				Inspection Points & Signatures			
				Hold (H), Witness (W), Review (R), Surveillance (S)			
No.	Description of Activities	Reference Specification	Acceptance Criteria	Vessco	Exheat	AI	Date
	PRE-SHIPMENT INSPECTION						
9	Prepare for dispatch						
9.1	- Packing & preservation	- VQ0007: <i>Handling, Storage, Packing and Delivery</i>		R			
9.2	Delivery of unit(s) to client	- Purchase order states delivery address and due date		R			
	FINAL DOCUMENTATION						
10	Final release / certification						
10.1	Manufacturing Data Book compilation	- <i>Approved Data Book Index</i>	ASME VIII Div. 1 - Signed approved doc's	R	R	R	
10.2	Complete ASME U1A Data Report	ASME VIII Div. 1 UG 120	Manufacturer to sign. AI to sign.	H	R	H/W	



DWG NORTH



VIEW 'A-A'



GENERAL NOTES

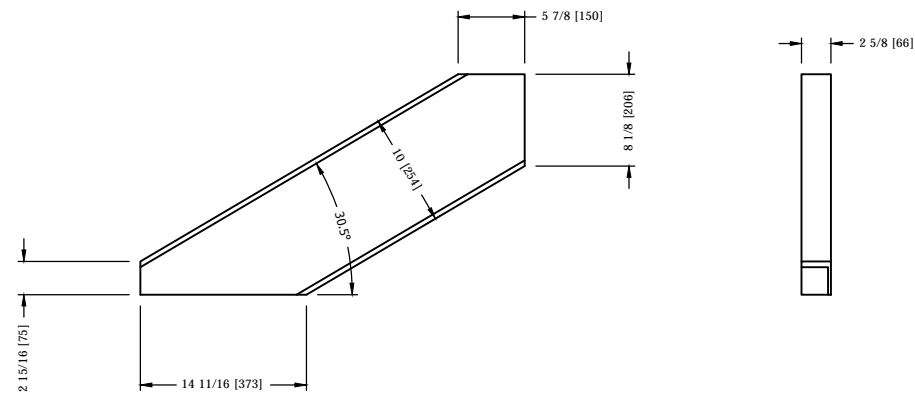
1. ALL DIMENSIONS ARE IN INCH [mm] U.N.O.
2. FABRICATION TOLERANCE +/- 1/8"[3mm] U.N.O.
3. HOLE & TAP LOCATIONS TOLERANCE +/- 1/32"[0.8mm] U.N.O.
4. CUT LENGTHS TO BE CONFIRMED BY FABRICATOR.
5. BREAK ALL SHARP EDGES AND CORNERS.
6. ALL HOLES FOR EQUIPMENT & PIPE CLAMPS TO BE DRILL & TAPPED DURING EQUIPMENT MOUNTING AND SPOOL ASSEMBLY.
7. JOINTS OF MAIN BEAMS (W8X21) SHALL BE FULL-PENETRATION WELDED.
8. NO JOINTS ARE ALLOWED FOR THE BEAMS THAT ARE DESIGNED AS ONE SINGLE PIECE.
9. WELDING EXAMINATIONS:
 - 100% VISUAL AND DIMENSIONAL CHECK.
 - 100% ULTRASONIC TEST FOR FULL PENETRATION WELDS.
 - 25% MPI FOR FILLET WELDS.
10. SURFACE PREPARATION & PAINTING:
 - SANDBLASTING TO SSPC-SP6.
 - ONE COAT OF RUST EXPOXY PRIMER (DFT: 4.0-8.0 mils) AND ONE TOP COAT OF URETHANE FINISH (DFT: 2.0-4.0 mils).
 - COLOR: WARM GRAY.

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.

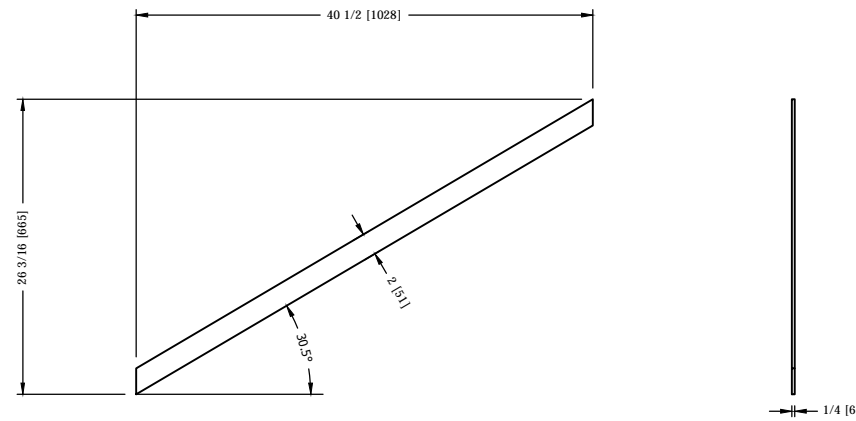


PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030

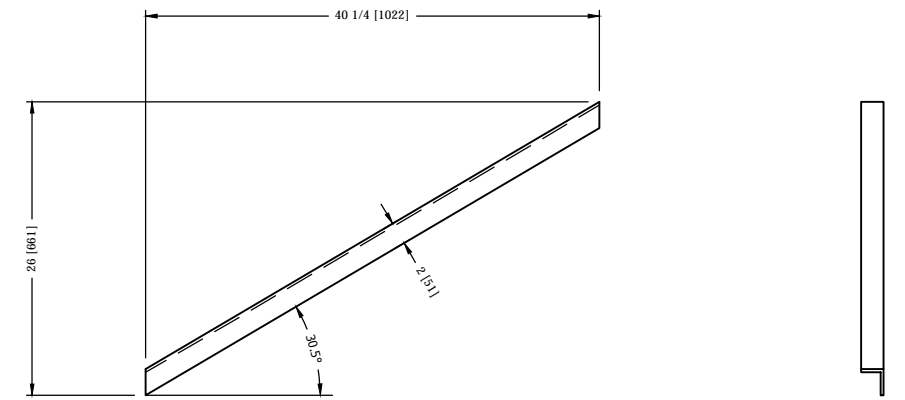
QA	ISSUED FOR APPROVAL	NSP	ET	PM	NOV 28/14
REV	DESCRIPTION	DWN	CHK	APP	DATE
CMT NG PRESSURE REDUCTION SKID PACKAGE STAIRS & PLATFORM					
SLS#:	338716	QUOTE:	CGY2014-85	PO#:	4512-109-130
DWN BY:	NSP	DATE:	NOV 28/14	DWG #:	338716-301-Rev0
CHK BY:	ET	DATE:	NOV 28/14	PAGE:	4 OF 7
APP BY:	COG	DATE:	NOV 28/14	CAD:	N/A
				REV:	0



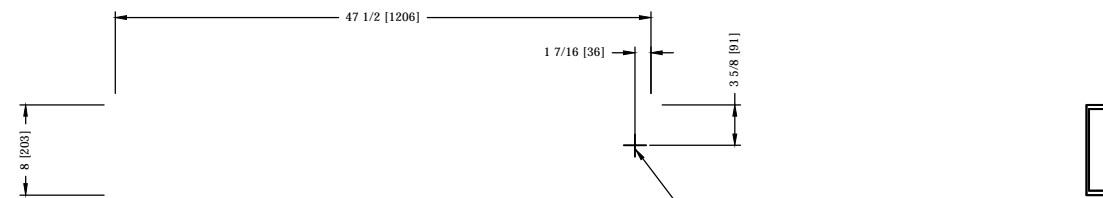
ITEM 1 DETAIL



ITEM 9 DETAIL

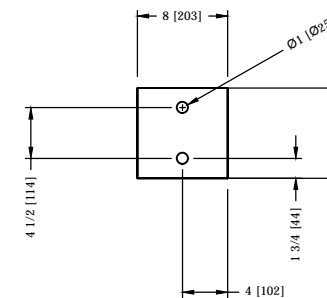


ITEM 13 DETAIL



ITEM 6 DETAIL

MATCH DRILL ϕ 5/8" HOLES
THRU WITH SKID ITEM 11
REFER TO DETAIL 338716-300



ITEM 18 DETAIL

GENERAL NOTES

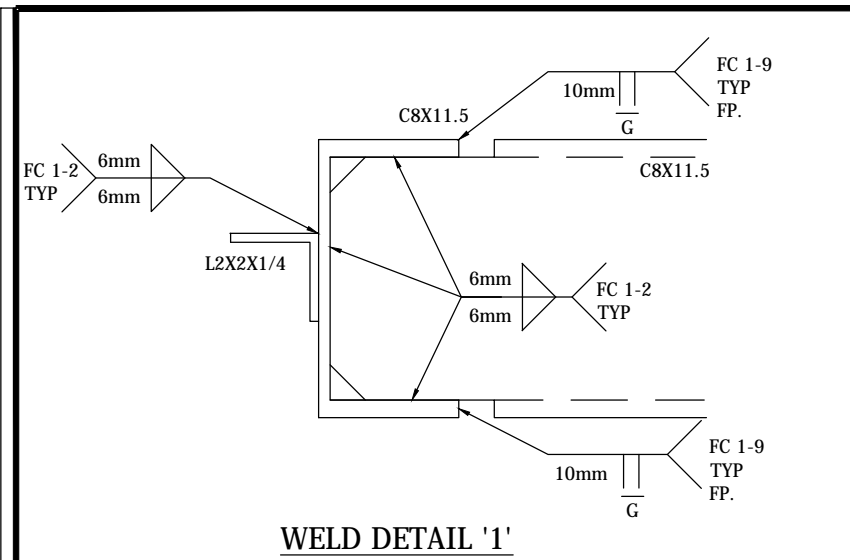
1. ALL DIMENSIONS ARE IN INCH [mm] U.N.O.
2. FABRICATION TOLERANCE +/- 1/8" [3mm] U.N.O.
3. HOLE & TAP LOCATIONS TOLERANCE +/- 1/32" [0.8mm] U.N.O.
4. CUT LENGTHS TO BE CONFIRMED BY FABRICATOR.
5. BREAK ALL SHARP EDGES AND CORNERS.
6. ALL HOLES FOR EQUIPMENT & PIPE CLAMPS TO BE DRILL & TAPPED DURING EQUIPMENT MOUNTING AND SPOOL ASSEMBLY.
7. JOINTS OF MAIN BEAMS (W8X21) SHALL BE FULL-PENETRATION WELDED.
8. NO JOINTS ARE ALLOWED FOR THE BEAMS THAT ARE DESIGNED AS ONE SINGLE PIECE.
9. WELDING EXAMINATIONS:
 - 100% VISUAL AND DIMENSIONAL CHECK.
 - 100% ULTRASONIC TEST FOR FULL PENETRATION WELDS.
 - 25% MPI FOR FILLET WELDS.
10. SURFACE PREPARATION & PAINTING:
 - SANDBLASTING TO SSPC-SP6.
 - ONE COAT OF RUST EXPOXY PRIMER (DFT: 4.0-8.0 mils) AND ONE TOP COAT OF URETHANE FINISH (DFT: 2.0-4.0 mils).
 - COLOR: WARM GRAY.

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.

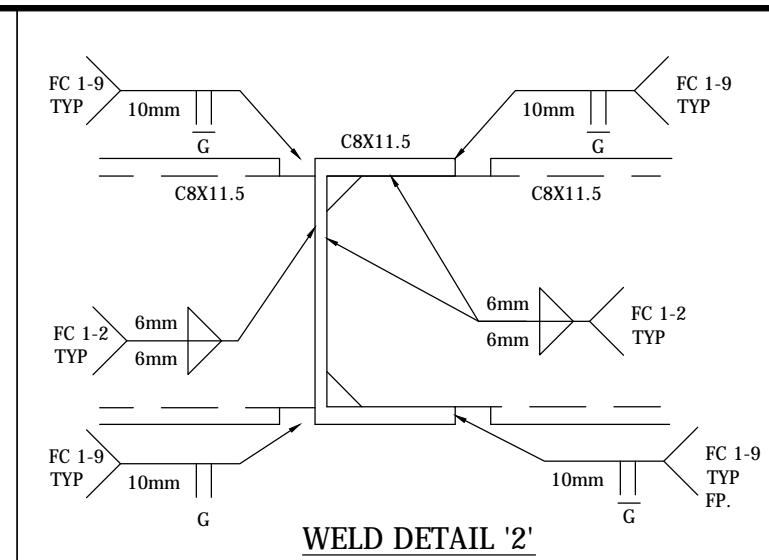


PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

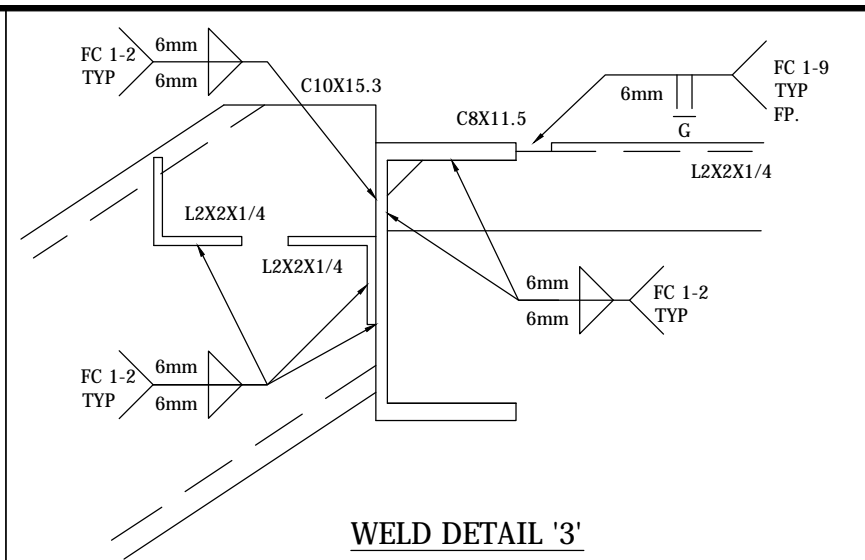
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02	DESCRIPTION	NSP	ET	PK	REV 28/14	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	
CMT NG PRESSURE REDUCTION SKID PACKAGE STAIRS & PLATFORM										001	NSP	NOV 28/14	002	ET	NOV 28/14	003	COG	NOV 28/14
338716-301-Rev0										004	NSP	NOV 28/14	005	ET	NOV 28/14	006	COG	NOV 28/14
6 OF 7										007	N/A	008	0					



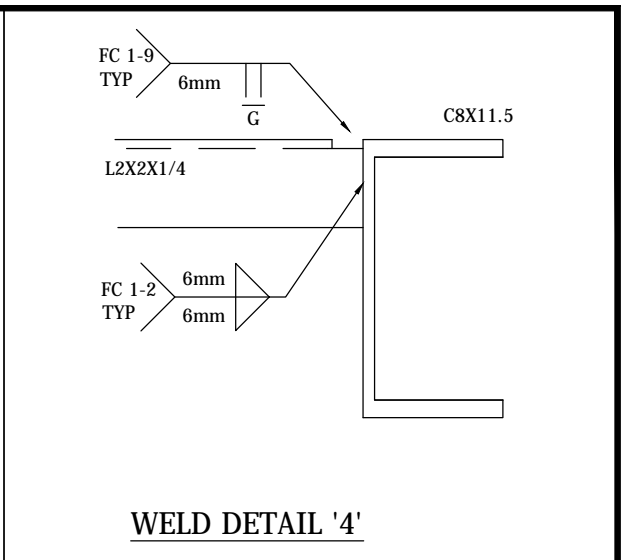
WELD DETAIL '1'



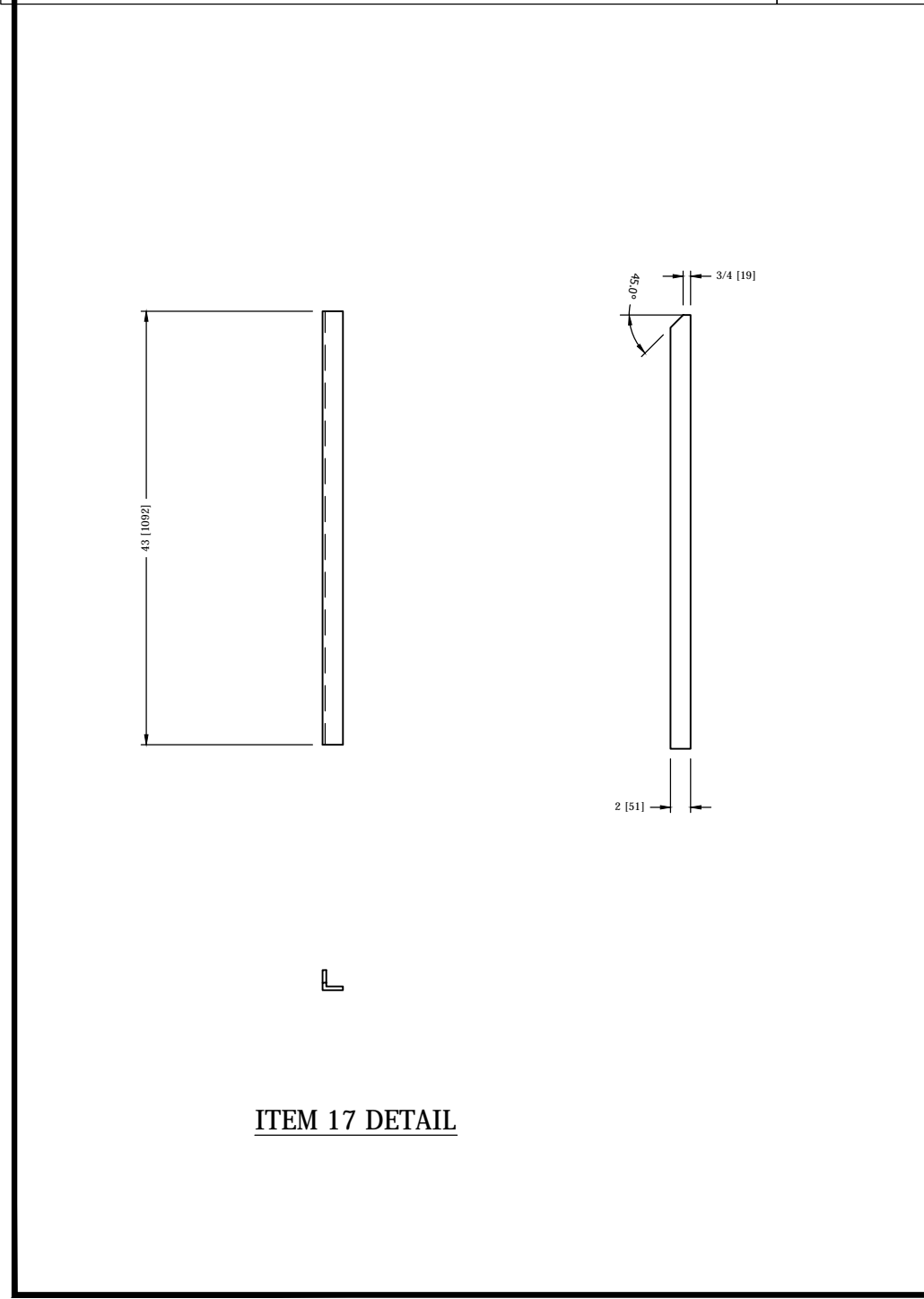
WELD DETAIL '2'



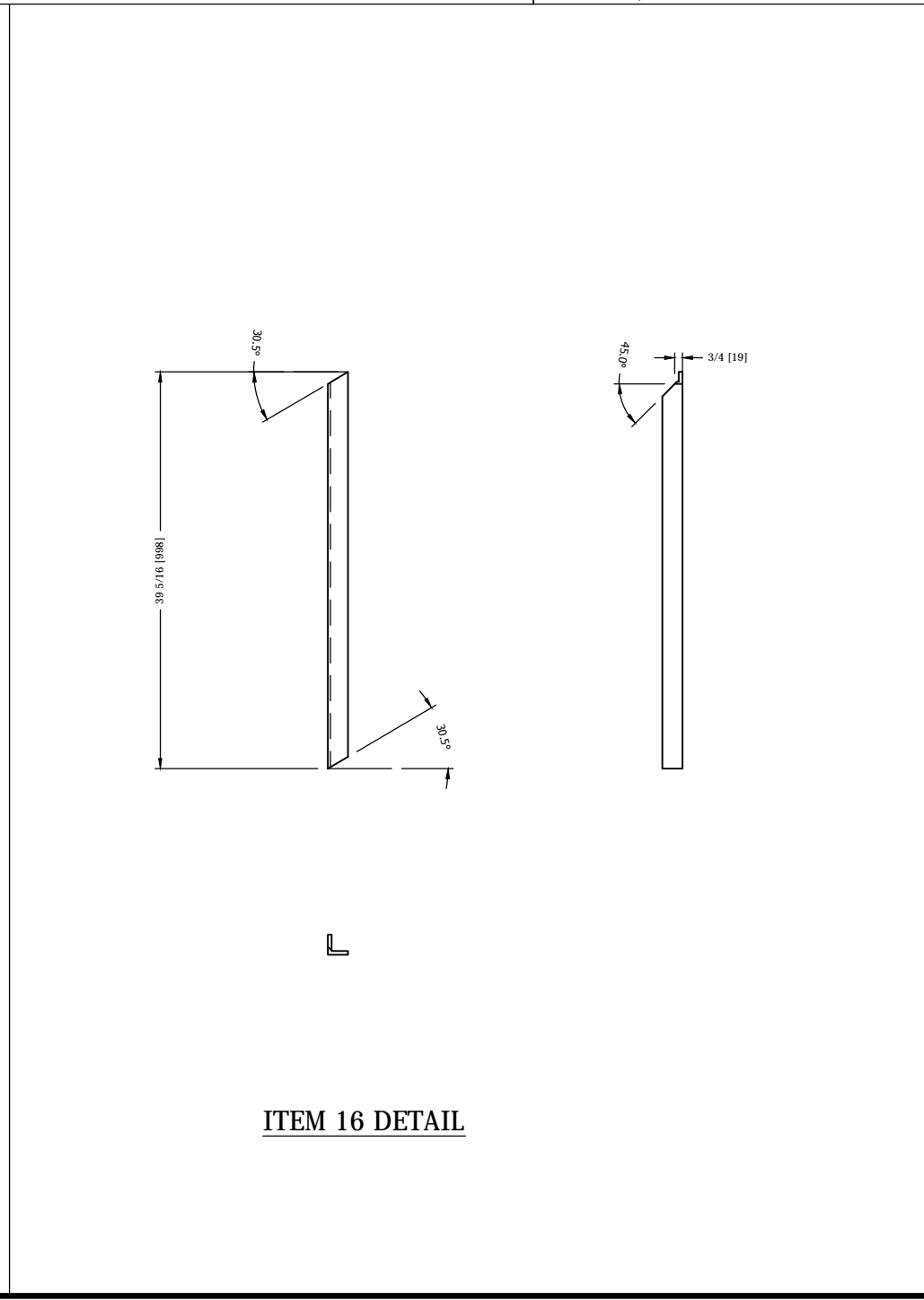
WELD DETAIL '3'



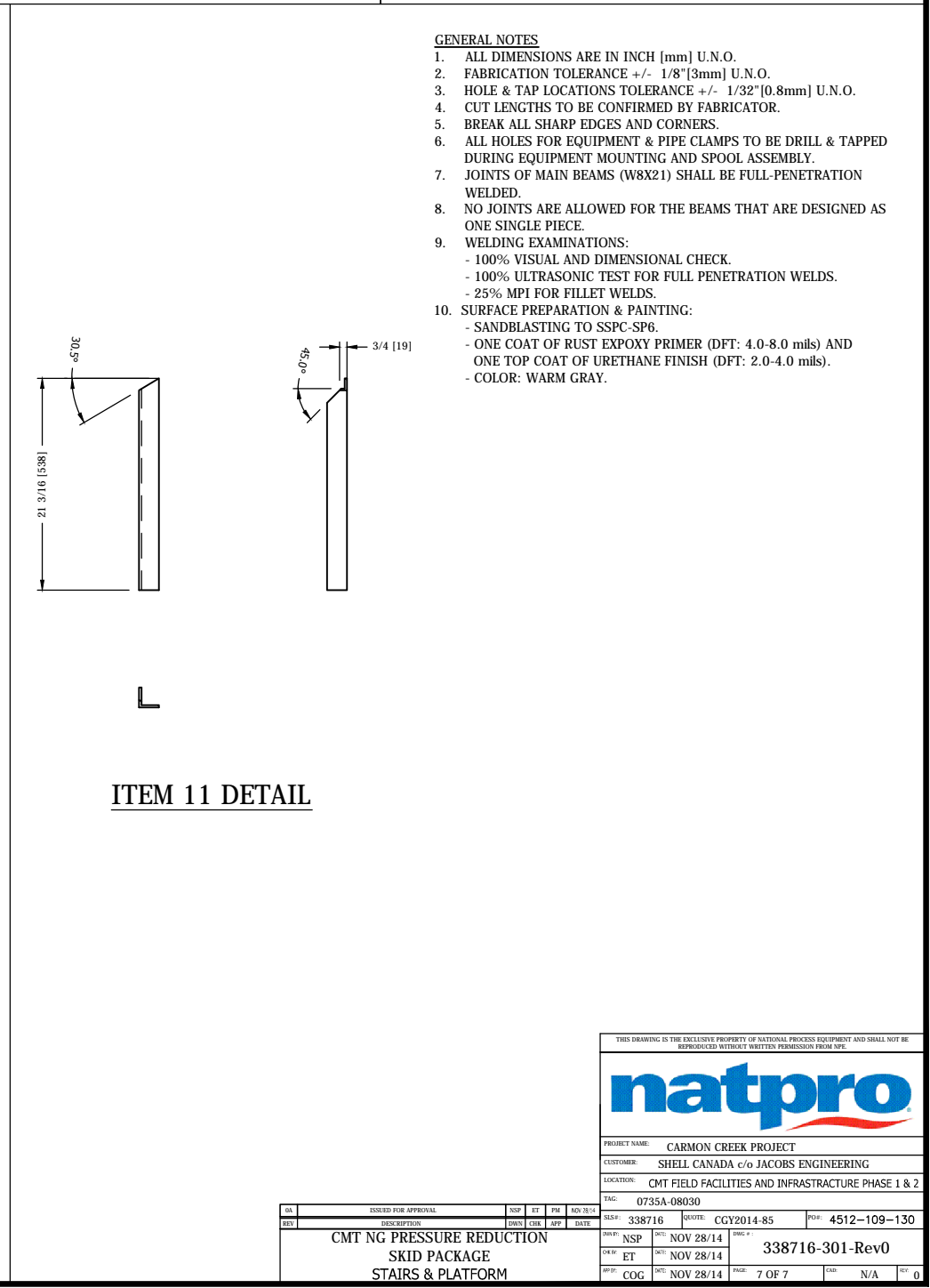
WELD DETAIL '4'



ITEM 17 DETAIL



ITEM 16 DETAIL



ITEM 11 DETAIL

- GENERAL NOTES**
1. ALL DIMENSIONS ARE IN INCH [mm] U.N.O.
 2. FABRICATION TOLERANCE +/- 1/8" [3mm] U.N.O.
 3. HOLE & TAP LOCATIONS TOLERANCE +/- 1/32" [0.8mm] U.N.O.
 4. CUT LENGTHS TO BE CONFIRMED BY FABRICATOR.
 5. BREAK ALL SHARP EDGES AND CORNERS.
 6. ALL HOLES FOR EQUIPMENT & PIPE CLAMPS TO BE DRILL & TAPPED DURING EQUIPMENT MOUNTING AND SPOOL ASSEMBLY.
 7. JOINTS OF MAIN BEAMS (W8X21) SHALL BE FULL-PENETRATION WELDED.
 8. NO JOINTS ARE ALLOWED FOR THE BEAMS THAT ARE DESIGNED AS ONE SINGLE PIECE.
 9. WELDING EXAMINATIONS:
 - 100% VISUAL AND DIMENSIONAL CHECK
 - 100% ULTRASONIC TEST FOR FULL PENETRATION WELDS.
 - 25% MPI FOR FILLET WELDS.
 10. SURFACE PREPARATION & PAINTING:
 - SANDBLASTING TO SSPC-SP6.
 - ONE COAT OF RUST EXPOXY PRIMER (DFT: 4.0-8.0 mils) AND ONE TOP COAT OF URETHANE FINISH (DFT: 2.0-4.0 mils).
 - COLOR: WARM GRAY.

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natpro

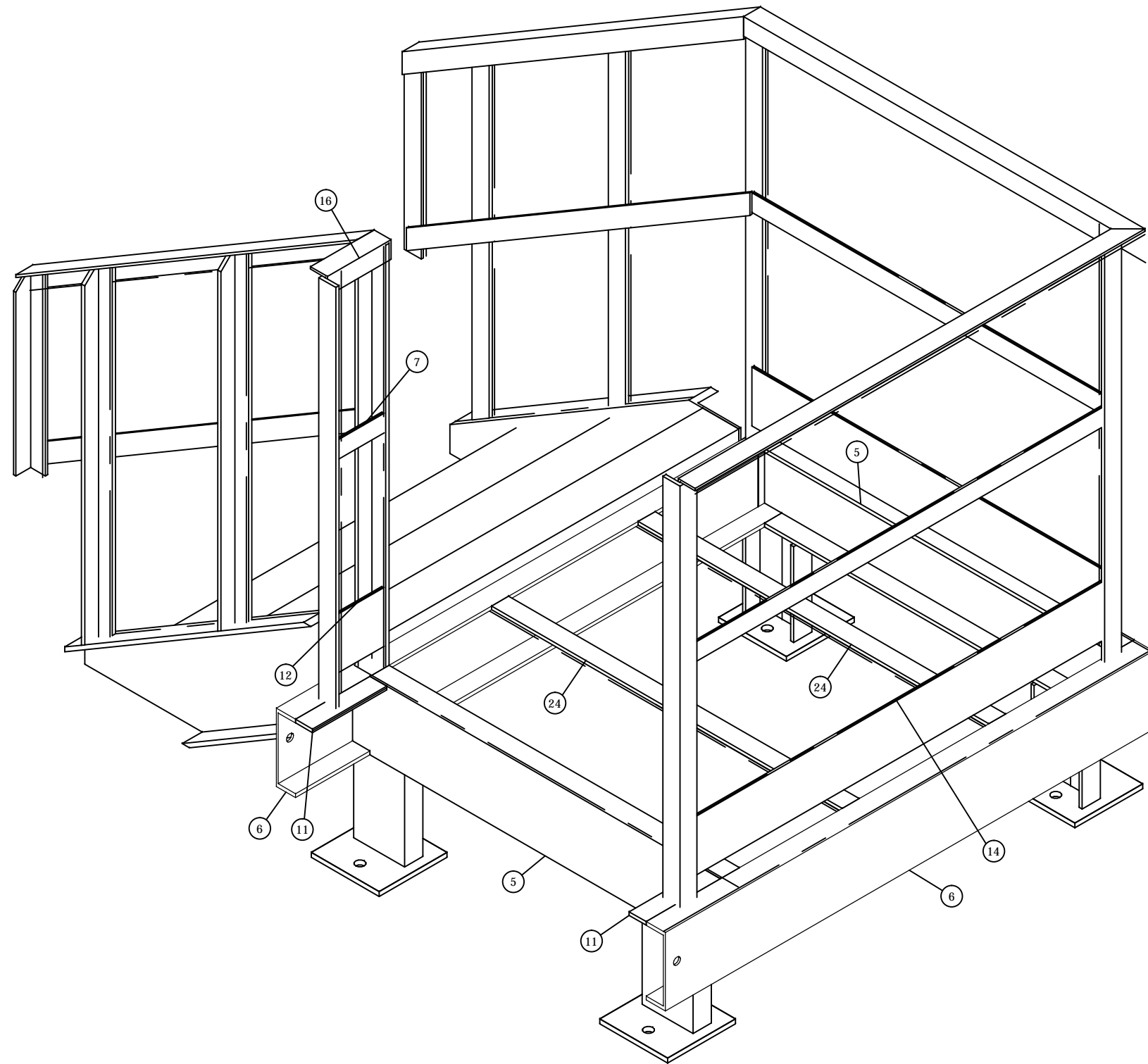
PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030

ISSUED FOR APPROVAL	NSP	ET	DATE	NOV 28/14
DESCRIPTION	OWN	CHK	APP	DATE
CMT NG PRESSURE REDUCTION SKID PACKAGE STAIRS & PLATFORM		NOV 28/14	NOV 28/14	NOV 28/14
NOV 28/14	NOV 28/14	NOV 28/14	NOV 28/14	NOV 28/14

338716 CGY2014-85 4512-109-130
 338716-301-Rev0
 7 OF 7 N/A 0



DWG NORTH



ISO VIEW

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.

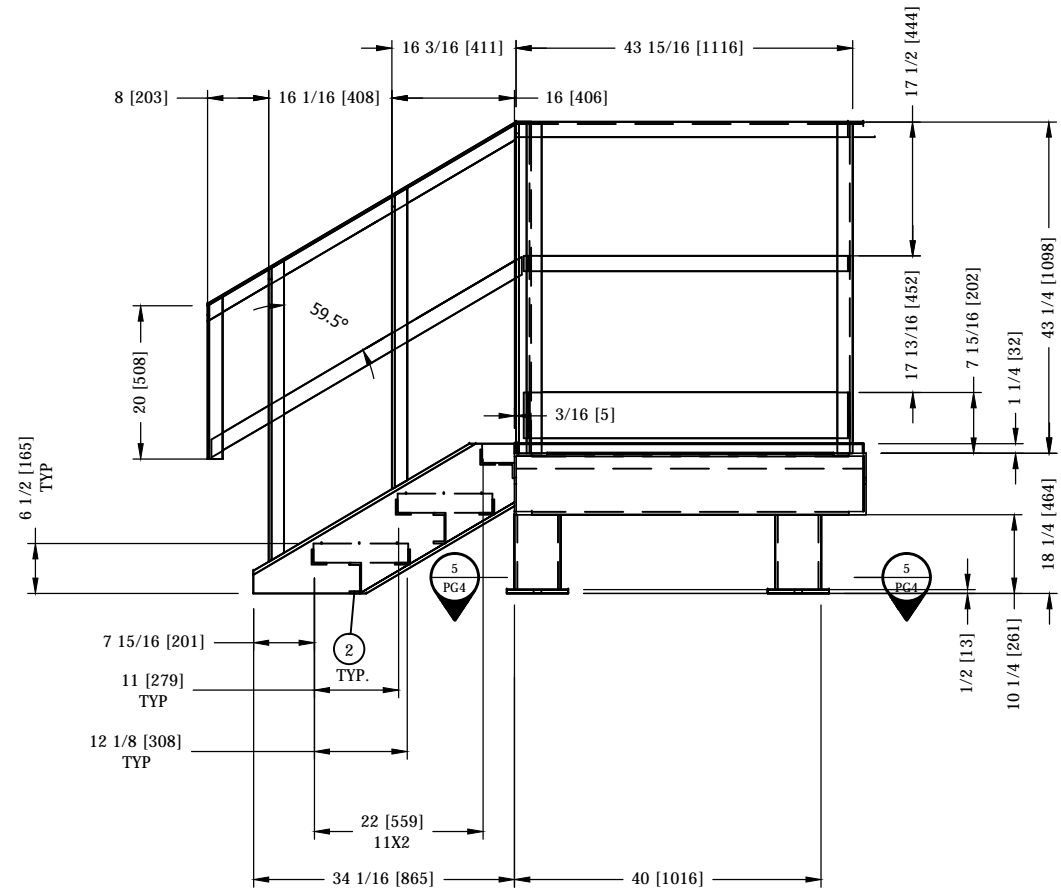


PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030

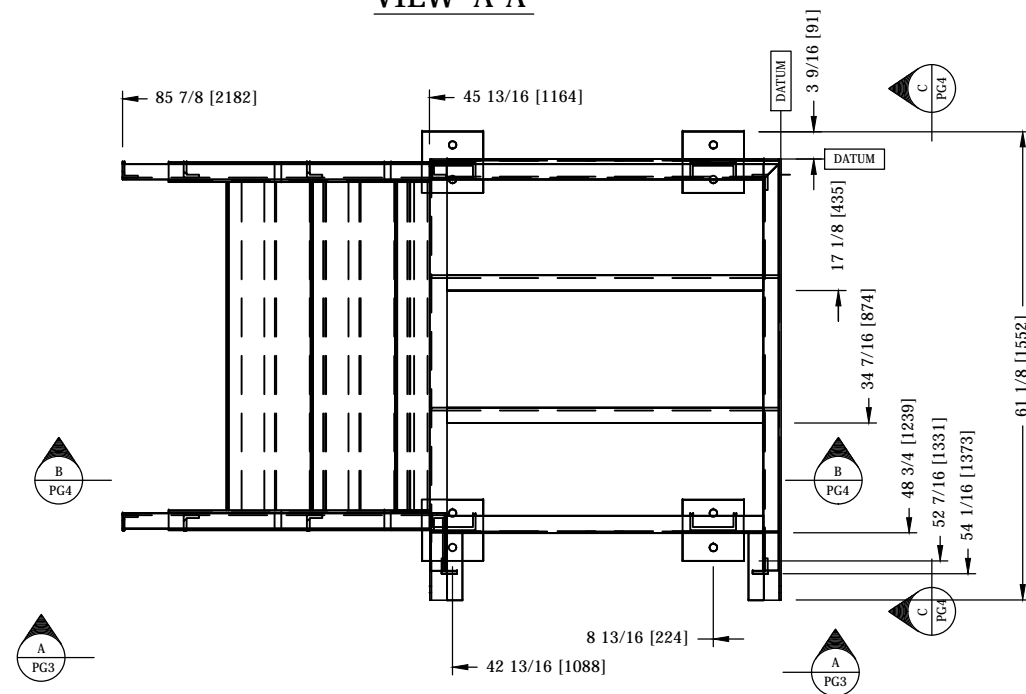
QA	ISSUED FOR APPROVAL	NSP	ET	PM	NOV 28/14	SLS#:	QUOTE:	PO#:
REV	DESCRIPTION	DWN	CHK	APP	DATE	338716	CGY2014-85	4512-109-130
	CMT NG PRESSURE REDUCTION SKID PACKAGE STAIRS & PLATFORM	DWN BY:	NSP	DATE:	NOV 28/14	DWG #:	338716-302-Rev0	
		CHK BY:	ET	DATE:	NOV 28/14	PAGE:	3 OF 7	CAD: N/A
		APP BY:	COG	DATE:	NOV 28/14	REV:	0	



DWG NORTH



VIEW 'A-A'



PLAN VIEW

GENERAL NOTES

1. ALL DIMENSIONS ARE IN INCH [mm] U.N.O.
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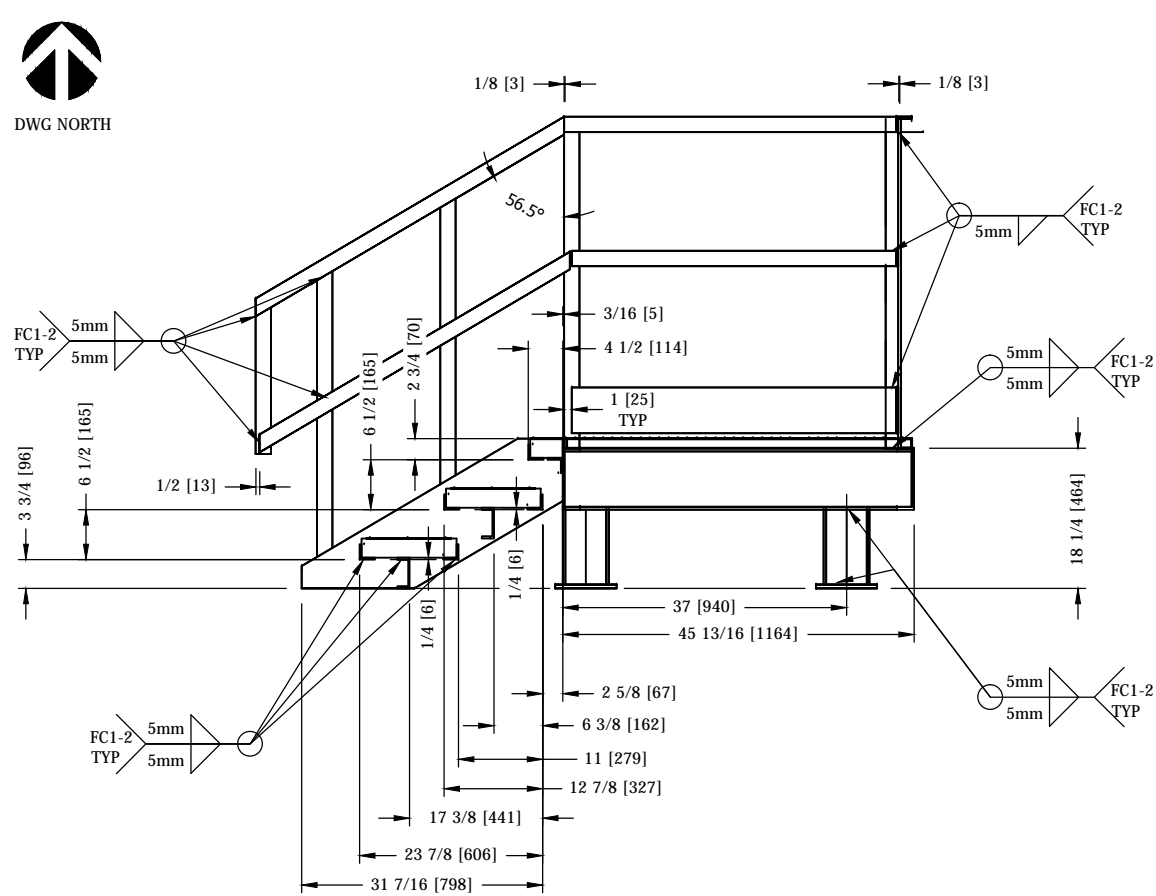


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 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030

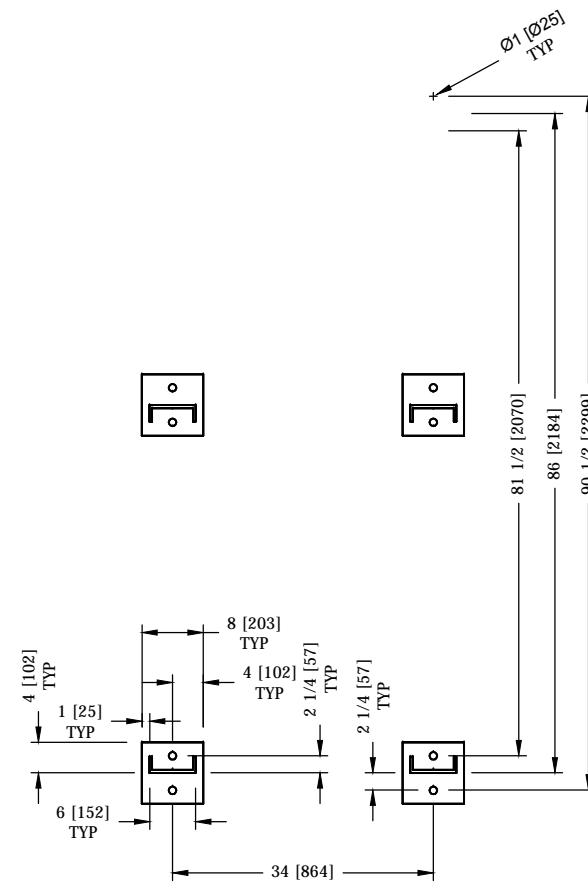
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REV	DESCRIPTION	DWN	CHK	APP	DATE	DWG #:	338716-302-Rev0				
CMT NG PRESSURE REDUCTION SKID PACKAGE STAIRS & PLATFORM						DWG BY:	NSP	DATE:	NOV 28/14		
						DWG BY:	ET	DATE:	NOV 28/14		
						APP BY:	COG	DATE:	NOV 28/14	PAGE:	4 OF 7
						CAD:	N/A	REV:	0		



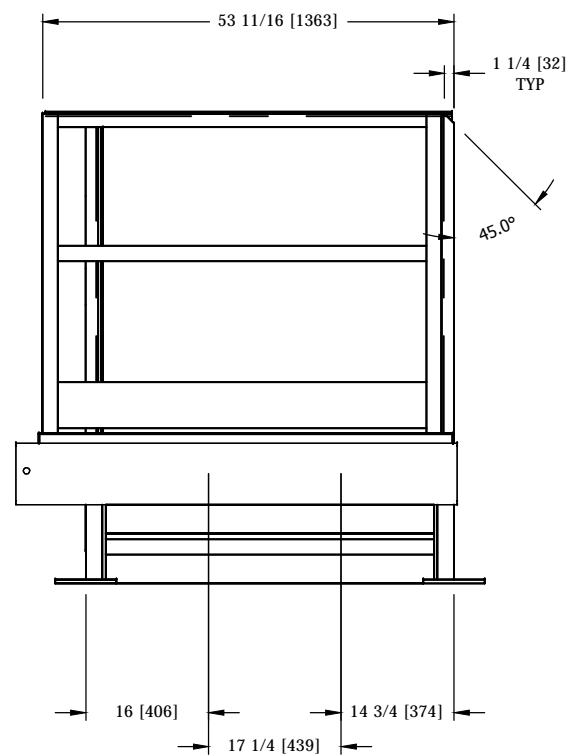
DWG NORTH



VIEW 'B-B'



SECTION '5-5'



VIEW 'C-C'

GENERAL NOTES

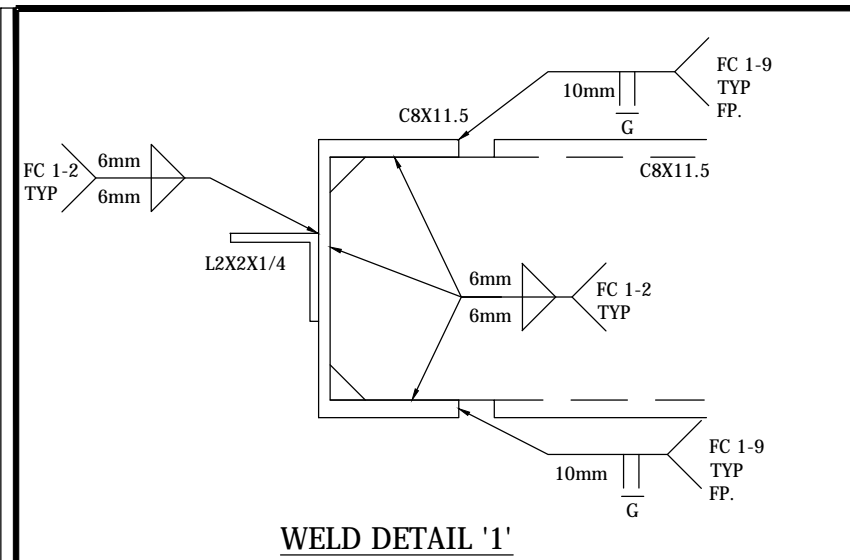
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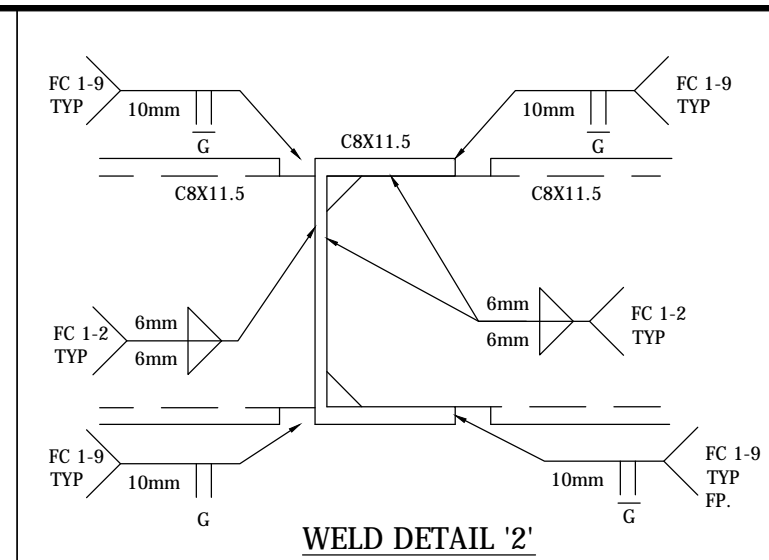


PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

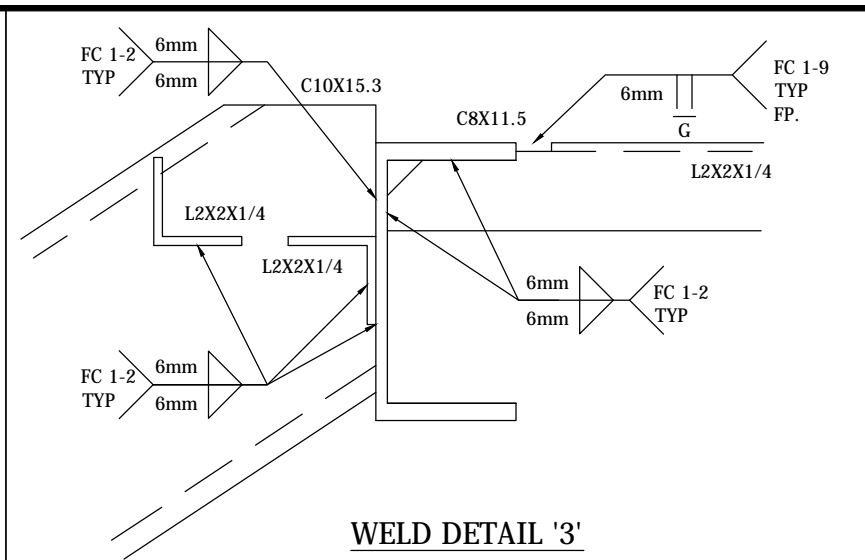
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	CMT NG PRESSURE REDUCTION SKID PACKAGE STAIRS & PLATFORM					DRN BY:	NSP	DATE:	NOV 28/14	PAGE:	5 OF 7
						APP BY:	ET	DATE:	NOV 28/14	CAD:	N/A
						APP BY:	COG	DATE:	NOV 28/14	REV:	0



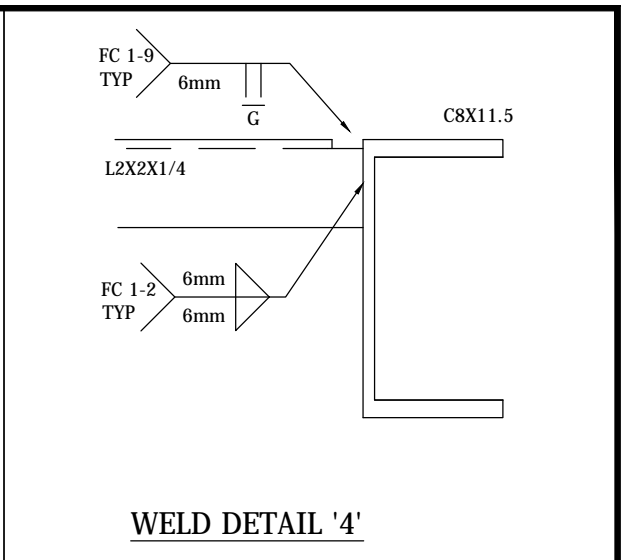
WELD DETAIL '1'



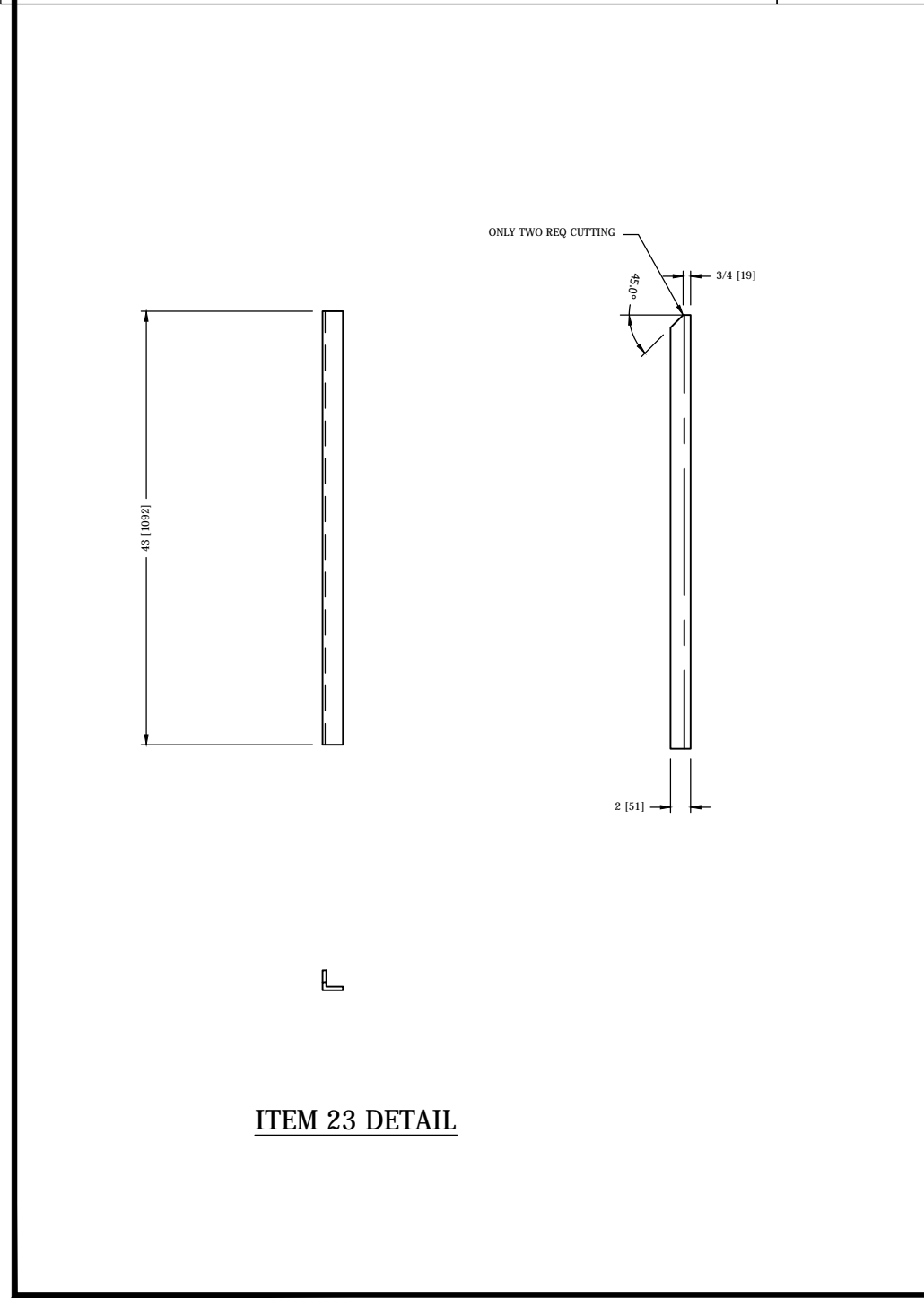
WELD DETAIL '2'



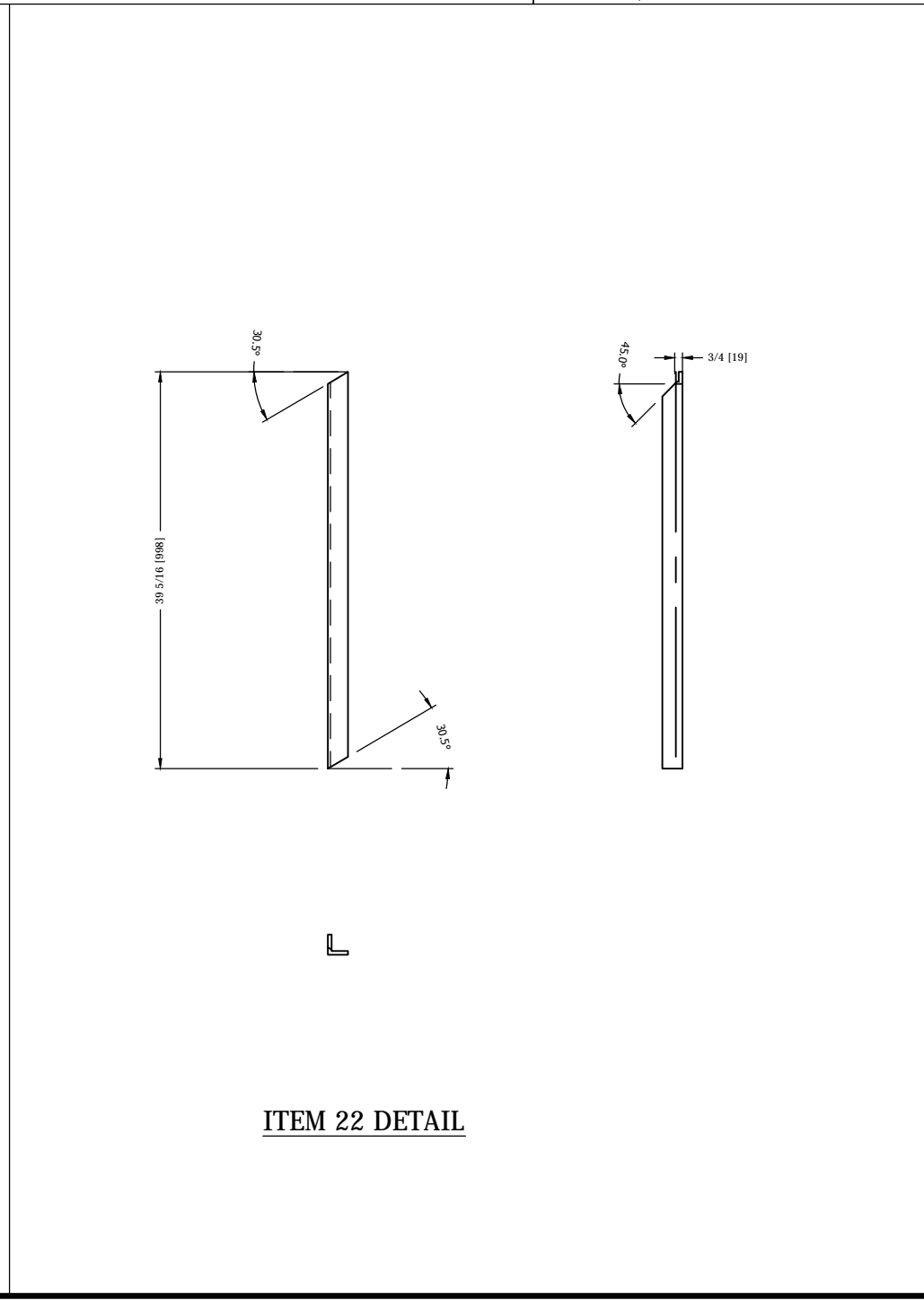
WELD DETAIL '3'



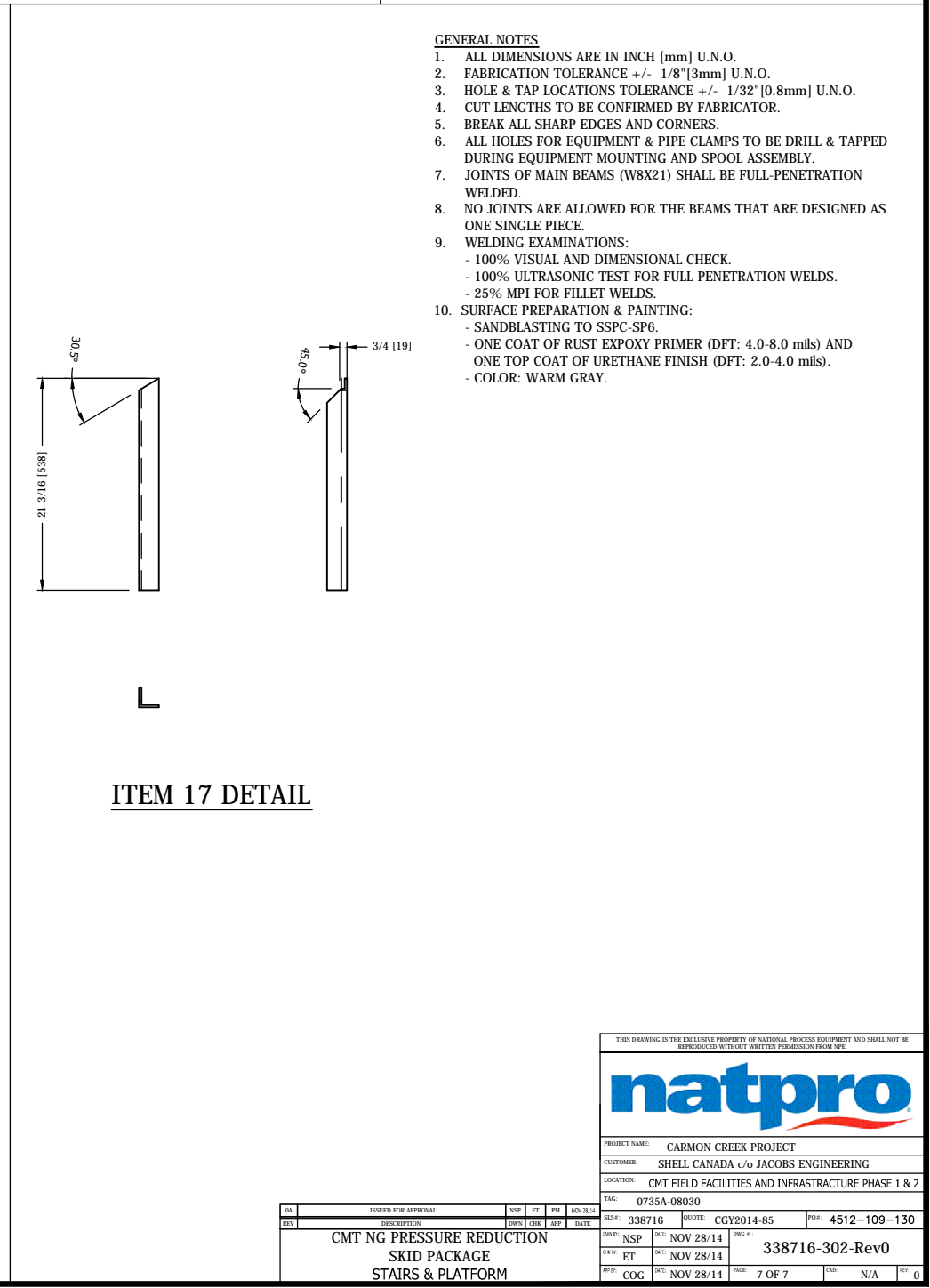
WELD DETAIL '4'



ITEM 23 DETAIL



ITEM 22 DETAIL



ITEM 17 DETAIL

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN INCH [mm] U.N.O.
 - FABRICATION TOLERANCE +/- 1/8" [3mm] U.N.O.
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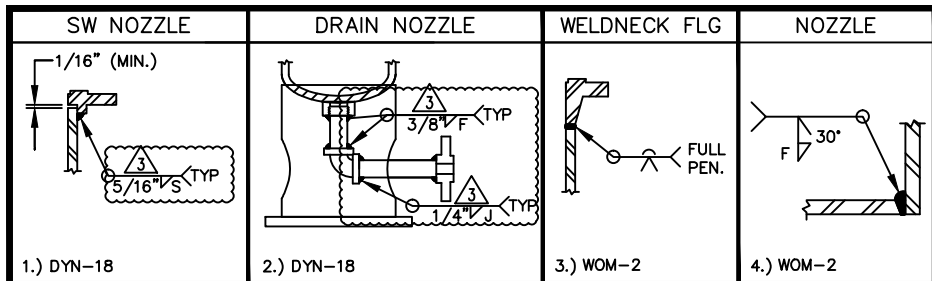
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natpro

PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

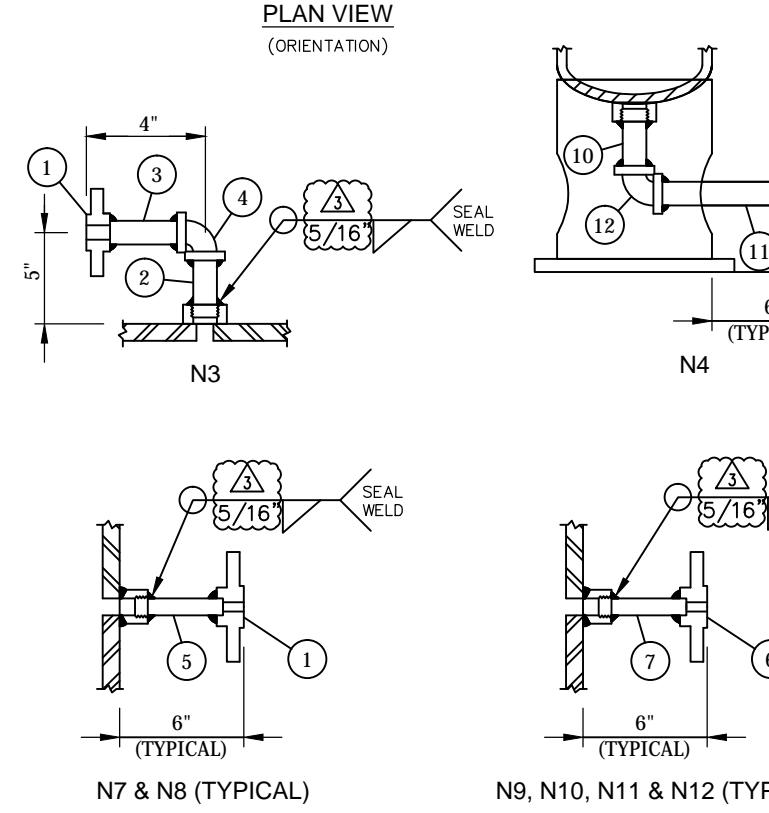
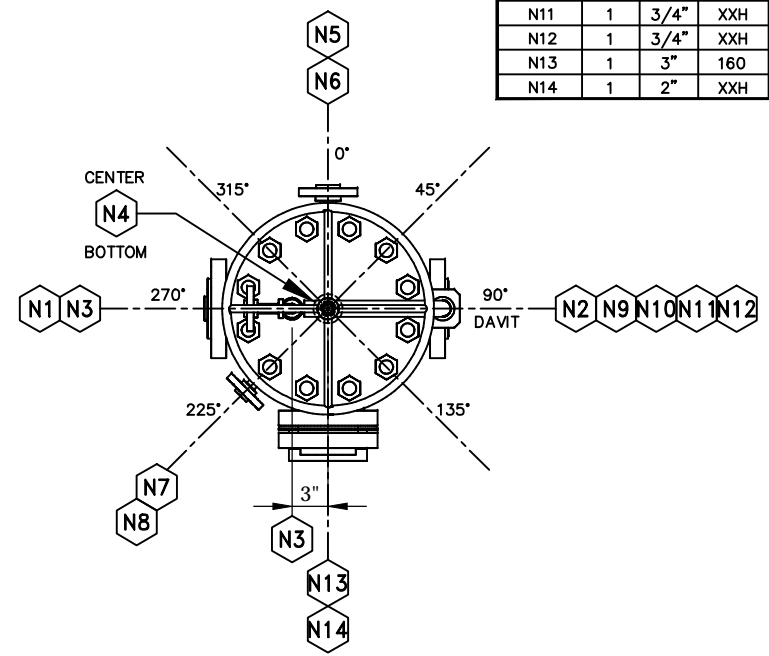
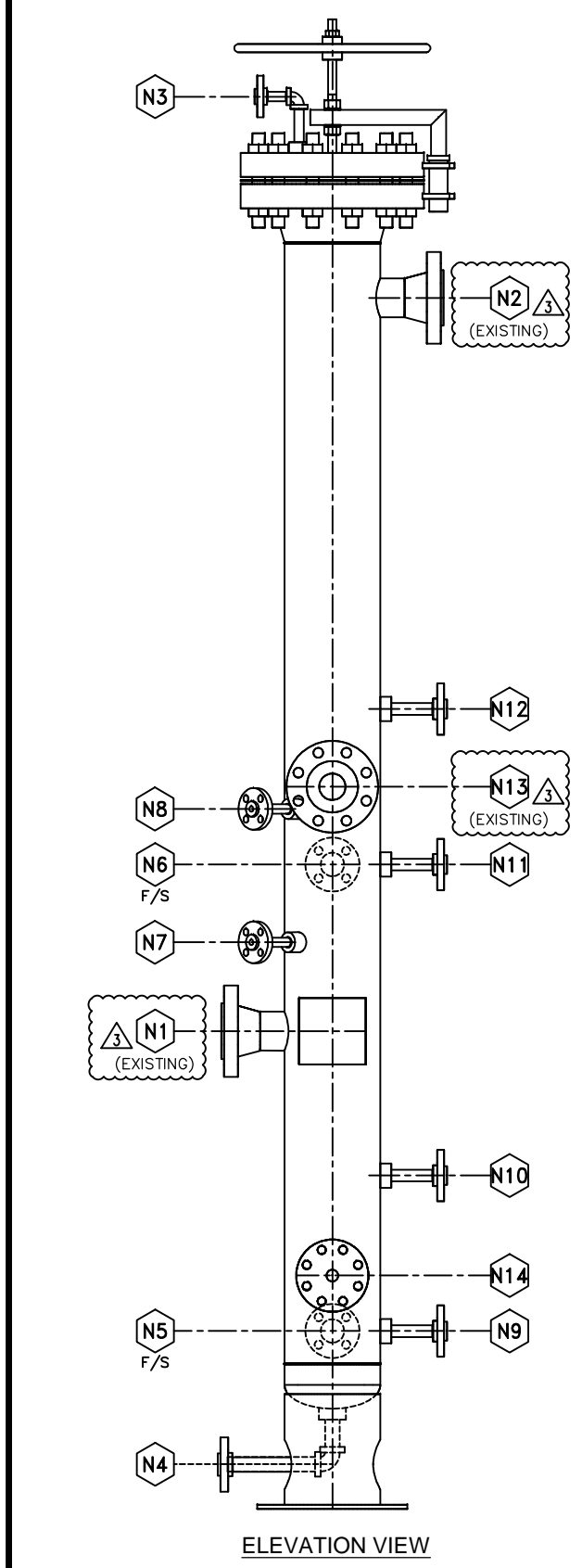
ISSUED FOR APPROVAL	NSP	ET	DATE	NOV 28/14
DESCRIPTION	OWN	CHK	APP	DATE
NO.:	338716	SCOPE:	CGY2014-85	PO#: 4512-109-130
DATE:	NOV 28/14	DATE:	NOV 28/14	DOC #:
DATE:	NOV 28/14	DATE:	NOV 28/14	338716-302-Rev0
DATE:	NOV 28/14	PAGE:	7 OF 7	REV:
				0

CMT NG PRESSURE REDUCTION
 SKID PACKAGE
 STAIRS & PLATFORM



ITEM NO.	NO. REQ'D	SIZE	SCH.	RATING AND FACING	SERVICE	PROJECTION		FILLET		REPAD			WELD#
						INSIDE(min)	OUTSIDE	"F"	"J"	"W"	"R"	"S"	
N1	1	3"	160	600# RFWN	INLET (EXISTING)	0"	5 11/16"	3/8"	-	-	-	-	3,4
N2	1	3"	160	600# RFWN	OUTLET (EXISTING)	0"	5 11/16"	3/8"	-	-	-	-	3,4
N3	1	1 1/2"	XXH	600# RFSW	VENT	-	AS SHOWN	3/8"	1/4"	-	-	-	5/16", 1,2
N4	1	1"	XXH	600# RFSW	DRAIN	-	AS SHOWN	3/8"	1/4"	-	-	-	5/16", 1,2
N5	1	1"	XXH	600# RFSW	LG	-	6"	3/8"	-	-	-	-	5/16", 1,2
N6	1	1"	XXH	600# RFSW	LG	-	6"	3/8"	-	-	-	-	5/16", 1,2
N7	1	1/2"	XXH	600# RFSW	DPI	-	6"	3/8"	-	-	-	-	5/16", 1,2
N8	1	1/2"	XXH	600# RFSW	DPI	-	6"	3/8"	-	-	-	-	5/16", 1,2
N9	1	3/4"	XXH	600# RFSW	LG/LT	-	6"	3/8"	-	-	-	-	5/16", 1,2
N10	1	3/4"	XXH	600# RFSW	LG/LT	-	6"	3/8"	-	-	-	-	5/16", 1,2
N11	1	3/4"	XXH	600# RFSW	LG/LT	-	6"	3/8"	-	-	-	-	5/16", 1,2
N12	1	3/4"	XXH	600# RFSW	LG/LT	-	6"	3/8"	-	-	-	-	5/16", 1,2
N13	1	3"	160	600# RFWN	LLC UPPER (EXISTING)	0"	5 11/16"	3/8"	-	-	-	-	3,4
N14	1	2"	XXH	600# RFWN	LLC LOWER	0"	7"	3/8"	-	-	-	-	3,4

BILL OF MATERIAL			
ITEM	QTY	DESCRIPTION	MAT'L
N3			
1	1	FLANGE - 1/2" CL600 RFSW SCH. XXH BORE	SA-350-LF2 CL.1
2	1 PC	NIPPLE - 1/2" SCH. XXH (TOE/POE) X 3 13/16" LG	SA-333-6
3	1 PC	NIPPLE - 1/2" SCH. XXH (PBE) X 2 3/8" LG	SA-333-6
4	1	90° ELBOW - 1/2" CL6000 SW	SA-350-LF2 CL.1
N4			
8	1	FLANGE - 1" CL600 RFSW SCH. XXH BORE	SA-350-LF2 CL.1
10	1 PC	NIPPLE - 1" SCH. XXH (TOE/POE) X 3 3/8" LG	SA-333-6
11	1 PC	NIPPLE - 1" SCH. XXH (PBE) X 8 5/16" LG	SA-333-6
12	1	90° ELBOW - 1" CL6000 SW	SA-350-LF2 CL.1
N5			
8	1	FLANGE - 1" CL600 RFSW SCH. XXH BORE	SA-350-LF2 CL.1
9	1 PC	NIPPLE - 1" SCH. XXH (TOE/POE) X 4 5/8" LG	SA-333-6
N6			
8	1	FLANGE - 1" CL600 RFSW SCH. XXH BORE	SA-350-LF2 CL.1
9	1 PC	NIPPLE - 1" SCH. XXH (TOE/POE) X 4 5/8" LG	SA-333-6
N7			
1	1	FLANGE - 1/2" CL600 RFSW SCH. XXH BORE	SA-350-LF2 CL.1
5	1 PC	NIPPLE - 1/2" SCH. XXH (TOE/POE) X 4 13/16" LG	SA-333-6
N8			
1	1	FLANGE - 1/2" CL600 RFSW SCH. XXH BORE	SA-350-LF2 CL.1
5	1 PC	NIPPLE - 1/2" SCH. XXH (TOE/POE) X 4 13/16" LG	SA-333-6
N9			
6	1	FLANGE - 3/4" CL600 RFSW SCH. XXH BORE	SA-350-LF2 CL.1
7	1 PC	NIPPLE - 3/4" SCH. XXH (TOE/POE) X 4 11/16" LG	SA-333-6
N10			
6	1	FLANGE - 3/4" CL600 RFSW SCH. XXH BORE	SA-350-LF2 CL.1
7	1 PC	NIPPLE - 3/4" SCH. XXH (TOE/POE) X 4 11/16" LG	SA-333-6
N11			
6	1	FLANGE - 3/4" CL600 RFSW SCH. XXH BORE	SA-350-LF2 CL.1
7	1 PC	NIPPLE - 3/4" SCH. XXH (TOE/POE) X 4 11/16" LG	SA-333-6
N12			
6	1	FLANGE - 3/4" CL600 RFSW SCH. XXH BORE	SA-350-LF2 CL.1
7	1 PC	NIPPLE - 3/4" SCH. XXH (TOE/POE) X 4 11/16" LG	SA-333-6
N14			
13	1	FLANGE - 2" 600# RFWN SCH. XXH BORE	SA-350-LF2 CL.1
14	1 PC	PIPE - 2" SCH. XXH (TOE/BOE) X 2 3/4" LG	SA-333-6
15	1	HEX HEAD PLUG - 3/4" CL6000 NPT	SA-350-LF2 CL.1



GENERAL NOTES:

- IMPACT TESTING NOT REQ'D.
- WHERE SEAL WELDING OF THREADED JOINTS IS PERFORMED, THREADS SHALL BE ENTIRELY COVERED BY THE SEAL WELD.
- SUBSTITUTION OF MATERIAL IS NOT ACCEPTABLE UNLESS ENGINEERING DEPARTMENT APPROVAL OBTAINED.
- NO PWHT REQUIRED PER SHELL APPROVED WELDING PROCEDURE.

FABRICATION NOTE:

- BW FOR NOZZLE N14 TO BE 100% RADIOGRAPHED.

DESIGN DATA

2013 ASME CODE SEC. VIII DIV. 1	ADD: -
PARA: UW-11(o)	
HEAD MATERIAL: SA-105N/SA-234-WPC	
SHELL MATERIAL: SA-106C SMLS	
MDMT: -50°F @ 1440 PSIG	
NOZZLE: SEE BOM	FLANGES: SEE BOM
MAX. W.P.: 1440 PSIG	TEMP.: 130°F
HYDROTEST: 1872 PSIG	RADIOGRAPHY: RT-1 (FULL)
STRESS RELIEVE: NO	
CORR. ALLOW.: 0.120"	JOINT EFF.: 100%
VOLUME: 2.94 CU. FT.	
EMPTY WT: 900 LBS	FULL WT: 1084 LBS
YEAR BUILT: 2014	SERIAL No.: N/A
CRN No.: T5967.213	
W.P.R. No.: N/A	
SURFACE PREP.: SEE JCI DRAWING W015408	
PRIME: SEE JCI DRAWING W015408	
PAINT: SEE JCI DRAWING W015408	
INSULATION: N/A	

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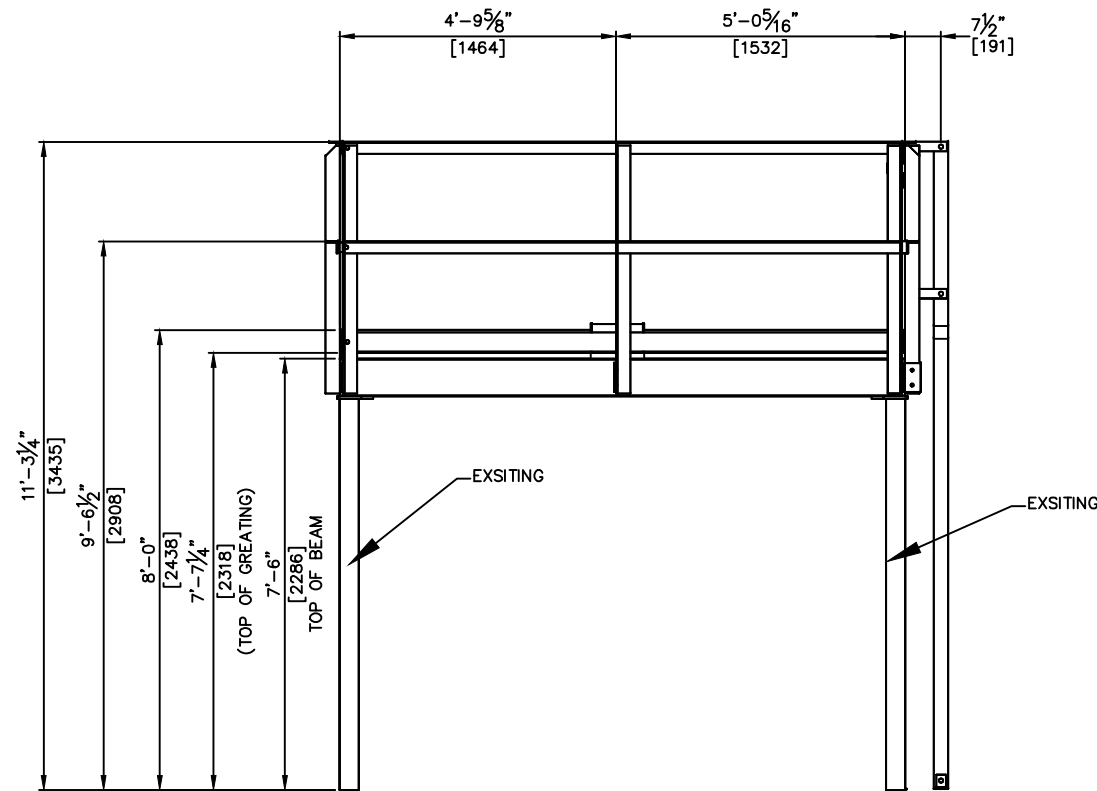
PROJECT NAME:	CARMON CREEK PROJECT
CUSTOMER:	SHELL CANADA c/o JACOBS ENGINEERING
LOCATION:	CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG:	0735A-08030 (VESSEL TAG# S-08070)
SLS#:	338716
QUOTE:	CGY2014-85
PO#:	4512-109-130
DWN BY:	GG
DATE:	OCT 03/14
DWG #:	338716-901-Rev3
CHK BY:	ET
DATE:	OCT 03/14
APP BY:	PM
DATE:	OCT 03/14
PAGE:	1 OF 1
CAD:	N/A
REV:	3

3	REVISED DESIGN DATA; ADDED WELD SIZE & VESSEL TAG NO.	GG	AA	ET	FEB 25/15
2	REVISED TO ASME VIII CODE	LK	AA	ET	FEB 12/15
1	CORRECTED TAG NO.	GG	ET	PM	DEC 16/14
0	ISSUED FOR CONSTRUCTION	GG	ET	ET	OCT 08/14
REV	DESCRIPTION	DWN	CHK	APP	DATE

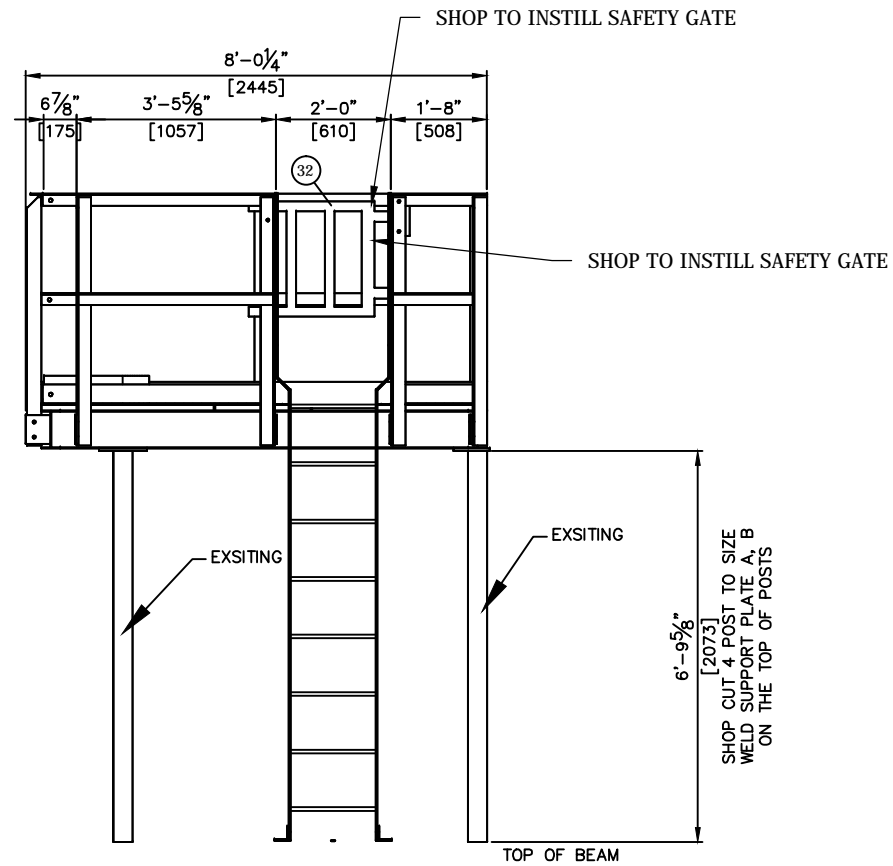
**CMT NG PRESSURE REDUCTION
SKID PACKAGE
COALESCER FILTER VESSEL**



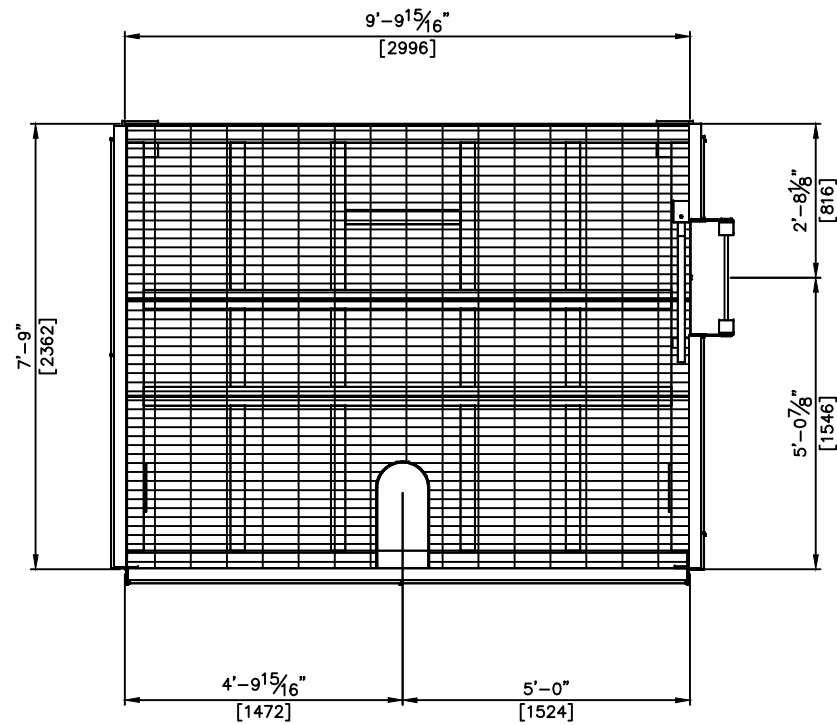
NORTH



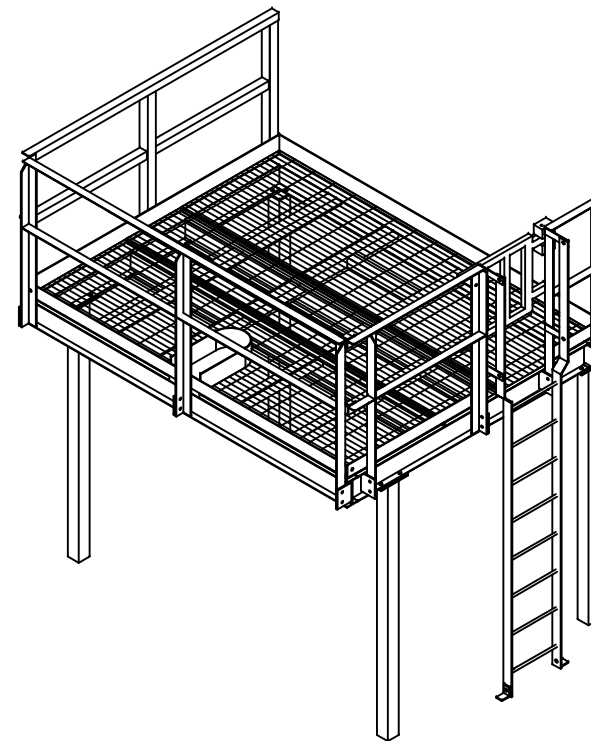
PLATFORM ELEVATION VIEW
SCALE 1 : 40



PLATFORM RIGHT ELEVATION VIEW
SCALE 1 : 40



PLATFORM PLAN VIEW
SCALE 1 : 40



ISO VIEW

GENERAL STRUCTURAL STEEL NOTES:

- ALL DIMENSION ARE IN INCHES [MILLIMETERS] UNLESS OTHERWISE NOTED. ALL ELEVATIONS ARE REFERED FROM TOP OF SKID FLOOR.
- ALL WORK SHALL GENERALLY CONFORM TO THE LATEST EDITIONS OF THE FOLLOWING CODES AND STANDARDS:
CSA W47.1-92
CISC HANDBOOK OF STEEL CONSTRUCTION
- ALL STEEL SHALL BE OF NEW STOCK AND SHALL BE IN ACCORDANCE WITH CSA G40.21-M. STRUCTURAL STEEL SHALL BE GRADE 50W/350W. PLATE MATERIAL SHALL BE 44W.
- WELDING SHALL BE IN GENERAL CONFORMANCE WITH CSA W59-2003. FILLER METAL SHALL CONFORM TO CSA STD. W48-06-E4802C-6-CH. WELDS TO BE 6mm CONTINUOUS FILLET WELD UNLESS NOTED. ALL WELDING PROCEDURE AND WELDERS TO BE CWB QUALIFIED.
- CLEAN ALL STEEL SURFACES PRIOR TO PAINTING TO SSPC-SP6 PRIMER. 3 MIL. DFT INORGANIC ZINC RICH (CARBOZINC11) COLOR GREY
- WEIGHT OF BOTH STRUCTURAL STEEL SKIDS AND PLATFORM IS APPROX. XXXX LBS (XXX KG)
- ALL SHARP CONERS, AND BURRS SHALL BE REMOVED
- ALL LADDERS AND HANDRAIL SHALL BE PAINTED SAFETY YELLOW.
- ALL FILLET WELD 6mm UNLESS NOTED OTHERUSE.

FABRICATION NOTES:

- WELDING EXAMINATIONS:
- 100% VISUAL AND DIMENSIONAL CHECK.
 - 100% UT TEST FOR FULL PENETRATION WELDS.
 - 25% MPI ALL FILLET WELDS.

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PROJECT NAME:		CARMON CREEK PROJECT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1&2	
CUSTOMER:		SHELL CANADA	
LOCATION:		CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2	
TAG:		0735A-08030	
SLS#:	QUOTE:	PO#:	
338716	CGY2014-85	4512-109-130	
DWN BY:	DATE:	DWG #:	
GG	JUN 27/14	338716-305-Rev1	
CHK BY:	DATE:		
ET	JUN 27/14		
APP BY:	DATE:	PAGE:	REV:
COG	JUN 27/14	1 OF 8	N/A 1

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	AS BUILT	NSP	AA	AA	SEPT 21/15
0	ISSUED FOR CONSTRUCTION	GW	ET	AA	MAY 06/15

**CAMP NG PRESSURE REDUCTION
PLATFORM
STRUCTURAL STEEL SKID**

BILL OF MATERIAL

MARK	QTY	LONG ANNOTATION	LENGTH (mm)	WEIGHT (KGS)
2	1	FB2x1/4	178	2.18
3	4	FB2x1/4	216	5.30
4	2	FB3x3/8	3456	191.16
5	1	FB4x1/4	19	30.11
6	1	FB4x1/4	489	12.01
7	1	FB4x1/4	2951	72.56
8	2	FB5x1/2	254	31.22
9	1	FB6x1/4	2356	86.86
10	1	FB6x1/4	2996	110.44
11	1	FB6x3/8	76	4.22
12	9	FB6x3/8	130	50.49
13	1	L2 1/2X2 1/2X1/4	508	15.03
14	2	L2 1/2X2 1/2X1/4	1232	11.09
15	1	L2 1/2X2 1/2X1/4	422	12.49
16	1	L2 1/2X2 1/2X1/4	1032	30.53
17	1	L2 1/2X2 1/2X1/4	2945	87.14
18	1	L2 1/2X2 1/2X1/4	2964	87.71
19	4	L3X3X1/4	510	66.35
20	1	L3X3X1/4	679	22.75
21	4	L3X3X1/4	864	116.31
21	4	L3X3X1/4	864	116.31
22	4	L3X3X1/4	876	118.12
24	3	L3X3X3/8	51	5.28
25	3	L3X3X3/8	51	5.28
26	9	L3X3X3/8	1314	478.17
27	2	PL-1/2 X 7.5000 X 7.5000	N/A	35.11
28	8	RB3/4	460	40.02
29	2	W8X10	2257	318.19

BILL OF MATERIAL

MARK	QTY	LONG ANNOTATION	LENGTH (mm)	WEIGHT (KGS)
30	2	W8X10	2891	409.64
31	2	W8X10	2996	432.45
32	1	SATY GATE, INTREPID INDUSTRIES UDG-27" OR EQUIVALENT, YELLOW	-	-
33	1	SERRATED GRATING, TYPE 30, 32mm x4.8mm, UNCOATED	2983 x 2324	-
34	1	FB6x1/4	1092	-
35	3	L2 1/2X2 1/2X1/4	51	4.29
36	1	L2 1/2X2 1/2X1/4	1133	32.80
37	1	L2 1/2X2 1/2X1/4	1124	33.95
38	1	L2 1/2X2 1/2X1/4	2337	69.08
TOTAL WEIGHT: 3139.36				

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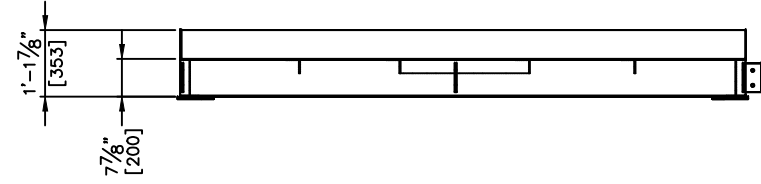
PROJECT NAME:	CARMON CREEK PROJECT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1&2		
CUSTOMER:	SHELL CANADA		
LOCATION:	CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2		
TAG:	0735A-08030		
SLS#:	338716	QUOTE:	CGY2014-85
PO#:	4512-109-130		
DWN BY:	GG	DATE:	JUN 27/14
CHK BY:	ET	DATE:	JUN 27/14
APP BY:	COG	DATE:	JUN 27/14
DWG #:	338716-305-Rev2		
PAGE:	2 OF 8	CAD:	N/A
REV:	2		

REV	DESCRIPTION	DWN	CHK	APP	DATE
2	AS BUILT, UPDATED AS PER CUSTOMER MARKUPS	NSP	AA	AA	DEC 4/15
1	AS BUILT	NSP	AA	AA	SEPT 21/15
0	ISSUED FOR CONSTRUCTION	GW	ET	AA	MAY 06/15

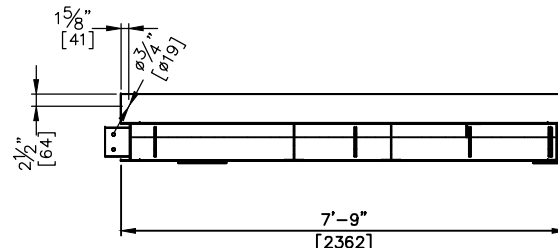
**CMT NG PRESSURE REDUCTION
PLATFORM
STRUCTURAL STEEL SKID**



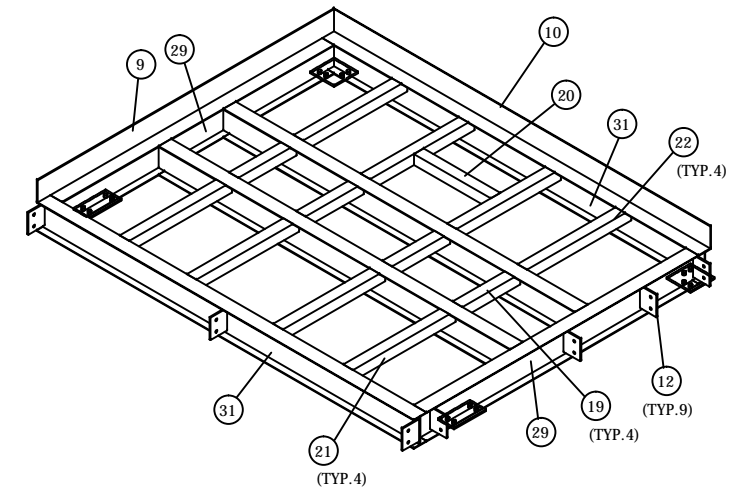
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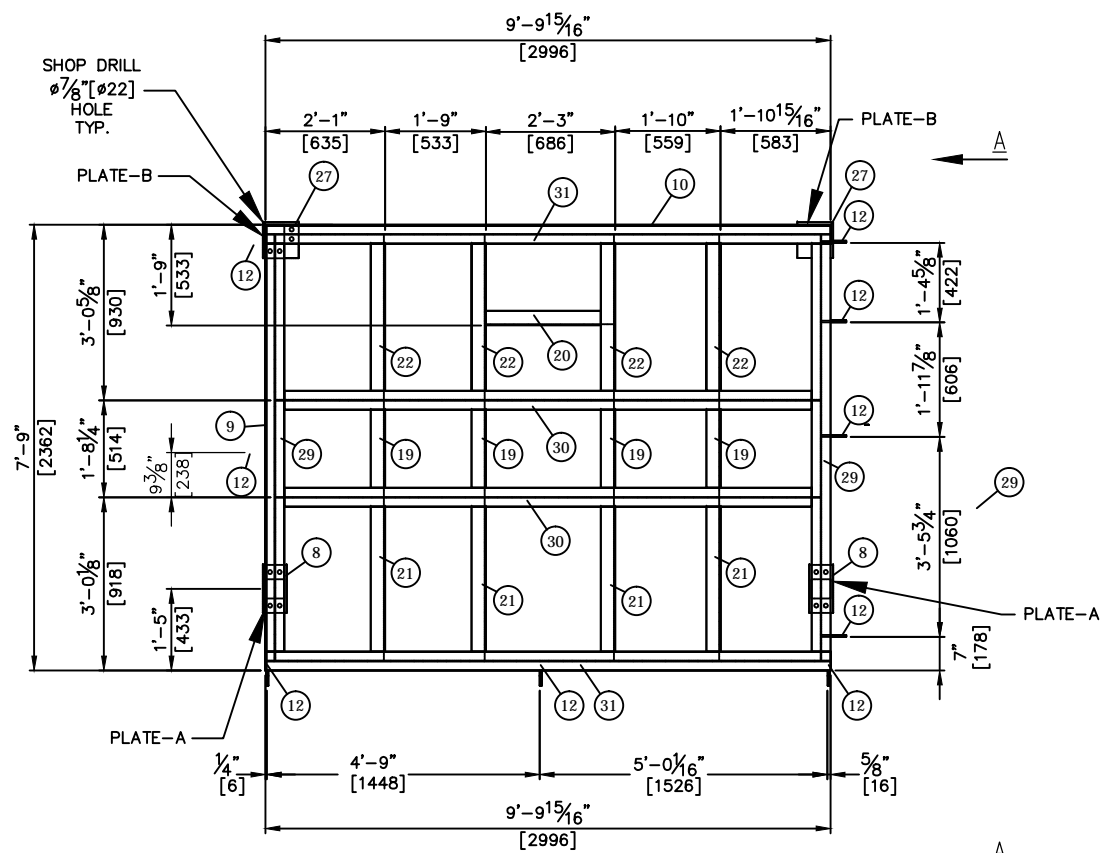
PLATFORM ELEVATION VIEW
SCALE 1 : 40



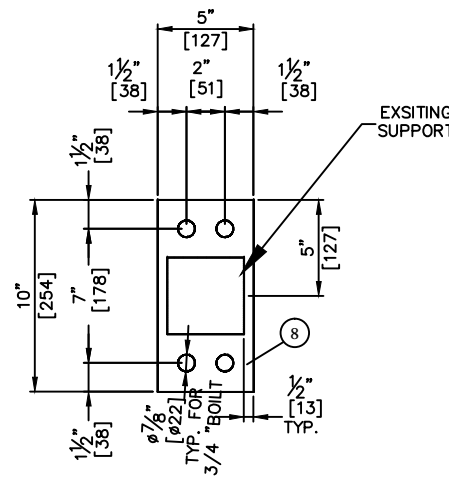
SECTION VIEW A-A
SCALE 1 : 40



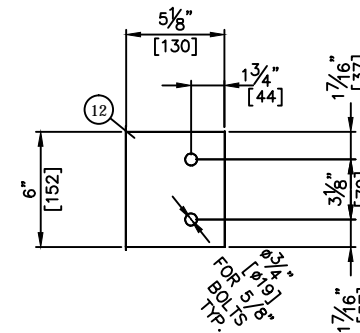
PLATFORM
ISO VIEW



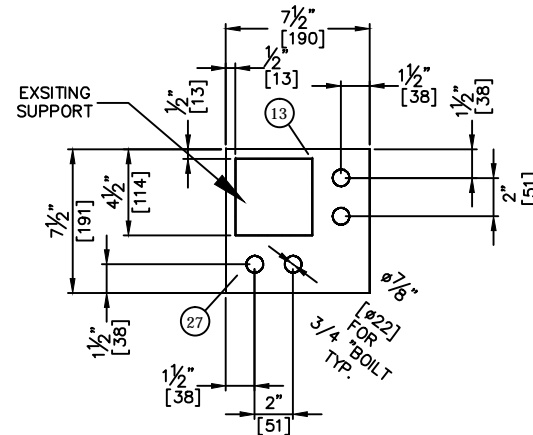
PLATFORM PLANVIEW
SCALE 1 : 40



PLATFORM SUPPORT
PLATE-A
SCALE 1 : 10
(2) REQUIRED



HANDRAIL SUPPORT
PLATE
SCALE 1 : 10
(9) REQUIRED



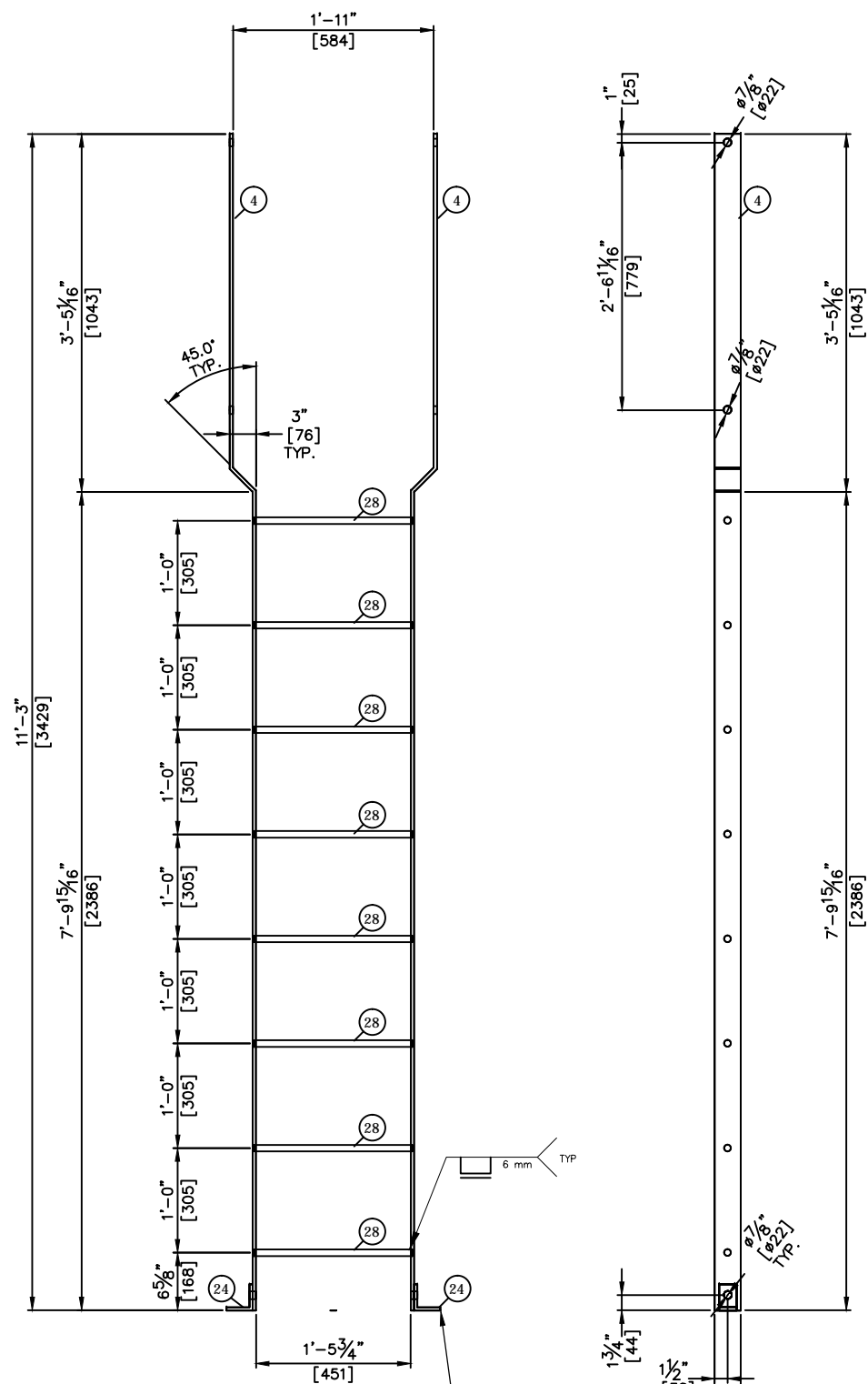
PLATFORM SUPPORT
PLATE-B
SCALE 1 : 10
(2) REQUIRED

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PROJECT NAME:		CARMON CREEK PROJECT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1&2	
CUSTOMER:		SHELL CANADA	
LOCATION:		CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2	
TAG:		0735A-08030	
SLS#:		QUOTE:	PO#:
338716		CGY2014-85	4512-109-130
DWN BY:	GG	DATE:	JUN 27/14
CHK BY:	ET	DATE:	JUN 27/14
APP BY:	COG	DATE:	JUN 27/14
DWC #:		338716-305-Rev1	
PAGE:	3 OF 8	CAD:	N/A
REV	1		

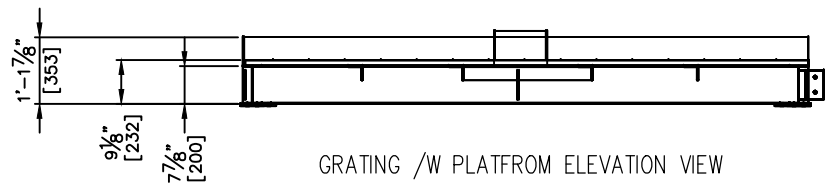
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0	ISSUED FOR CONSTRUCTION	GW	ET	AA	MAY 06/15
REV	DESCRIPTION	DWN	CHK	APP	DATE
CAMP NG PRESSURE REDUCTION PLATFORM STRUCTURAL STEEL SKID					



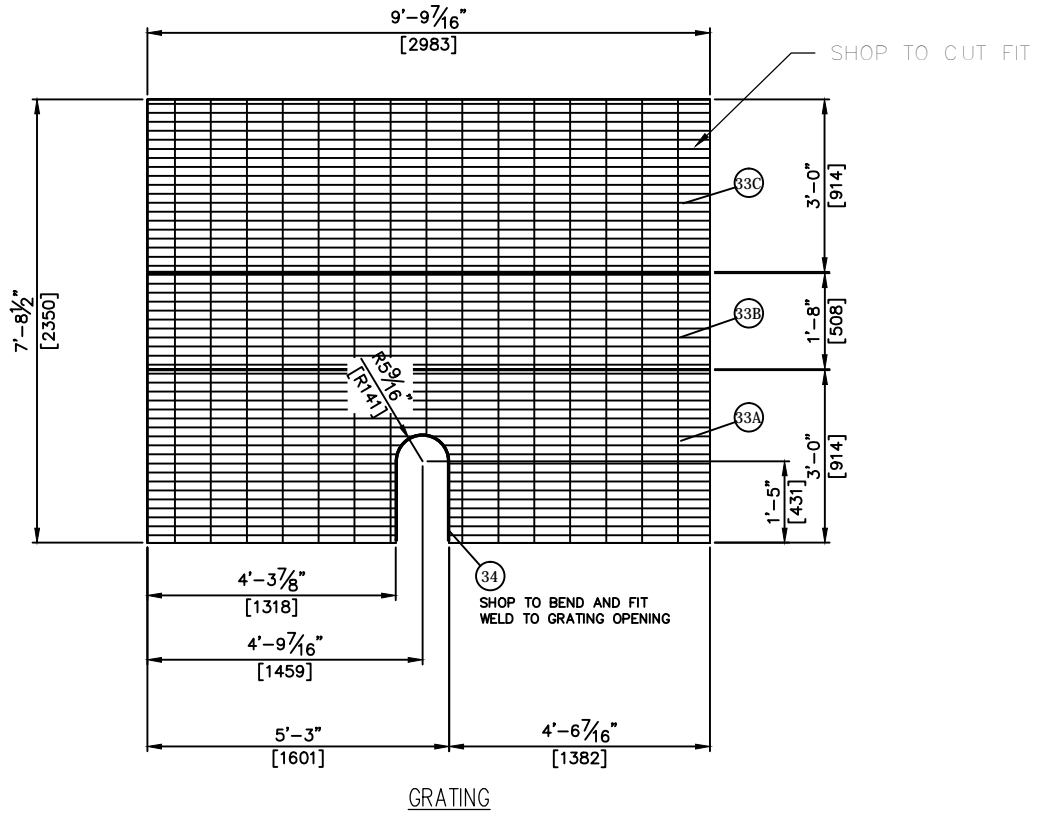
LADDER FRONT VIEW
SCALE 1 : 40

LADDER SIDE VIEW
SCALE 1 : 40

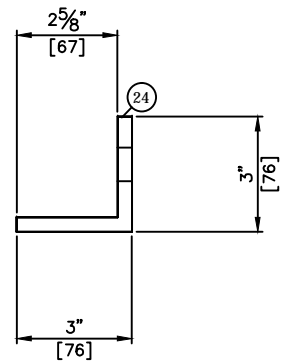
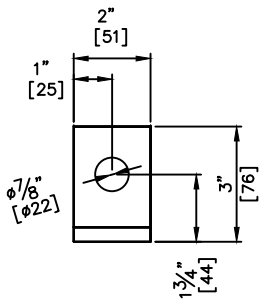
ITEM# 25 WELD ON CHECKER PLATE



GRATING /w PLATFORM ELEVATION VIEW



GRATING



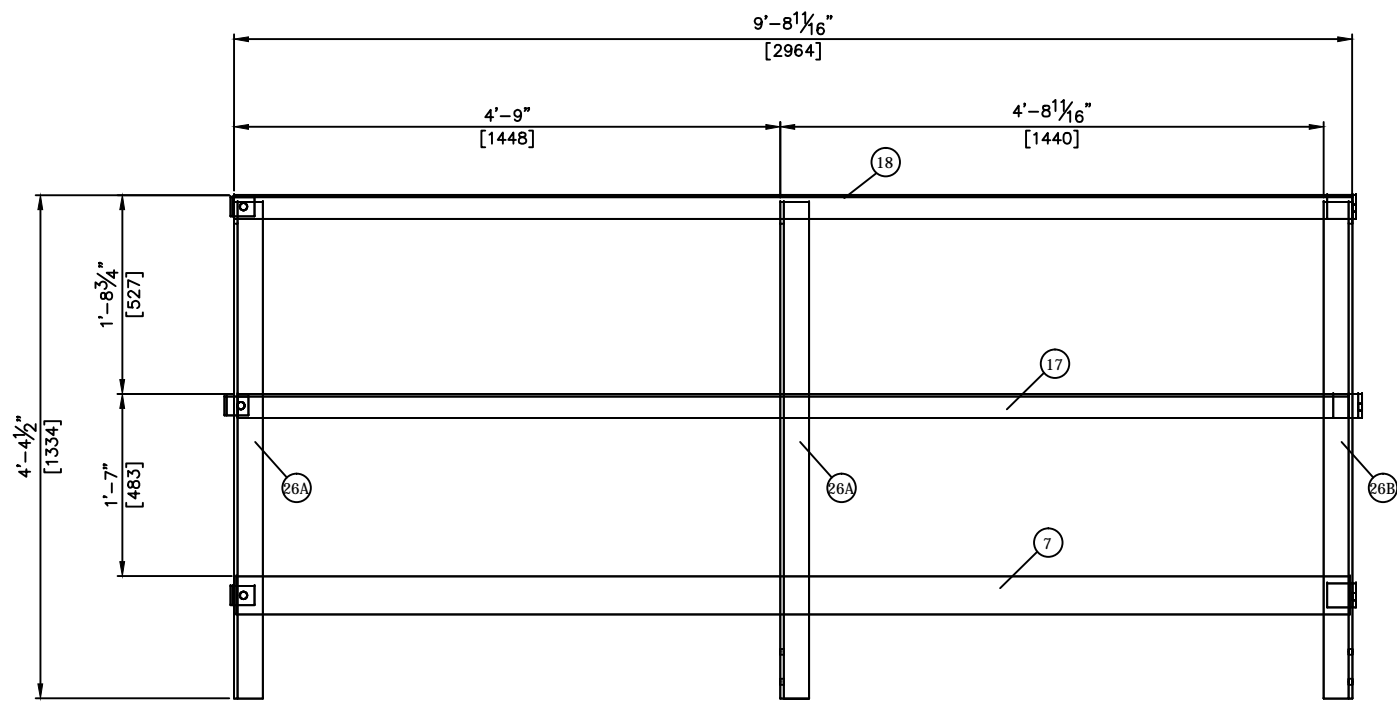
LADDER CLIP
ITEM 24
SCALE 1 : 10
(2) REQUIRED

REV	DESCRIPTION	DWN	CHK	APP	DATE
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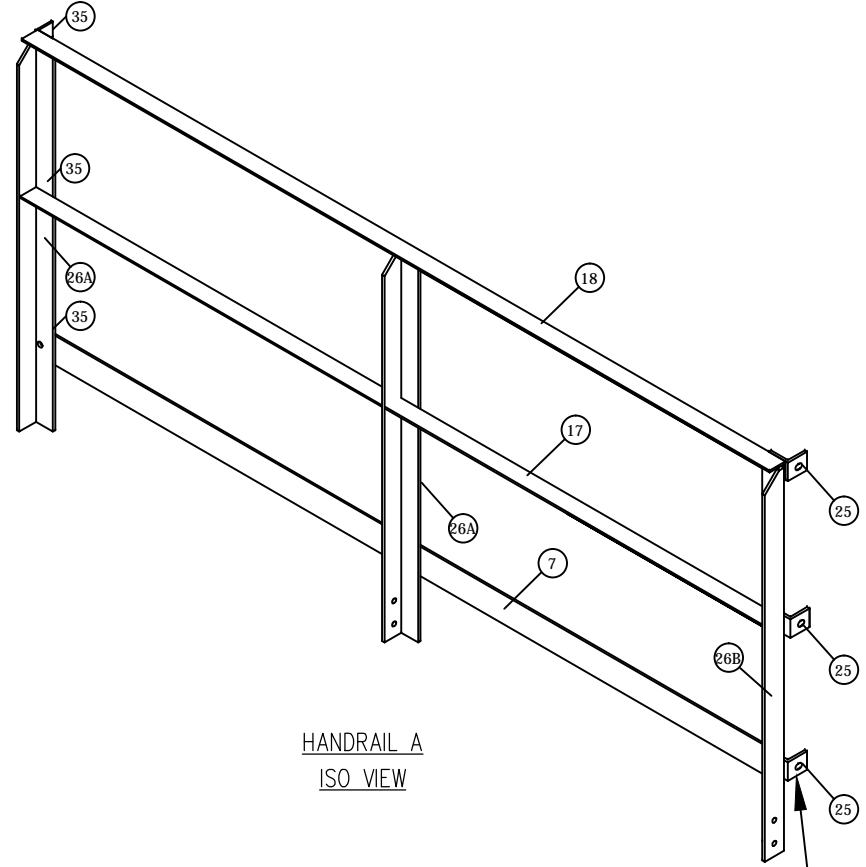
CAMP NG PRESSURE REDUCTION
PLATFORM
STRUCTURAL STEEL SKID

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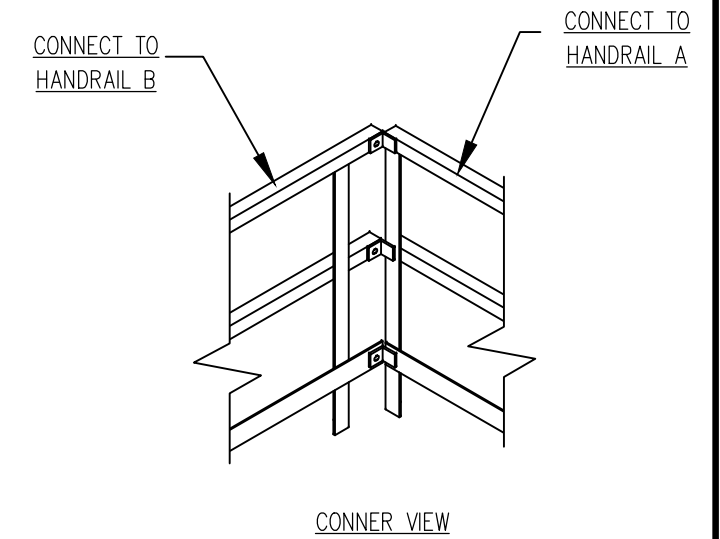
PROJECT NAME: CARMON CREEK PROJECT
FIELD FACILITIES AND INFRASTRUCTURE PHASE 1&2
CUSTOMER: SHELL CANADA
LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
DWN BY: GG DATE: JUN 27/14 DWG #: 338716-305-Rev1
CHK BY: ET DATE: JUN 27/14
APP BY: COG DATE: JUN 27/14 PAGE: 4 OF 8 CAD: N/A REV: 1



HANDRAIL A
SCALE 1 : 20



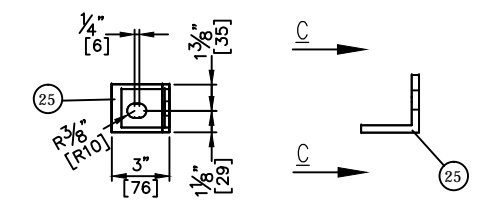
HANDRAIL A
ISO VIEW



CONNER VIEW

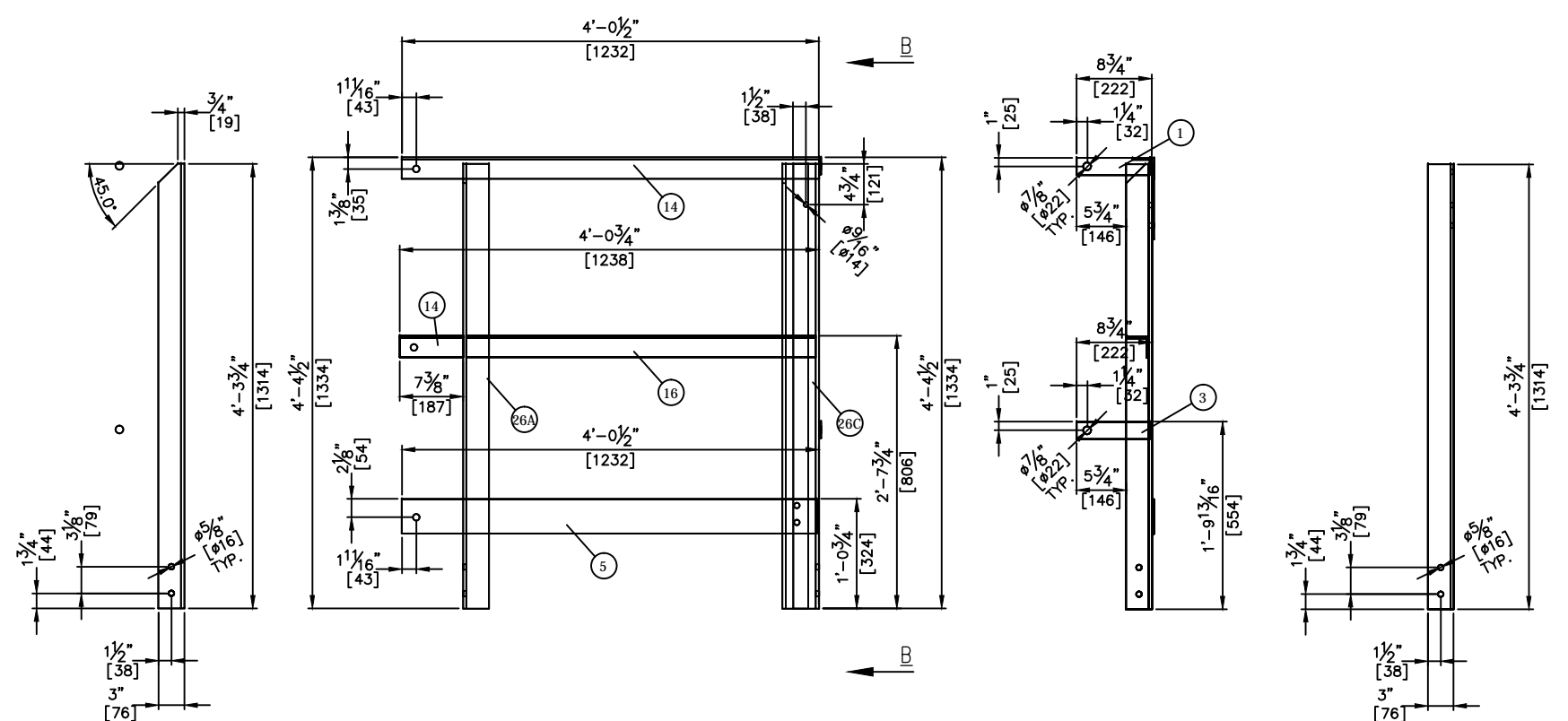
CONNECT TO
HANDRAIL B

CONNECT TO
HANDRAIL A



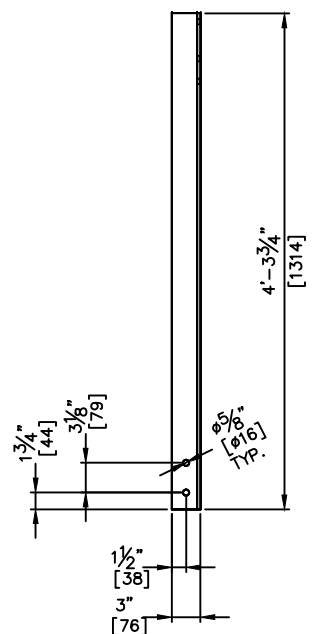
SECTION VIEW C-C
SCALE 1 : 10

ITEM 25
SCALE 1 : 10



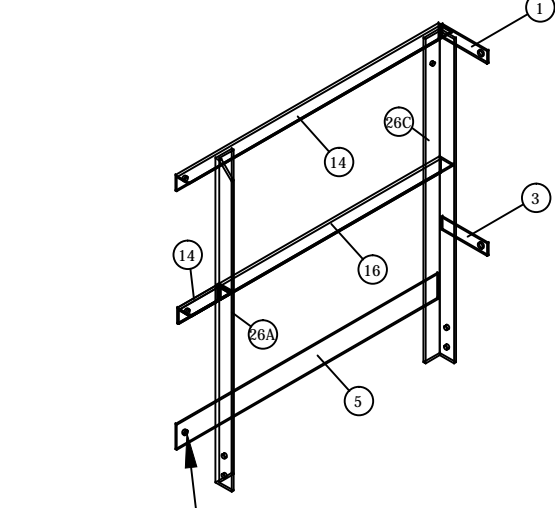
HANDRAIL B
SCALE 1 : 20

SECTION VIEW B-B
SCALE 1 : 20



ITEM 26C
SCALE 1 : 20

ITEM 26A
SCALE 1 : 20



HANDRAIL B
ISO VIEW

CONNECT TO
HANDRAIL B

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	AS BUILT	NSP	AA	AA	SEPT 21/15
0	ISSUED FOR CONSTRUCTION	GW	ET	AA	MAY 06/15

CAMP NG PRESSURE REDUCTION
PLATFORM
STRUCTURAL STEEL SKID

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PROJECT NAME: CARMON CREEK PROJECT
FIELD FACILITIES AND INFRASTRUCTURE PHASE 1&2

CUSTOMER: SHELL CANADA

LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

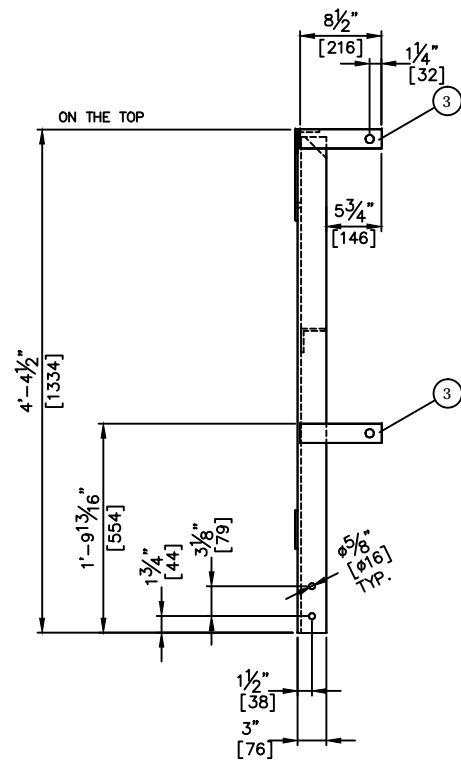
TAG: 0735A-08030

SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

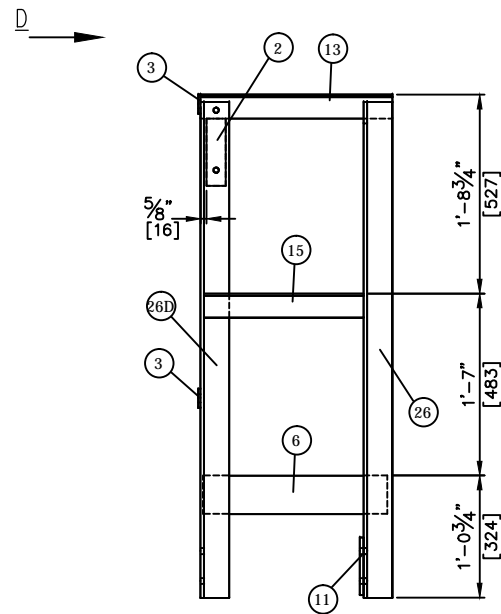
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CHK BY: ET DATE: JUN 27/14

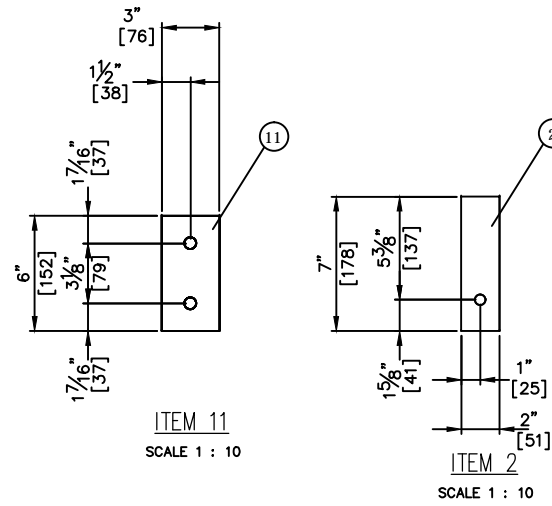
APP BY: COG DATE: JUN 27/14 PAGE: 5 OF 8 CAD: N/A REV: 1



SECTION VIEW D-D
SCALE 1 : 20

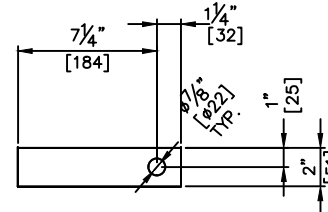


HANDRAIL C
SCALE 1 : 20

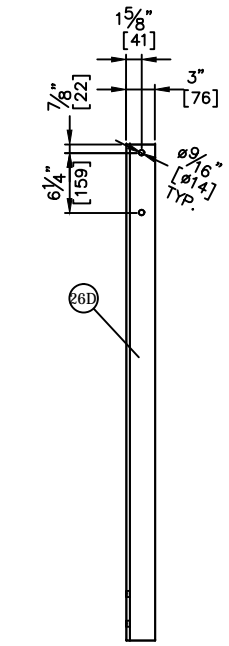


ITEM 11
SCALE 1 : 10

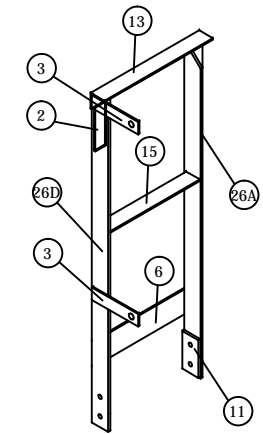
ITEM 2
SCALE 1 : 10



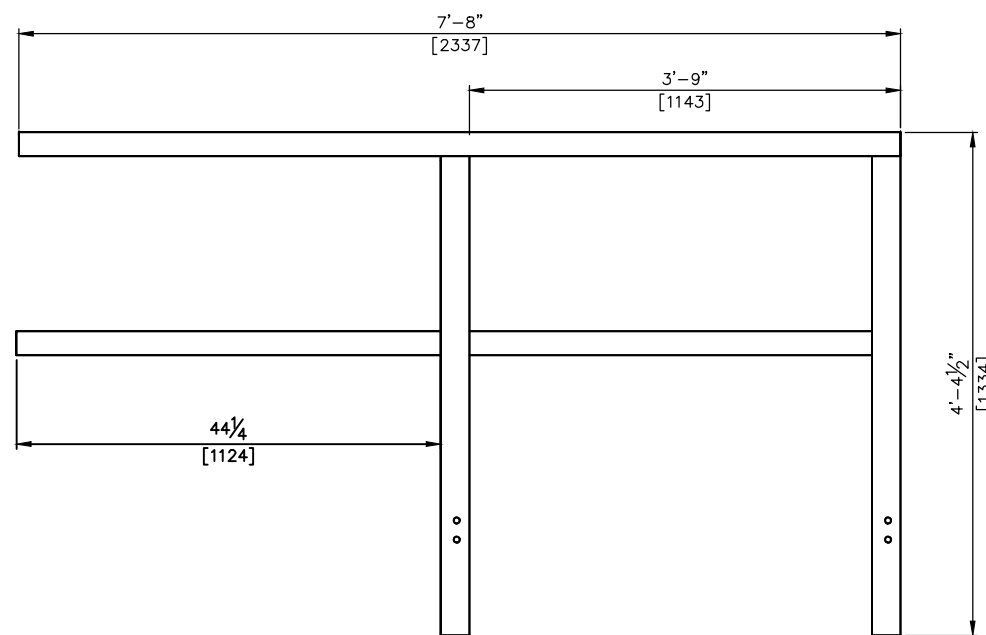
ITEM 1 & 3
SCALE 1 : 10



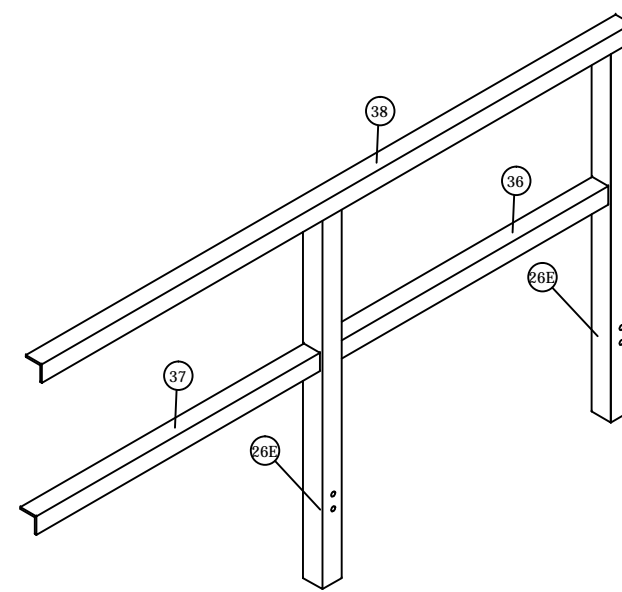
ITEM 26D
SCALE 1 : 20



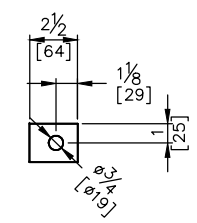
HANDRAIL C
ISO VIEW



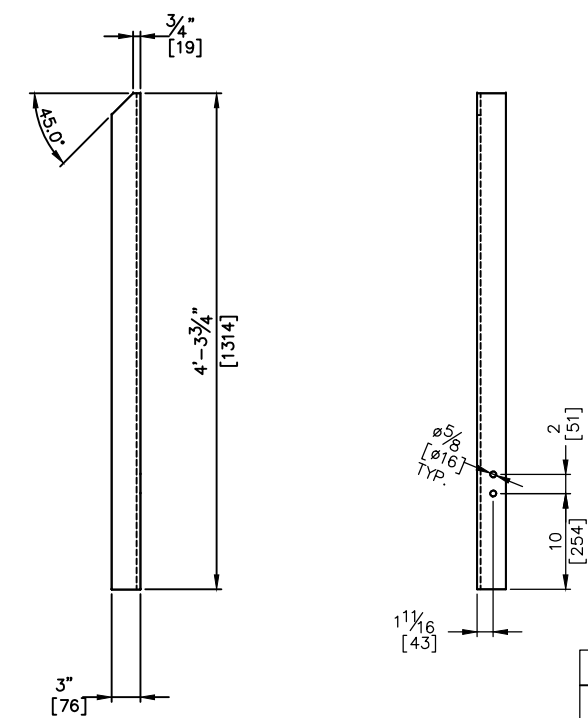
HANDRAIL D
SCALE 1 : 20



HANDRAIL D
ISO VIEW



ITEM 35



ITEM 26E
SCALE 1 : 20

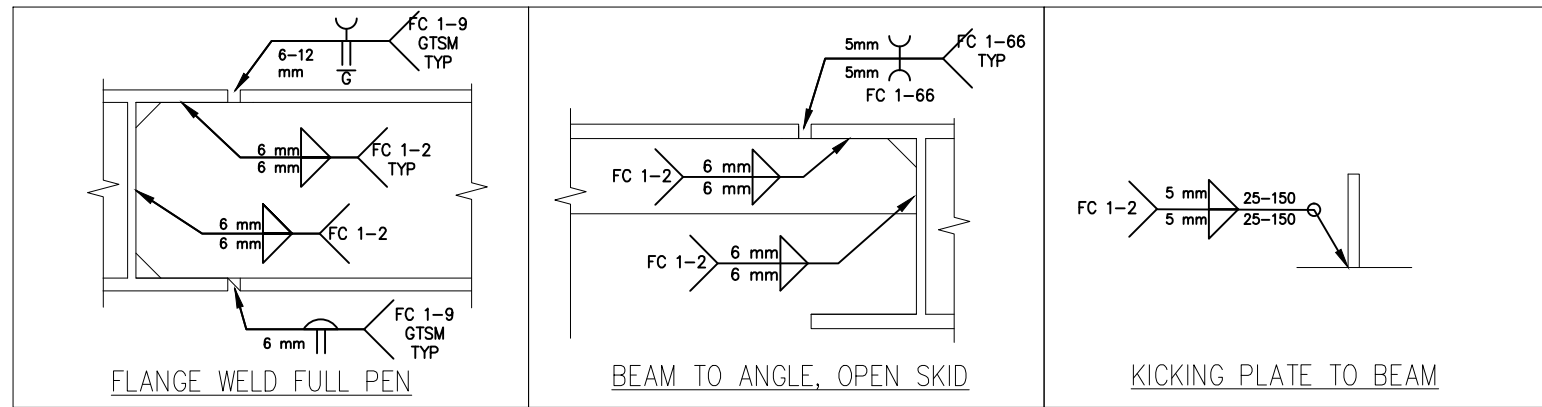
REV	DESCRIPTION	DWN	CHK	APP	DATE
2	AS BUILT, UPDATED AS PER CUSTOMER MARKUPS	NSP	AA	AA	DEC 4/15
1	AS BUILT	NSP	AA	AA	SEPT 21/15
0	ISSUED FOR CONSTRUCTION	GW	ET	AA	MAY 06/15

CMT NG PRESSURE REDUCTION
PLATFORM
STRUCTURAL STEEL SKID

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PROJECT NAME:	CARMON CREEK PROJECT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1&2					
CUSTOMER:	SHELL CANADA					
LOCATION:	CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2					
TAG:	0735A-08030					
SLS#:	338716	QUOTE:	CGY2014-85	PO#:	4512-109-130	
DWN BY:	GG	DATE:	JUN 27/14	DWG #:	338716-305-Rev2	
CHK BY:	ET	DATE:	JUN 27/14	PAGE:		6 OF 8
APP BY:	COG	DATE:	JUN 27/14	CAD:		N/A
				REV:	2	



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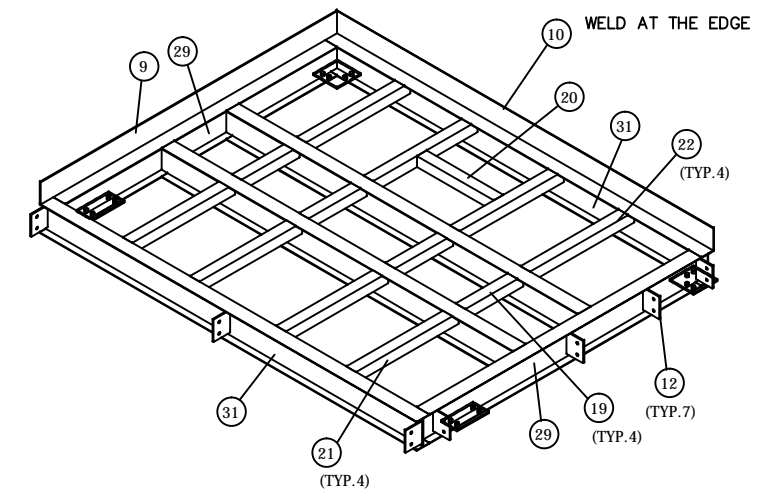
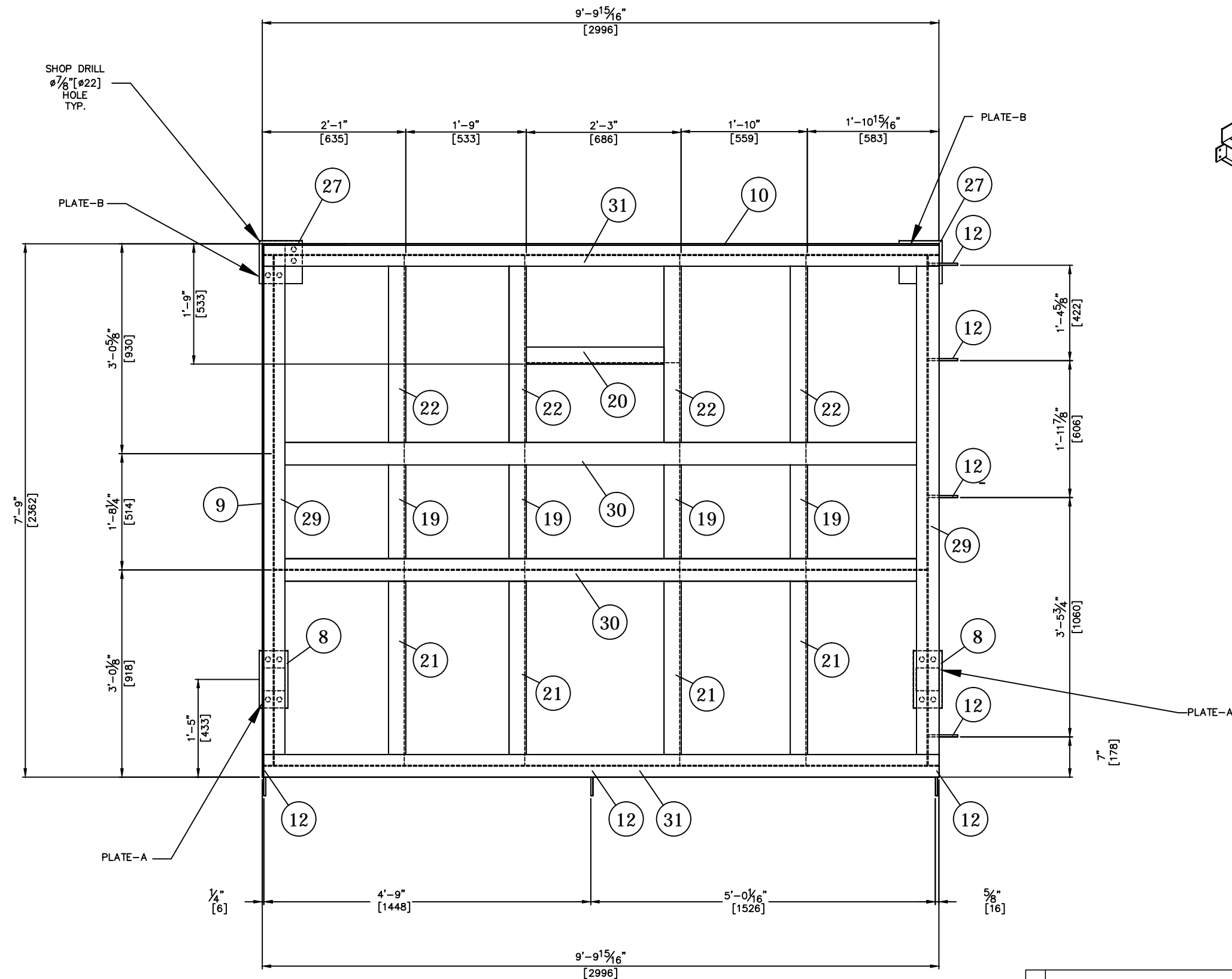
PROJECT NAME:		CARMON CREEK PROJECT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1&2	
CUSTOMER:		SHELL CANADA	
LOCATION:		CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2	
TAG:		0735A-08030	
SLS#:	QUOTE:	PO#:	
338716	CGY2014-85	4512-109-130	
DWN BY:	DATE:	DWG #:	
GG	JUN 27/14	338716-305-Rev1	
CHK BY:	DATE:		
ET	JUN 27/14		
APP BY:	DATE:	PAGE:	CAD: REV
COG	JUN 27/14	7 OF 8	N/A 1

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	AS BUILT	NSP	AA	AA	SEPT 21/15
0	ISSUED FOR CONSTRUCTION	GW	ET	AA	MAY 06/15

**CAMP NG PRESSURE REDUCTION
PLATFORM
STRUCTURAL STEEL SKID**



NORTH



PLATFORM
ISO VIEW

FOR REFERENCE

PLATFORM PLANVIEW

SCALE 1 : 20

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PROJECT NAME:	CARMON CREEK PROJECT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1&2		
CUSTOMER:	SHELL CANADA		
LOCATION:	CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2		
TAG:	0735A-08030		
SLS#:	QUOTE:	PO#:	
338716	CGY2014-85	4512-109-130	
DWN BY:	DATE:	DWG #:	
GG	JUN 27/14	338716-305-Rev1	
CHK BY:	DATE:	PAGE:	
ET	JUN 27/14	8 OF 8	
APP BY:	DATE:	CAD:	REV
COG	JUN 27/14	N/A	1

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	AS BUILT	NSP	AA	AA	SEPT 21/15
0	ISSUED FOR REFERENCE	GW	ET	AA	MAR 10/15

**CAMP NG PRESSURE REDUCTION
PLATFORM
STRUCTURAL STEEL SKID**

BRAKE

18 @ 10' Bottom Channel		
9 @ 10' Top Channel		
6 @ 10' Eaves Drip		
4 @ 158.0" Lining Corners		
4 @ 57.7" of 6.5" Ins Channels		
34 @ 57.7" of 9.5" Insulation Ribs 24GA		
9 @ 10' Base Flashing		
6 @ 10' Eaves Trough Support		
1 @ (344.0) 2 Ridge C/W Joiners		
28'11" RidgeCap (Standard)		
4 @ 72.7" Gable Flashing		
83 of 10' of 1.5"x3.5"x1.5 Z-Bars (R22 Walls)		
2 @ 28'8" EavesTrough 4 Caps		
2 @ 10' of No Lip Top Channel		
5 @ 10' U Channel 6.5" Wide		
3 @ 10' of 1"x1"x1" Drip		
10 @ 10' of Lining Corner		
2 @ 10' of Inside Louver Trim. (6.5" Wall)		
6 @ 10' of White Outside Cooler Flashing		

Slope Up 4:12

ACCESSORIES

2 @ 12'8" DownSpouts 2 Elbows 4 Brackets		
4 Flashing EndCaps		
2 @ Name Plates		
2 @ Fall Protection Clips c/w Under Plates		
1 @ Window Trim		

NO.	SIZE	TYPE
1 @	Double	Door Canopy
1 @	Single	Door Canopy

DOORS

#	TP	SW	G	P	L	C	A	B	WS	S	T	H	FM
1	DD	L	2	1	-	1	1	2	2	2	2	2	1
1	SD	R	1	1	-	-	1	-	1	1	1	1	1

FABRICATION

2 @ 28'8" 3"x3" Angle Ice Rakes		
1 @ 129.0" HSS Sway Braces (UP=18.2")		
1 @ 129.0" Custom HSS Sway Braces (UP=10.9")		

See Detail

MISC

2.0 Rolls of Certified 6Mil Poly Vapour Barrier		
69 @ 3x10 Fluted Alum. White Liner		
24 @ Bags of R12 Insulation(133)		
5000 @ 1/2" Long #8 Screws		
2415 @ 1/2" Long White #8 Screws		
500 @ 1/2" Long Tan #8 Screws		
700 @ 3/4" Long #10 Screws		
36 @ 1.25" Long Super 10 Screws		
160 @ 1.5" Long #14 Screws		
32 @ Ø3/8" A307 Bolts		
10 @ Door Pins		
8 @ Tubes of White Caulking		
18 @ Tubes of Gray Caulking		
4 @ Tubes of Clear Caulking		

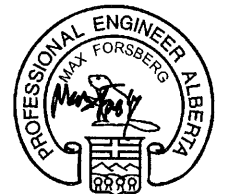
WINDOWS

NO.	SIZE	TYPE
1	40x40	Fixed

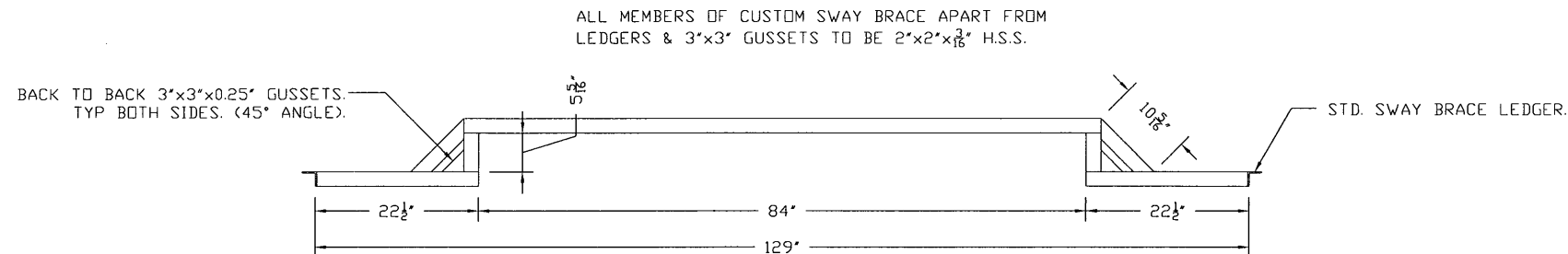
Straight-Up Metal Buildings Ltd.
 22GA Tan Exterior Walls 2 Layers of R-12
 22GA Metro Brown Exterior Roof 2 Layers of R-12
 24GA Fluted Alum. White Interior
 Metro Brown Trim

INSULATION CHANGED IN CUT LIST
 ON REVISION 1B.

20GA, R12 Slab, 16GA Expandable Welded Frame, von Duprin 88TP Panic Hardware, Kick Plate
 20GA, R12 Slab, 16GA Expandable Welded Frame, von Duprin 88TP Panic Hardware, Kick Plate



2015-10-27
 APEGA PERMIT TO PRACTICE P12663



ALL MEMBERS OF CUSTOM SWAY BRACE APART FROM
 LEDGERS & 3"x3" GUSSETS TO BE 2"x2"x1/8" H.S.S.

CLIENT:	NATIONAL PROCESS
PROJECT:	BU-216
TITLE:	PLAN/PANEL LAYOUT
SIZE:	W 11'4" L 28'8" H 13'2" 4.0:12
Sq. FT:	W 1053' C 21' R 342' P 159' T 1575'
Perimeter:	80'0" Weight
Quote:	J15-031054R2 Unit: BU-216
Drawn by:	M.FORSBERG Date: OCT 27/15
Checked by:	Date:
Page:	2/2 Date:
Job:	15-5056 Drawing: 15-5056 Rev: 2A

<i>BRAKE</i>													
18 @ 10' Bottom Channel													
9 @ 10' Top Channel													
6 @ 10' Eaves Drip													
4 @ 158.0" Lining Corners													
4 @ 57.7" of 6.5" Ins Channels													
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<i>ACCESSORIES</i>													
2 @ 12'8" DownSpouts 2 Elbows 4 Brackets													
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2 @ Fall Protection Clips c/w Under Plates													
1 @ Window Trim													
<i>NO.</i>	<i>SIZE</i>	<i>TYPE</i>											
1 @ Double	Door Canopy												
1 @ Single	Door Canopy												
<i>DOORS</i>													
#	TP	SW	G	P	L	C	A	B	WS	S	T	H	FM
1	DD	L	2	1	-	1	1	2	2	2	2	2	1
1	SD	R	1	1	-	-	1	-	1	1	1	1	1
<i>FABRICATION</i>													
2 @ 28'8" 3"x3" Angle Ice Rakes													
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Slope Up 4:12

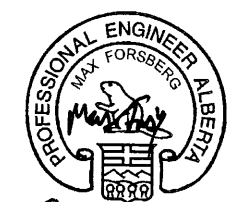
See Detail

<i>MISC</i>		
2.0 Rolls of Certified 6Mil Poly Vapour Barrier		
69 @ 3x10 Fluted Alum. White Liner		
24 @ Bags of R12 Insulation(133)		
5000 @ 1/2" Long #8 Screws		
2415 @ 1/2" Long White #8 Screws		
500 @ 1/2" Long Tan #8 Screws		
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36 @ 1.25" Long Super 10 Screws		
160 @ 1.5" Long #14 Screws		
32 @ ø3/8" A307 Bolts		
10 @ Door Pins		
8 @ Tubes of White Caulking		
18 @ Tubes of Gray Caulking		
4 @ Tubes of Clear Caulking		
<i>WINDOWS</i>		
<i>NO.</i>	<i>SIZE</i>	<i>TYPE</i>
1	40x40	Fixed

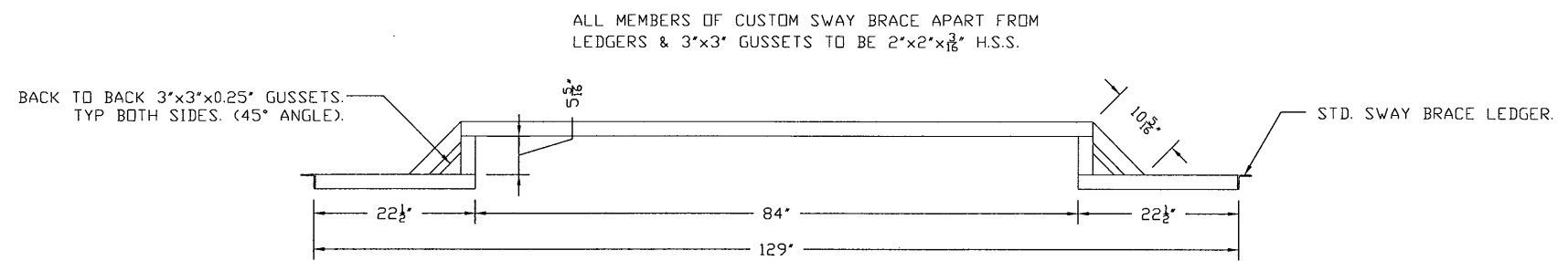
<i>Straight-Up Metal Buildings Ltd.</i>	
22GA Tan	Exterior Walls 2 Layers of R-12
22GA Metro Brown	Exterior Roof 2 Layers of R-12
24GA Fluted Alum. White	Interior
Metro Brown	Trim

INSULATION CHANGED IN CUT LIST ON REVISION 1B.

20GA, R12 Slab, 16GA Expandable Welded Frame, von Duprin 88TP Panic Hardware, Kick Plate
 20GA, R12 Slab, 16GA Expandable Welded Frame, von Duprin 88TP Panic Hardware, Kick Plate



2015-10-02
 APEGA PERMIT TO PRACTICE P12663



<i>CLIENT:</i>	NATIONAL PROCESS
<i>PROJECT:</i>	BU-216
<i>TITLE:</i>	PLAN/PANEL LAYOUT
<i>SIZE:</i>	W 11'4" L 28'8" H 13'2" 4.0:12
<i>Sq. FT.:</i>	W 1053' C 21' R 342' P 159' T 1575'
<i>Perimeter:</i>	80'0" <i>Weight</i>
<i>Quote:</i>	J15-031054R2 <i>Unit:</i> BU-216
<i>Drawn by:</i>	M.FORSBERG <i>Date:</i> OCT 01/15
<i>Checked by:</i>	<i>Date:</i>
<i>Page:</i> 2/2	<i>Date:</i>
<i>Job:</i> 15-5056	<i>Drawing:</i> 15-5056 <i>Rev:</i> 2



the pressure equipment safety authority

Certificate of Authorization Permit

Quality Management System

Expiry Date: **May 4, 2017**

Reg. No.: **AQP-1478**

DYNACORP FABRICATORS INC.

5152 - 74 AVENUE S.E.
CALGARY, ALBERTA

having complied with the provisions of the SAFETY CODES ACT, is hereby authorized to perform the activities identified in the following table:

	Construction	Repair	Alter
Pressure Vessels			
ASME Section VIII-1	Shop/Field	Shop/Field	Shop/Field
Miniature Vessels in accordance with CSA B51	Shop/Field	---	---
Boilers			
ASME Section I Power Boilers	---	Shop/Field	Shop/Field
ASME Section IV	---	Shop/Field	Shop/Field
Indirect Fired Heater Coils			
ASME B31.3 Indirect Fired Heater Coils	Shop/Field	Shop/Field	Shop/Field
Pressure Piping			
ASME B31.3 Process Piping	Shop/Field	Shop/Field	Shop/Field
Fittings			
Category A,E,H	Shop/Field	Shop/Field	Shop/Field

As a condition of this permit, the holder is required to participate in interim audits by a safety codes officer to verify that the quality management system is being maintained in a manner acceptable to a safety codes officer.

Dated at Edmonton, this 7th day of April, 2014



Chief Inspector and Administrator

Certificate No.: 9835

September 02, 2011

Jeff Gardippe
DYNACORP FABRICATORS INC
5152 74 AVENUE SE
CALGARY, AB

Dear Jeff Gardippe,

The welding procedure, tracking number 2011-05370, originally received on August 24, 2011 was surveyed and accepted for registration as follows:

Reg. No. : WP-1073.2

Accepted on: September 02, 2011

Reg Type : New Design

Spec. No. : DYN-18

Design registered in the name of : DYNACORP FABRICATORS INC

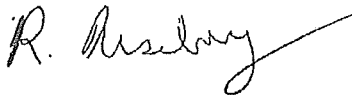
Please note the acceptance of the registration does not allow the use of this welding procedure in the construction, modification, or repair of any boiler, pressure vessel, pressure piping system or fitting in Alberta unless the contractor/manufacturer has registered a Quality Control system for such work with ABSA.

Welding procedures, which specify impact testing, have been accepted in accordance with A.S.M.E. Section IX only. Other A.S.M.E. Code Sections may have additional requirements respecting impact testing.

An invoice covering survey and registration fees will be forwarded from our Revenue Accounts.

Enclosed is a stamped welding procedure for your reference.

Sincerely,



ROSEBERG, BOB, P. Eng.
Design Survey Engineer

January 06, 2015

Attention: Loren Peers
DYNACORP FABRICATORS INC
5152 74 AVENUE SE
CALGARY, AB

The welding procedure, tracking number 2014-10755, originally received on December 31, 2014 was surveyed and accepted for registration as follows:

Reg. No. : WP-1073.2

Accepted on: January 05, 2015

Reg Type: Revision To accepted Design

Spec. No. : WOM-2 REV 4

Design registered in the name of : DYNACORP FABRICATORS INC

An invoice covering survey and registration fees will be forwarded from our Revenue Accounts.

Enclosed is a stamped welding procedure for your reference.

Please note the acceptance of this registration does not allow the use of this welding procedure in the construction, modification, on any boiler, pressure vessel, pressure piping system or fitting in Alberta unless the contractor/manufacturer has registered a Quality Control System for such work with ABSA.

Sincerely,



REINHART, JASON, P. Eng.

WELDING PROCEDURE SPECIFICATION NO.: DYN-18

WELDING PROCEDURE QUALIFICATION RECORD NO. (S): DYN-18-1, DYN-18-2

QUALIFIED FOR

Restricted Applications: ASME Section IX or NBIC Part 3, Section 2, Method 2,
Temper bead welding without fluid backing - Controlled deposit
technique (Restricted to through wall repairs welded from both sides
and / or repairs and weld metal build-up that are not through wall)

Base Metal (Typical): Std. Appl. P1 to P1 Notch Appl. P1 Grp. 1 & 2 to P1 Grp. 1 & 2
(SA 333 Gr. 6, SA 350 Gr. LF2, SA 420 WPL6, SA 516 Gr. 70, etc.)

Process(es): SMAW Weld Types: GROOVE & FILLET

Position: ALL POSITIONS Diameter: ALL DIAMETERS

Filler Metal: E7018-1-H4

BASE METAL CONDITIONS & THICKNESS RANGE QUALIFIED:

BASE METAL THICKNESS RANGE
STANDARD APPLICATIONS AS WELDED 4.8 mm (0.188 in.) to unlimited

NOTCH TOUGHNESS APPLICATIONS TO -46°C (-50°F) AS WELDED
9.52 mm (0.375 in.) to unlimited

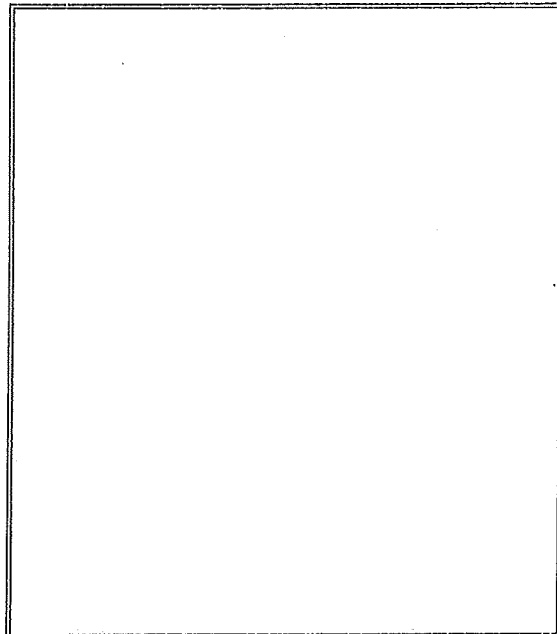
DEPOSITED WELD METAL THICKNESS
ASME SECTION IX (Repair Groove Depth) 203 mm (8.00 in.) maximum.

NBIC PART 3, Section 2, Method 2 38.1 mm (1.50 in.) maximum.

PROVINCIAL REGISTRATION

SAFETY CODE ACT - PROVINCE OF ALBERTA
WELDING PROCEDURE
RESTRICTED APPLICATION

Reg. No. WP 1073.2 Reg. No. DYN-18
Weld Process SMAW (TEMPER BEAD)
Mat. No. P1 Gr. 1 & 2 to Mat. No. P1 Gr. 1 & 2
Elec. Gr. F No. 4 A No. 1
Th. Qual. For UNLIMITED P.W.H.T. NO
* Limited to: TEMPER BEAD USED IN CONSTRUCTION
WITH ACCEPTED REPAIR PROCEDURE
C/N -46°C, min Th. Qual. 9.5 mm
Y. 11 No. 9 Day 2 Signed [Signature]



Competent technical advice shall be obtained from the manufacturer of the pressure retaining item or from another qualified source, such advice being especially necessary if the alternative is to be used in highly stressed areas, if service conditions are conducive to stress corrosion cracking, if materials are subject to hydrogen embrittlement or are operating at temperatures in the creep range. This alternative is not suitable for "on stream" repairs or "hot tapping".

QW-482 WELDING PROCEDURE SPECIFICATION (WPS)

Dynacorp Fabricators Inc.

Welding Procedure Specification No. DYN-18 Date August 22, 2011
Supporting PQR No. (s) DYN-18-1, DYN-18-2
Welding Process(es) SMAW Type(s) Manual

JOINTS (QW-402)

Joint Design Groove design permitting proper application of controlled deposit temper bead welding
Backing With (Through thickness repairs must be welded from both sides)
Retainers Not required
Root Opening 0 - 6.35 mm (0 - 1/4 in.) Fluid Backing None

BASE METALS (QW-403)

P-Number Std. Appl. P1 To P-Number P1
P-Number Notch Appl. P1 Groups 1 & 2 To P-Number P1 Groups 1 & 2
Thickness Range: Groove See cover page for thickness qualified by governing code
Fillet All base metal thicknesses
Base Metal See cover page
Pipe Diameter Ranges: Groove All diameters Fillet All diameters
Deposited Weld Metal (Per Pass) 2.5 to 3.2 mm (0.090 to 0.125 in.)
Carbon Equivalent* 0.40 Maximum for controlled hardness applications
Other *C.E. formula per ASME Section IX: C.E. = C + Mn / 6 + (Cr+Mo+V) / 5 + (Ni+Cu) / 15

FILLER METALS (QW-404)

Specification No. (SFA) SFA 5.1 AWS No. (Class) E7018-1-H4
F-No. F4 A-No. A1
Size of Electrode See Table #1
Filler Metal Storage Purchase in hermetically sealed containers and store in heated ovens prior to use
Diffusible Hydrogen Level Filler metal to have optional supplemental diffusible hydrogen designator of H4
Maximum Deposited Weld Metal Thickness:
Groove ASME Section IX (Repair Groove Depth): 203 mm (8.00 in.) max.
NBIC Part 3, Section 2, Method 2: 38.1 mm (1.50 in.) max.
Fillet All fillet sizes

POSITION (QW-405)

Position of Groove & Fillet All positions Weld Progression Vertical up

PREHEAT (QW-406)

Minimum Preheat Temperature 178°C (350°F) The preheat zone shall extend at least 102 mm (4.0 in.) Beyond each edge of the weld joint or four times the material thickness (whichever is greater).
Minimum Preheat Soaking Time As required to obtain preheat zone
Preheat Maintenance See above prior to welding. Preheat maintenance is to be maintained until the completion of welding.
Maximum Interpass Temperature 232°C (450°F)
Hydrogen Bake-Out Required only if hydrogen designation H4 electrodes are not used. After completion of welding and without allowing the weldment to cool below the minimum preheat temperature, 260°C + 28°C (500°F + 50°F) for a minimum period of 2 hours.

POST WELD HEAT TREATMENT (QW-407)

Temperature Range None Time Range N/A

ELECTRICAL CHARACTERISTICS (QW-409)

Current Direct Polarity Reverse, electrode positive

Amps See Table #1 Volts See Table #1

Heat Input Range See Table #1, Volume of weld metal

Heat Input Ratio An increase or decrease in the heat input ratio between weld layers shall not exceed 20% until a minimum of 2 weld layers totaling a minimum thickness of 5 mm (3/16 inch) has been deposited over the base metal. The maximum deposited weld metal thickness per layer is 3.2 mm (1/8 in.)

TECHNIQUE (QW-410)

String or Weave Weld beads against base metal and temper beads: Controlled Weave
Fill weld beads: String or weave

Initial & Interpass Cleaning Brushing, chipping or grinding as required

Method of Back Gouging Grind to bright metal

Multiple or Single Pass Per Side Multiple, all welds shall be three layers minimum

Multiple or Single Electrodes Single Peening Not permitted

Surface Temper Beads Surface temper beads cover the weld surface

Thermal preparation of base metal Ground to bright metal before welding

Surface Bead Placement From the toe of the weld to the edge of any tempering bead
1.6 – 3.2 mm (0.062 to 0.125 in.)

Surface Bead Removal Method Grinding Bead Overlap 25% - 75%

Grinding To remove slag or surface defects

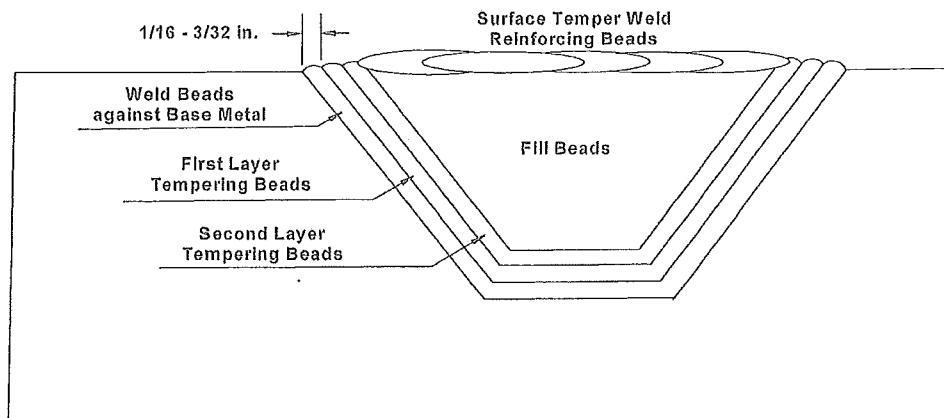
Other NBIC PART 3, Section 2.2.5.3.2 Method 2, Temper Bead
Welding – Controlled deposit, follow weld sequence outlined
in Figure 1 or Figure 2.

TABLE 1 – WELDING PARAMETERS**Base Metal Thickness Range: 4.8 mm (0.188 in.) ≤ T < 15.9 mm (0.625 in.)**

Layer	Process	Filler Metal	Diameter mm (in.)	Current / Polarity	Amperage	Voltage	Travel Speed mm/min. (i.p.m.)	Volume of Weld Metal*
All	SMAW	E7018-1	2.4 (3/32)	DCRP	75 - 85	21 - 23	117 - 163 (4.6 - 6.4)	0.41 - 0.55
Note: 1) Filler metal to have optional supplemental diffusible hydrogen designator of H4 2) * Volume of Weld Metal = Length of weld bead per unit length of electrode (mm/mm or in./in.)								

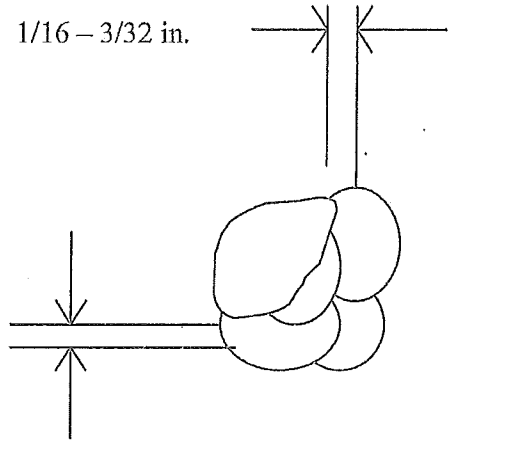
Base Metal Thickness Range: 15.9 mm (0.625 in.) to unlimited

Layer	Process	Filler Metal	Diameter mm (in.)	Current / Polarity	Amperage	Voltage	Travel Speed mm/min. (i.p.m.)	Volume of Weld Metal*
Weld Beads against Base Metal	SMAW	E7018-1	2.4 (3/32)	DCRP	125 - 130	22 - 24	229 - 277 (9.0 - 10.9)	0.94 - 1.12
First Layer Temper Beads	SMAW	E7018-1	2.4 (3/32)	DCRP	125 - 130	22 - 24	231 - 246 (9.1 - 9.7)	0.94 - 1.07
Second Layer Temper Beads	SMAW	E7018-1	2.4 (3/32)	DCRP	125 - 130	22 - 24	229 - 246 (9.0 - 9.7)	0.94 - 1.07
Fill Weld Beads	SMAW	E7018-1	3.2 (1/8)	DCRP	110 - 120	20 - 22	108 - 152 (3.2 - 7.6)	0.29 - 0.77
Surface Temper Weld Reinforcing Beads	SMAW	E7018-1	3.2 (1/8)	DCRP	110 - 120	20 - 22	234 - 246 (9.2 - 9.7)	0.94 - 1.00
Note: 1) Filler metal to have optional supplemental diffusible hydrogen designator of H4 2) * Volume of Weld Metal = Length of weld bead per unit length of electrode (mm/mm or in./in.)								

FIGURE 1 - TEMPERING TECHNIQUE GROOVE WELDS

1. Prior to excavating defect, preheat base material as specified in QW-406 of this WPS. Following defect removal examination of the repair area using Magnetic Particle or Liquid Penetrant testing is required to ensure complete removal of defects. Acceptance shall be based on original code of construction.
2. Prior to welding, the welding area and adjacent parent metal shall be preheated as specified in QW-406 of this WPS.
3. Weld installation shall follow the steps listed below. Welding parameters shall be as specified in QW-409 & QW-410 of this WPS. E7018-1 (H4) electrodes only.
 - a. Weld beads against the base metal, first layer tempering beads, and second layer tempering beads shall be welded with the same diameter of electrode. It is recommended that the amperage and voltage setting remain the same for the three weld layers and adjust the travel speed to stay within the specified heat input of QW-409.
 - b. Weld beads against the base metal shall be deposited over the entire welding area using 3/32 or 1/8 in. diameter electrodes. Progression should start from the center of the evacuation and work outwards, ensure that each weld bead overlaps the previous by 25% - 75%
 - c. First layer tempering beads and second layer tempering beads (3/32 or 1/8 in. diameter) shall employ a tempering technique in a manner to ensure tempering of the prior weld passes and their HAZ; ensure that each weld bead overlaps the previous by 25% - 75%. The first and second layer tempering beads shall not come into contact with the base material. After the completion of the tempering welds beads, the remainder of the groove shall be welded using 3/32 or 1/8 in. electrodes.
 - d. Surface temper weld reinforcing beads shall be deposited after the repair area is completely filled. This layer shall not come into contact with the base material.
 - e. After the hydrogen bake-out (see QW-406 of this WPS) and the finished repair weld have cooled to ambient temperature, the final temper bead weld reinforcement layer shall be removed substantially flush with the surface of the base material.
 - f. The finished weld shall be examined by Magnetic Particle or Liquid Penetrant testing to determine that no defects exist. In addition, welds that were originally required to be radiographed shall be radiographically examined.

FIGURE 2 - TEMPERING TECHNIQUE FILLET WELDS



1. Prior to welding, the repair area and adjacent parent metal shall be preheated as specified in QW-406 of this WPS.
2. Weld installation shall follow the steps listed below. Welding parameters shall be as specified in QW-409 & QW-410 of this WPS.
 - a. Using $3/32$ or $1/8$ in. diameter electrodes complete the fillet weld. A minimum of two weld layers is required.
 - b. Weld the temper bead weld reinforcement layer. This layer shall not come into contact with the base metal.
 - c. After the hydrogen bake-out (see QW-406 of this WPS) and the finished repair weld have cooled to ambient temperature, the final temper bead weld reinforcement layer shall be removed by grinding. The final fillet weld contour shall be flat to slightly concave.

The finished weld shall be examined by Magnetic Particle or Liquid Penetrant testing to determine that no defects exist.

QW-483 PROCEDURE QUALIFICATION RECORD (PQR)

Dynacorp Fabricators Inc.

Procedure Qualification Record No. DYN-10-4 Date September 11, 2012
Welding Procedure Specification No. DYN-10 (Rev. 1)
Welding Process(es) SMAW / FCAW Type(s) Manual / Semi-auto.

JOINTS (QW-402)

Type Butt joint, single vee groove, see next page

BASE METALS (QW-403)

Material Spec. SA 516 to SA 516 Type or Grade Gr. 60 to Gr. 70
P-No. P1 Grp. 1 To P-No. P1 Grp. 2 Thickness 9.52 mm (0.375 in.)
Diameter N/A - Plate Heat No. 347418 - 62983
Deposited Weld Metal (Per pass) Did not exceed 12.7 mm (0.500 in.)

FILLER METALS (QW-404)

	SMAW	SMAW	FCAW
Specification No. (SFA)	<u>SFA 5.1</u>	<u>SFA 5.1</u>	<u>SFA 5.20</u>
AWS No. (Class)	<u>E6010</u>	<u>E7018-1</u>	<u>E71T-12MJ</u>
Filler Metal F-No.	<u>F3</u>	<u>F4</u>	<u>F6</u>
Filler Metal A-No.	<u>A1</u>	<u>A1</u>	<u>A1</u>
Filler Metal Product Form	<u>N/A</u>	<u>N/A</u>	<u>Flux cored wire</u>
Supplementary Fillers	<u>N/A</u>	<u>N/A</u>	<u>Without</u>
Size of Electrode	<u>See attached sketch</u>		
Deposited Weld Metal Thickness	<u>2.4 mm (0.094 in.)</u>	<u>3.56 mm (0.140 in.)</u>	<u>3.58 mm (0.141 in.)</u>
Trade Name	<u>E6010 - Lincoln, Fleetweld 5P+ E7018-1 - Air Liquide, LA 18 Plus</u> <u>E71T-12MJ - Kobelco, DWA-55ESR</u>		

POSITION (QW-405)

Position of Groove 3G Weld Progression Vertical Up

PREHEAT (QW-406)

Preheat Temperature 10°C (50°F) Interpass Temp. (Max.) 232°C (450°F)

POSTWELD HEAT TREATMENT (QW-407)

Temperature 621°C (1150°F) Time 4 hours
Note Additional Vickers hardness test from 1 hour PWHT time

GAS (QW-408)

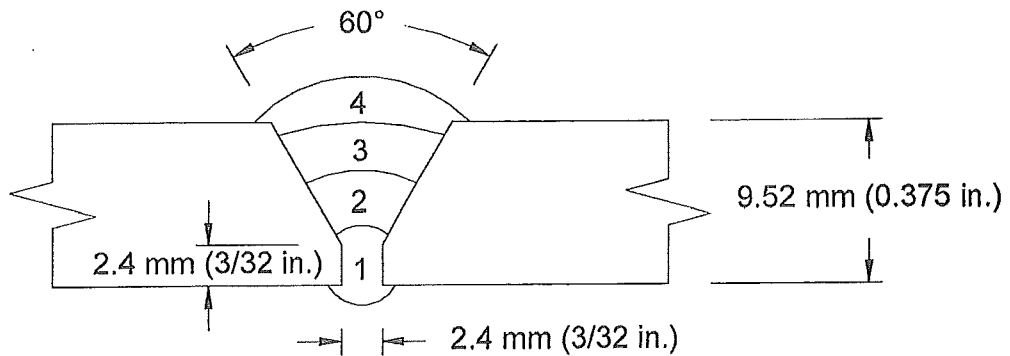
Specification No. (SFA) SFA 5.32 AWS No. SG-AC-25
Shielding FCAW: 75% Argon, 25% CO₂, 15 liters per minute (30 cfph)
Backing None Trailing Without

ELECTRICAL CHARACTERISTICS (QW-409)

Current Direct Polarity Reverse, electrode positive
Amps See next page Volts See next page
Electrode Wire Feed Speed FCAW: 7620 mm/min (300 in./min)
Maximum Heat Input F3: 1.25 kJ/mm (31,818 J/in.) F4: 1.24 kJ/mm (31,500 J/in.)
F6: 1.63 kJ/mm (41,293 J/in.)
Mode of Metal Transfer FCAW: Globular

TECHNIQUE (QW-410)

String or Weave	F3: String	F4: Weave	F6: Weave
Travel Speed	See below		
Orifice or Gas Cup Size	FCAW: 12.7 mm (0.500 in.)		
Initial & Interpass Cleaning	Brushing, chipping & grinding to remove slag		
Method of Back Gouging	Not used	Oscillation	N/A
Tube to Work Distance	FCAW: 12.7 - 19.1 mm (0.500 - 0.750 in.)		
Multiple or Single Pass Per Side	Multiple		
Multiple or Single Electrodes	Single	Electrode Spacing	N/A
Peening	None		
Use of Thermal Processes	Not used		



Pass	Process	Filler Metal	Diameter mm (in.)	Current & Polarity	Amperage Range	Voltage Range	Travel Speed mm/min (ipm.)
1	SMAW	E6010	3.2 (1/8)	DCRP	65 - 75	24 - 26	84 (3.3)
2	SMAW	E7018-1	2.4 (3/32)	DCRP	75 - 85	20 - 22	81 (3.2)
3	FCAW	E71T-12MJ	1.1 (0.045)	DCRP	200 - 210	23 - 24	241 (9.5)
4	FCAW	E71T-12MJ	1.1 (0.045)	DCRP	200 - 210	23 - 24	178 (7.0)

CHARPY IMPACT TOUGHNESS

Type of Test Charpy V-Notch Orientation Transverse
 Test Temperature -46°C (-50°F) Specimen Size 10 X 8 mm (0.394 X 0.315 in.)

Specimen No.	Notch Location	Impact Values J (ft-lbf)
N2.1	Weld Metal	71.6 (52.8)
N2.2	within 1/16"	70.8 (52.2)
N2.3	of root	14.9 (11.0)
N3.1	Gr. 60 - HAZ	>141 (>104)
N3.2	Gr. 60 - HAZ	>141 (>104)
N3.3	Gr. 60 - HAZ	>141 (>104)
P3.1	Gr. 70 - HAZ	>141 (>104)
P3.2	Gr. 70 - HAZ	>141 (>104)
P3.3	Gr. 70 - HAZ	>141 (>104)

OTHER TESTS

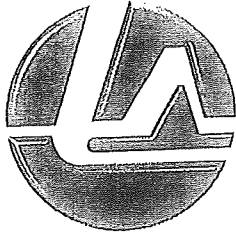
Vickers Hardness (4 hour PWHT) - see attached laboratory test report # C12-1399.2
Vickers Hardness (1 hour PWHT) - see attached laboratory test report # C12-1399.3

Welders Name Darren Grey Certificate File No. W-22175
 Tests Conducted By Ludwig Associates Ltd.
 Laboratory Test No. C12-1399.2 & C12-1399.3

We certify the statements in this record are correct and that the test welds were prepared, welded and tested in accordance with the requirements of Section IX of the ASME Code.

Manufacturer DYNACORP FABRICATORS INC.

Date 22 Oct 12 Certified by *[Signature]*



LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: Dynacorp Fabricators Inc.
5152 - 74th Avenue S.E.
Calgary, Alberta
T2C 3C9

Laboratory Test No.: C12-1399.2
Date: September 18, 2012

Attention: Lorne Peers

PQR Number: DYN-10-4
Material: SA 516 Gr. 60 to SA 516 Gr. 70 (Heat No.: 347418 - 62983)
Thickness: 9.52 mm (0.375 in.)
Thermal Condition: PWHT @ 621°C (1150°F) for 240 minutes

CHARPY V-NOTCH IMPACT TEST


Machine: Satec, SI-1C SN:1363
Capacity: 325 J (240 ft-lbf)
Verified Range: 1.7 - 141.3 J (1.3 - 104.2 ft-lbf)

Specimen Size: 10 x 8 mm (0.394 x 0.315 in.)
Orientation: Transverse
Test Temp.: -46°C (-50°F)

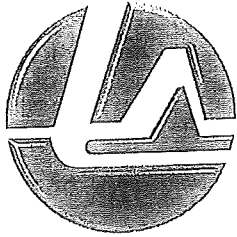
Specimen Number	Notch Location	Impact Values	
		Joules	(ft-lbf)
N2.1	Weld Metal within 1/16 in. of root	71.6	(52.8)
N2.2		70.8	(52.2)
N2.3		14.9	(11.0)
N3.1	Gr. 60 - HAZ	>141	(>104)
N3.2	Gr. 60 - HAZ	>141	(>104)
N3.3	Gr. 60 - HAZ	>141	(>104)
P3.1	Gr. 70 - HAZ	>141	(>104)
P3.2	Gr. 70 - HAZ	>141	(>104)
P3.3	Gr. 70 - HAZ	>141	(>104)

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section VIII, Div. 1, UG-84 – 2010 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. **Samples associated with this report will be discarded in 45 days.**

Laboratory Test Conducted By: _____


Xin (Vincent) Su, T.T. / Dan Nguyen, C.E.T.





LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: Dynacorp Fabricators Inc.
5152 - 74th Avenue S.E.
Calgary, Alberta
T2C 3C9

Laboratory Test No.: C12-1399.2
Date: September 26, 2012

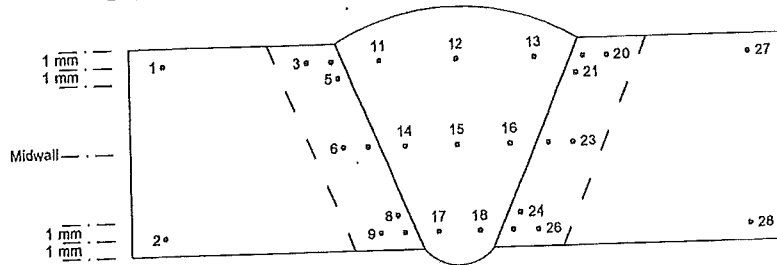
Attention: Lorne Peers

PQR Number: DYN-10-4
Material: SA 516 Gr. 60 to SA 516 Gr. 70 (Heat No.: 347418 - 62983)
Thickness: 9.52 mm (0.375 in.)
Thermal Condition: PWHT @ 621°C (1150°F) for 240 minutes

HARDNESS TEST

Type of Test: Vickers 10 kg (HV10)

Instrument: Mitutoyo AVK-C1

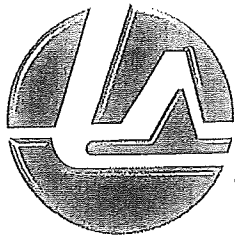


SA 516 Gr. 60				Weld Metal		SA 516 Gr. 70			
Parent Metal		HAZ				HAZ		Parent Metal	
1	139	3	154	11	178	19	160	27	143
2	144	4	168	12	180	20	149	28	142
		5	178	13	177	21	163		
		6	149	14	157	22	155		
		7	155	15	155	23	152		
		8	157	16	161	24	159		
		9	147	17	142	25	151		
		10	154	18	142	26	150		

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASTM E384-11^{e1} and ANSI/NACE MR0175/ISO 15156-2:2009(E). The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. **Samples associated with this report will be discarded in 45 days.**

Laboratory Test Conducted By: Michelle Marien, P.T. / Dan Nguyen, C.E.T.





LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: Dynacorp Fabricators Inc.
5152 - 74th Avenue S.E.
Calgary, Alberta
T2C 3C9

Laboratory Test No.: C12-1399.3
Date: September 26, 2012

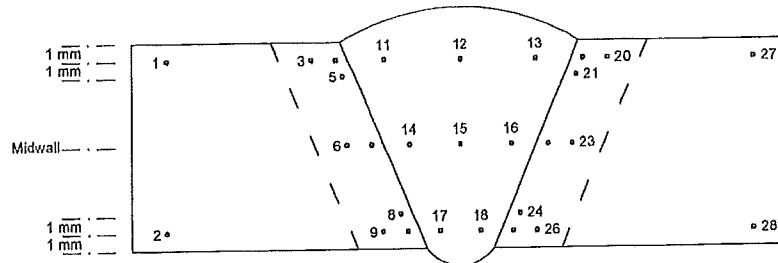
Attention: Lorne Peers

PQR Number: DYN-10-4
Material: SA 516 Gr. 60 to SA 516 Gr. 70 (Heat No.: 347418 - 62983)
Thickness: 9.52 mm (0.375 in.)
Thermal Condition: PWHT @ 621°C (1150°F) for 60 minutes

HARDNESS TEST

Type of Test: Vickers 10 kg (HV10)

Instrument: Mitutoyo AVK-C1



SA 516 Gr. 60				Weld Metal		SA 516 Gr. 70			
Parent Metal		HAZ				HAZ		Parent Metal	
1	145	3	156	11	186	19	157	27	144
2	145	4	173	12	184	20	147	28	156
		5	174	13	181	21	177		
		6	159	14	162	22	159		
		7	160	15	164	23	162		
		8	164	16	163	24	156		
		9	155	17	153	25	160		
		10	162	18	155	26	158		

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASTM E384-11^{e1} and ANSI/NACE MR0175/ISO 15156-2:2009(E). The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. **Samples associated with this report will be discarded in 45 days.**


Laboratory Test Conducted By: _____

Michelle Marieh
Michelle Marieh, T.T. / Dan Nguyen, C.E.T.






DILLINGER HÜTTE

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204-2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204-1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 364443-07.07.10	A08/ Manufacturer's order/ A03 Certificate No. 355530-001	Sheet 1/...
A05 Established inspecting body DH	A06 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10549-J1010-ER	A07.2 No.	B01 Product HOT ROLLED PLATES
B02/ Steel design. SA516-60		SA20-S5		
B03 Any suppl. requirements	ASME-II-A:07+A09 DIL-HUE-1:R27-2010-01-31			 15684

B01-B99 Description of the product

B14 Item No.	B88 Number of pieces	B09 Thickness	B10 Width	B11 Length	B12 Theoretical mass KG	B04 Product delivery condition	B07.2 Heat No.	B07.1 Rolled plate No./ Test No.	A09 Purchaser article number
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62976-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62976-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62976-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62977-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62977-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62977-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62978-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62978-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62978-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62979-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62979-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62979-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62980-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62980-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62980-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62981-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62981-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62981-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62982-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62982-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62982-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62983-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62983-02	

A04  Manufacturer's mark	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order. QM-System: Certification as per ISO 9001	 B. BALDAUF Test House Manager	 Inspector's stamp	AG der Dillinger Hüttenwerke Postfach 1580, D-66748 Dillingen/Saar Inspection department	A01 Date 07.07.10 PP 1
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A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 364443-07.07.10	A08/ Manufacturer's order/ A03 Certificate No. 355530-001	Sheet 2/...
A05 Established inspecting body DE	A08 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10549-J1010-ER	A07.2 No.	
B02/ Steel design. SA516-60	SA20-S5			
B03 Any suppl. requirements	ASME-II-A:07+A09 DIL-HUE-1:R27-2010-01-31			

B01-B99 Description of the product

B14 Item No.	B08 Number of pieces	B09 Thickness	B10 Width INCH	B11 Length	B12 Theoretical mass KG	B04 Product delivery condition	B07.2 Heat No.	B07.1 Rolled plate No./ Test No.	A09 Purchaser article number
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62983-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62984-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62984-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62984-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37285-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37285-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37285-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37286-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37286-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37286-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37287-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37287-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37287-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37288-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37288-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37288-03	
**	39				108810				
***	39				108810				




B04 Product delivery condition

ITEM NO.: 01

N: HF: 1670 GR.F +36 -27 GR.F

SOAKING TIME TO ATTAIN THE TARGET TEMPERATURE OVER THE WHOLE SECTION: 1-1,75 MIN/MM (25-45 MIN/INCH)

COOLING IN STILL AIR

A04  Manufacturer's mark	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order. QM-System: Certification as per ISO 9001	 B. BALDAUF Test House Manager	 Inspector's stamp	AG der Dillinger Hüttenwerke Postfach 1580, D-66748 Dillingen/Saar Inspection department	A07
		Date 07.07.10	PP	I	



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A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 364443-07.07.10	A08/ Manufacturer's order/ A03 Certificate No. 355530-001	Sheet 3/...
A05 Established inspecting body DH	A05 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10549-J1010-ER	A07.2 No.	B07 Product HOT ROLLED PLATES
B02/ Steel design. SA516-60	SA20-S5			
B03 Any suppl. requirements	ASME-II-A:07+A09 DIL-HUE-1:R27-2010-01-31			

B06 Marking of the product

ITEM NO.: 01
STEEL DESIGNATION SA516 70 MELTY SAS16 60 MELTY
HEAT NO. / TRADEMARK / ROLLED PLATE NO.-TEST NO. / INSPECTOR'S STAMP

B07-B99 Further information about the product

ITEM NO.: 01
THICKNESS REDUCTION RATIO >= 3,0 IS FULFILLED (CF. A/SA20 PAR. 5.3)

C10-C29 Tensile test

B14 Item No.	B07.2 Heat No.	B07.1 Rol.plate/ Test No.	B05 Reference (heat) treatment	C01 Temp. GRF	C02 Temp. GRF	C03 Temp. GRF	C10 KSI RP02	C11 KSI RP02	C12 RM	C13 A % L0-BIN	C14-C15
01	347418	62976		K1 Q	RT		52,1		75,5	24	
01	347418	62977		K1 Q	RT		51,5		74,8	28	
01	347418	62978		K1 Q	RT		50,9		74,8	29	
01	347418	62979		K1 Q	RT		50,8		74,7	25	
01	347418	62980		K1 Q	RT		51,3		74,8	28	
01	347418	62981		K1 Q	RT		51,9		75,0	24	
01	347418	62982		K1 Q	RT		51,8		75,3	27	
01	347418	62983		K1 Q	RT		51,2		75,5	26	
01	347418	62984		K1 Q	RT		52,2		75,5	26	
01	347427	37285		K1 Q	RT		48,4		73,5	26	
01	347427	37286		K1 Q	RT		48,1		73,2	27	
01	347427	37287		K1 Q	RT		47,4		72,6	27	
01	347427	37288		K1 Q	RT		47,9		73,2	28	

A04 	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order. QM-System: Certification as per ISO 9001	 B. BALDAUF Test House Manager	 Inspector's stamp	AG der Dillinger Hüttenwerke Postfach 1580, D-66748 Dillingen/Saar Inspection department	A01
			Date 07.07.10	PP 1	



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A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 364443-07.07.10	A08/ Manufacturer's order/ A09 Certificate No. 355530-001	Sheet 4/...
A05 Established inspecting body DH	A06 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10549-J1010-ER	A07.2 No.	
B02/ Steel design. SA515-60	SA20-S5			
B03 Any suppl. requirements:	ASME-II-A:07+A09 DIL-HUE-1:R27-2010-01-31			

C30-C39 Hardness test

B14 Item No.	B07.2 Heat No.	B07.1 Rol.plate/ Test No.	B05 Reference (heat) treatment	C01	C02/C01	C03 Temp. GR.F	C30 Method of test	C35	C31 Individual values	C32 Mean value
01	347418	62976		K1	0	RT	HBW 5/750	HB	143 144 143	143
01	347418	62977		K1	0	RT	HBW 5/750	HB	147 148 148	148
01	347418	62978		K1	0	RT	HBW 5/750	HB	147 146 148	147
01	347418	62979		K1	0	RT	HBW 5/750	HB	143 143 142	143
01	347418	62980		K1	0	RT	HBW 5/750	HB	149 148 147	148
01	347418	62981		K1	0	RT	HBW 5/750	HB	150 148 148	149
01	347418	62982		K1	0	RT	HBW 5/750	HB	149 147 150	149
01	347418	62983		K1	0	RT	HBW 5/750	HB	148 149 150	149
01	347427	37285		K1	0	RT	HBW 5/750	HB	151 149 150	150
01	347427	37286		K1	0	RT	HBW 5/750	HB	138 136 136	137
01	347427	37287		K1	0	RT	HBW 5/750	HB	138 135 137	137
01	347427	37288		K1	0	RT	HBW 5/750	HB	141 143 142	142
01	347427	37288		K1	0	RT	HBW 5/750	HB	137 136 138	137

C40-C49 Impact test

B14 Item No.	B07.2 Heat No.	B07.1 Rol.plate/ Test No.	B05 Reference (heat) treatment	C01	C02/ C01	C03 Temp. GR.F	C41 Width of test piece	C40 Type of test piece	C44 Testing method	C46 Energy	C45	C42 Individual values AV=FT.LGF	C43 Mean value
01	347418	62976		K1	LV	-51	3/4	CHP-V			AV	151 138 153	147
01	347418	62977		K1	LV	-51	3/4	CHP-V			AV	136 121 97	116
01	347418	62978		K1	LV	-51	3/4	CHP-V			AV	146 136 146	143
01	347418	62979		K1	LV	-51	3/4	CHP-V			AV	142 139 139	140
01	347418	62980		K1	LV	-51	3/4	CHP-V			AV	117 139 111	122
01	347418	62981		K1	LV	-51	3/4	CHP-V			AV	142 104 141	129
01	347418	62982		K1	LV	-51	3/4	CHP-V			AV	141 142 137	140
01	347418	62983		K1	LV	-51	3/4	CHP-V			AV	138 143 143	141

A04 Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.



QM-System: Certification as per ISO 9001

B. BALDAUF
Test House Manager



Inspector's stamp Date 07.07.10

AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
inspection department

A01



DILLINGER HÜTTE

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 364443-07.07.10	A08/ Manufacturer's order/ A03 Certificate No. 355530-001	Sheet 5/...
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A05 Established inspecting body DH	A06 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10549-J1010-ER	A07.2 No.	B01 Product HOT ROLLED PLATES
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B02/ Steel design. SA516-60	SA20-S5
B03 Any suppl. requirements	ASME-II-A:07+A09 DIL-HUE-1:R27-2010-01-31

C40-C49 Impact test

B14 Item No.	B07.2 Heat No.	B07.1 Roll.plate/ Test No.	B05 Reference (heat) treatment	C01	C02/ C01	C03 Temp. GRF	C41 Width of test piece	C40 Type of test piece	C44 Testing method	C46 Energy	C45	C42 Individual values AV=FTLBF			C43 Mean value
01	347418	62984		KL	LV	-51	3/4	CHP-V			AV	143	119	140	134
01	347427	37285		KL	LV	-51	3/4	CHP-V			AV	92	115	103	103
01	347427	37286		KL	LV	-51	3/4	CHP-V			AV	102	119	102	108
01	347427	37287		KL	LV	-51	3/4	CHP-V			AV	91	112	100	101
01	347427	37288		KL	LV	-51	3/4	CHP-V			AV	90	142	111	114

C70-C99 Chemical composition % - Heat analysis

B07.2 Heat	C70	C	SI	MN	P	S	N	CU	MO	NI	CR	V	NS	SH	T
347418	Y	0,170	0,381	1,19	0,011	0,0010	0,0081	0,030	0,005	0,036	0,039	0,000	0,900	0,001	0,002
347427	Y	0,173	0,329	1,14	0,008	0,0020	0,0060	0,029	0,011	0,039	0,037	0,001	0,000	0,001	0,003

B07.2 Heat	C70	S	CA	AL-T
347418	Y	0,0001	0,0019	0,031
347427	Y	0,0002	0,0006	0,049

C94 Heat analysis Carbon equivalent / Alloying restrictions

B07.2 Heat	FO-02=	0,38	FO-51=	0,000	FO-55=	0,11	FO-78=	0,04	FO-91=	7,0
347418	FO-02=	0,38	FO-51=	0,000	FO-55=	0,11	FO-78=	0,04	FO-91=	7,0
347427	FO-02=	0,38	FO-51=	0,001	FO-55=	0,12	FO-78=	0,05	FO-91=	6,6

C95 Ladle treatment

ITEM NO.: 01
HEAT OF THE INDICATED ITEM: VACUUM DEGASSED / SULPHIDE SHAPE CONTROL

A04	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order. QM-System: Certification as per ISO 9001			A01
		B. BALDAUF Test House Manager	Inspector's stamp	AG der Dillinger Hüttenwerke Postfach 1580, D-66748 Dillingen/Saar Inspection department
			Date 07.07.10	PP 1



DILLINGER HÜTTE

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A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10274:1991 MATERIAL TEST REPORT (MTR)		A70 Advice of dispatch No./ Date of dispatch 364443-07.07.10	A08/ Manufacturer's order/ A03 Certificato No. 355530-001	Sheet 6/...
A05 Established inspecting body DH	A06 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10549-J1010-ER	A07.2 No.	
B02/ Steel design. SA516-60	SA20-S5			
B03 Any suppl. requirements	ASME-II-2:07+A09 DIL-HUE-1:R27-2010-01-31			

C95 Further information about ladle treatment

ITEM NO.: 01
CALCIUM TREATED

C70-C99 Chemical composition % - Product analysis

B07.2 Heat	B07.1 Test No.	C01	C	SI	MN	P	S	N	CU	MO	NI	CR	V	MS	SN	Ti
347418	62978	K1	0,166	0,380	1,18	0,010	0,0009	0,0076	0,028	0,005	0,036	0,040	0,000	0,000	0,000	0,002
347427	37285	K1	0,169	0,346	1,15	0,008	0,0014	0,0065	0,031	0,010	0,041	0,036	0,000	0,000	0,000	0,002

B07.2 Heat	B07.1 Test No.	C01	B	CA	AL-T
347418	62978	K1	0,0001	0,0018	0,031
347427	37285	K1	0,0002	0,0009	0,043

C94 Product analysis Carbon equivalent / Alloying restrictions

B07.2 Heat	B07.1 Test No.	C01	FO-02=	0,36	FO-51=	0,000	FO-55=	0,11
347418	62978	K1	FO-02=	0,36	FO-51=	0,000	FO-55=	0,11
347427	37285	K1	FO-02=	0,37	FO-51=	0,000	FO-55=	0,12

C94 Carbon equivalent formula / Alloying restrictions

FO-02 = C + (MN/6) + (CR+MO+V) / 5 + (NI+CU) / 15
FO-51 = V + NB
FO-55 = CU+MO+NI+CR
FO-78 = CR+MO
FO-91 = MN/C

A04	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order. QM-System: Certification as per ISO 9001			AG der Dillinger Hüttenwerke Postfach 1580, D-66748 Dillingen/Saar Inspection department	A01
	Manufacturer's mark	B. BALDAUF Test House Manager	Inspector's stamp	Date 07.07.10	PP 1



DILLINGER HÜTTE


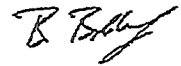

Erklärungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 364443-07.07.10	A08/ Manufacturer's order/ A03 Certificate No. 355530-001	Sheet 7
A05 Established inspecting body DH	A06 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10549-J1010-ER A07.2 No.	B01 Product HOT ROLLED PLATES	
B02/ Steel design. SA516-60	SA20-S5			
B03 Any suppl. requirements	ASME-II-A:07+A09 DIL-HUE-1:R27-2010-01-31			

DD1 Marking and identification, surface appearance, shape and dimensional properties

ITEM NO.: 01
 RESULT OF MARKING, SURFACE, SHAPE AND DIMENSIONS: NO REMARKS
 SURFACE AS PER ASME-SA20
 THICKNESS AS PER ASME-SA20
 LENGTH AND WIDTH AS PER ASME-SA20
 FLATNESS AS PER 1/2-ASME-SA20

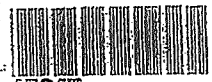


A04  Manufacturer's mark	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order. QM-System: Certification as per ISO 9001	 B. BALDAUF Test House Manager	 Inspector's stamp	AG der Dillinger Hüttenwerke Postfach 1580, D-66748 Dillingen/Saar Inspection department	A01
		Date 07.07.10	PP 1		




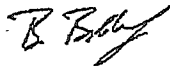

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A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 364443-07.07.10	A08/ Manufacturer's order/ A03 Certificate No. 355530-001	Sheet 1/...
A05 Established inspecting body DH	A06 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10549-J1010-ER A07.2 No.	B01 Product HOT ROLLED PLATES	
B02/ Steel design. SA516-70	SA20-S5		 25645	
B03 Any suppl. requirements	ASME-II-A:07+A09 DIL-HUE-1:R27-2010-01-31			

B01-B99 Description of the product

B14 Item No.	B08 Number of pieces	B09 Thickness	B10 Width INCH	B11 Length	B12 Theoretical mass KG	B04 Product delivery condition	B07.2 Heat No.	B07.1 Rolled plate No./ Test No.	A09 Purchaser article number
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62976-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62976-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62976-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62977-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62977-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62977-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62978-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62978-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62978-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62979-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62979-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62979-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62980-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62980-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62980-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62981-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62981-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62981-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62982-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62982-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62982-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62983-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62983-02	

A04	 Manufacturer's mark	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order. QM-System: Certification as per ISO 9001	 B. BALDAUF Test House Manager	 Inspector's stamp	AG der Dillinger Hüttenwerke Postfach 1580, D-66748 Dillingen/Saar Inspection Department	A01
					Date 07.07.10	PP 1



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A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 364443-07.07.10	A08/ Manufacturer's order/ A05 Certificate No. 355530-001	Sheet 2/...
A05 Established inspecting body DH	A06 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10549-J1010-ER A07.2 No.	B01 Product HOT ROLLED PLATES	
B02/ Steel design. SA516-70	SA20-S5			
B03 Any suppl. requirements	ASME-II-A:07+A09 DIL-HUE-1:R27-2010-01-31			

B01-B99 Description of the product

B14 Item No.	B08 Number of pieces	B09 Thickness	B10 Width	B11 Length	B12 Theoretical mass KG	B04 Product delivery condition	B07.2 Heat No.	B07.1 Rolled plate No./ Test No.	A09 Purchaser article number
			INCH						
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62983-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62984-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62984-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347418	62984-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37285-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37285-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37285-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37286-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37286-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37286-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37287-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37287-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37287-03	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37288-01	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37288-02	
01	1	0,3750 x	120,50000 x	480,00000	2790	N	347427	37288-03	
**	39				108810				
***	39				108810				


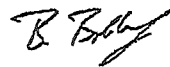

B04 Product delivery condition

ITEM NO.: 01

N: HT: 1670 GR.F +36 -27 GR.F

SOAKING TIME TO ATTAIN THE TARGET TEMPERATURE OVER THE WHOLE SECTION: 1-1,75 MIN/MM (25-45 MIN/INCH)

COOLING IN STILL AIR

A04  Manufacturer's mark	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order. QM-System: Certification as per ISO 9001	 B. BALDAUF Test House Manager	 Inspector's stamp	AG der Dillinger Hüttenwerke Postfach 1580, D-66748 Dillingen/Saar Inspection department	A01 Date 07.07.10 PP 1
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A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)	A10 Advice of dispatch No./ Date of dispatch 364443-07.07.10	A08/ Manufacturer's order/ A03 Certificate No. 355530-001	Sheet 3/...
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A05 Established inspecting body DE	A06 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10549-J1010-ER A07.2 No.	B09 Product HOT ROLLED PLATES
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B02/ Steel design. SA516-70	SA20-S5
B03 Any suppl. ASME-II-A:07+A09 requirements DIL-HUE-1:R27-2010-01-31	

B06 Marking of the product




ITEM NO.: 01
STEEL DESIGNATION SA516 70 MTLFV SA516 60 MTLFV
HEAT NO. / TRADEMARK / ROLLED PLATE NO.-TEST NO. / INSPECTOR'S STAMP

B07-B99 Further information about the product

ITEM NO.: 01
THICKNESS REDUCTION RATIO >= 3,0 IS FULFILLED (CF. A/SA20 PAR. 5.3)

C10-C29 Tensile test

E14 Item No.	B07.2 Heat No.	B07.1 Rol.plate/ Test No.	B05 Reference (heat) treatment	C01 C02 C03 C10 C11	C12	C13	A % LG=3IN	C14-C15
				Temp. GRF KSI RP02	RM			
01	347418	62976		RT 52,1	75,5		24	
01	347418	62977		RT 51,5	74,8		28	
01	347418	62978		RT 50,9	74,8		29	
01	347418	62979		RT 50,8	74,7		25	
01	347418	62980		RT 51,3	74,6		28	
01	347418	62981		RT 51,9	75,0		24	
01	347418	62982		RT 51,8	75,3		27	
01	347418	62983		RT 51,2	75,5		26	
01	347418	62984		RT 52,2	75,5		26	
01	347427	37285		RT 48,4	73,5		26	
01	347427	37286		RT 48,1	73,2		27	
01	347427	37287		RT 47,4	72,6		27	
01	347427	37288		RT 47,9	73,2		28	

A04  Manufacturer's mark	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order. QM-System: Certification as per ISO 9001	 B. BALDAUF Test House Manager	 Inspector's stamp	AG der Dillinger Hüttenwerke Postfach 1580, D-66748 Dillingen/Saar Inspection department Date 07.07.10	A01 PP 1
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A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A70 Advice of dispatch No/ Date of dispatch 364443-07.07.10	A08/ Manufacturer's order/ A03 Certificate No. 355530-001	Sheet 4/...
A05 Established inspecting body DH	A06 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10549-J11010-ER	A07.2 No.	
B07/ Steel design. SA516-70	SA20-S5			
B03 Any suppl. requirements	ASME-II-A:07+A09 DIL-HUE-1:R27-2010-01-31			

B01 Product
HOT ROLLED PLATES

C30-C39 Hardness test

B14 Item No.	B07.2 Heat No.	B07.1 Roll plate/ Test No.	B05 Reference (heat) treatment	C01	C02/C01	C03 Temp. GRF	C38 Method of test	C35	C34 Individual values	C32 Mean value
01	347418	62976		KL	0	RT	HBW 5/750	HB 143	144 143	143
01	347418	62977		KL	0	RT	HBW 5/750	HB 147	148 148	148
01	347418	62978		KL	0	RT	HBW 5/750	HB 147	146 146	147
01	347418	62979		KL	0	RT	HBW 5/750	HB 143	143 142	143
01	347418	62980		KL	0	RT	HBW 5/750	HB 149	148 147	148
01	347418	62981		KL	0	RT	HBW 5/750	HB 150	148 148	149
01	347418	62982		KL	0	RT	HBW 5/750	HB 149	147 150	149
01	347418	62983		KL	0	RT	HBW 5/750	HB 148	149 150	149
01	347418	62984		KL	0	RT	HBW 5/750	HB 151	149 150	150
01	347427	37285		KL	0	RT	HBW 5/750	HB 138	136 136	137
01	347427	37286		KL	0	RT	HBW 5/750	HB 138	135 137	137
01	347427	37287		KL	0	RT	HBW 5/750	HB 141	143 142	142
01	347427	37288		KL	0	RT	HBW 5/750	HB 137	136 138	137

C40-C49 Impact test

B14 Item No.	B07.2 Heat No.	B07.1 Roll plate/ Test No.	B05 Reference (heat) treatment	C01	C02/C01	C03 Temp. GRF	C44 Width of test piece	C40 Type of test piece	C44 Testing method	C46 Energy	C45 C42 Individual values AV=FTLEF	C43 Mean value
01	347418	62976		KL	LV	-51	3/4	CHP-V		AV 151	138 153	147
01	347418	62977		KL	LV	-51	3/4	CHP-V		AV 136	121 97	118
01	347418	62978		KL	LV	-51	3/4	CHP-V		AV 146	136 146	143
01	347418	62979		KL	LV	-51	3/4	CHP-V		AV 142	139 139	140
01	347418	62980		KL	LV	-51	3/4	CHP-V		AV 117	139 111	122
01	347418	62981		KL	LV	-51	3/4	CHP-V		AV 142	104 141	129
01	347418	62982		KL	LV	-51	3/4	CHP-V		AV 141	142 137	140
01	347418	62983		KL	LV	-51	3/4	CHP-V		AV 138	143 143	141

A04	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order. QM-System: Certification as per ISO 9001			AG der Dillinger Hüttenwerke Postfach 1580, D-66748 Dillingen/Saar Inspection department	A01
		B. BALDAUF Test House Manager	Inspector's stamp	Date 07.07.10	PP 1



DILLINGER HÜTTE

Erklärungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004
 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991
 MATERIAL TEST REPORT (MTR)

A10 Advice of dispatch No./ Date of dispatch: 364443-07.07.10
 A08/ Manufacturer's order/ A03 Certificate No.: 355530-001
 Sheet: 5/...

A05 Established inspecting body: DE
 A06 Purchaser: EDMONTON STEEL, EDMON
 A07.1 No.: ED10549-J1010-ER
 Final receiver: EDMONTON STEEL, EDMON
 A07.2 No.: SA20-S5

B01 Product: HOT ROLLED PLATES

B02/ Steel design: SAS16-70
 B03 Any suppl. requirements: ASME-II-A:07-A09
 DIL-HUE-1:R27-2010-01-31

C40-C49 Impact test

B14 Item No.	B07.2 Heat No.	B07.1 Roll plate/ Test No.	B05 Reference (heat) treatment	C01	C02/ C01	C03 Temp. GRF	C41 Width of test piece	C40 Type of test piece	C46 Testing method	C46 Energy	C45 C42 Individual values AV=FTLBF	C42 Mean value
01	347418	62984		KL	LV	-51	3/4	CHP-V			AV 143 119	140 134
01	347427	37285		KL	LV	-51	3/4	CHP-V			AV 92 115	103 103
01	347427	37286		KL	LV	-51	3/4	CHP-V			AV 102 119	102 108
01	347427	37287		KL	LV	-51	3/4	CHP-V			AV 91 112	100 101
01	347427	37288		KL	LV	-51	3/4	CHP-V			AV 90 142	111 114

C70-C99 Chemical composition % - Heat analysis

B07.2 Heat	C70	C	SI	MN	P	S	N	CU	MO	NI	CR	V	MS	SN	TI
347418	Y	0,170	0,381	1,19	0,011	0,0010	0,0081	0,030	0,005	0,036	0,039	0,000	0,000	0,001	0,002
347427	Y	0,173	0,329	1,14	0,008	0,0020	0,0060	0,029	0,011	0,039	0,037	0,001	0,000	0,001	0,003

B07.2 Heat	C70	B	CA	AL-T
347418	Y	0,0001	0,0019	0,031
347427	Y	0,0002	0,0006	0,049

C94 Heat analysis Carbon equivalent / Alloying restrictions

B07.2 Heat	FO-02=	0,38	FO-51=	0,000	FO-55=	0,11	FO-78=	0,04	FO-91=	7,0
347418										
347427				0,001	FO-55=	0,12	FO-78=	0,05	FO-91=	6,6

C95 Ladle treatment

ITEM NO.: 01
HEAT OF THE INDICATED ITEM: VACUUM DEGASSED / SULPHIDE SHAPE CONTROL

A04

Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

QM-System: Certification as per ISO 9001

B. Baldauf
B. BALDAUF
Test House Manager

AHB
Inspector's stamp

AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
inspection department

Date 07.07.10

PP 1





Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204-1:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A40 Advice of dispatch No./ Date of dispatch 364443-07.07.10	A08/ Manufacturer's order/ A03 Certificate No. 355530-001	Sheet 5/...
A05 Established inspecting body DE	A06 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10549-J1010-ER	A07.2 No.	
B02/ Steel design. SA516-70	SA20-S5			
B03 Any suppl. requirements	ASME-II-A:07+A09 DIL-HUB-1:R27-2010-01-31			

B01 Product HOT ROLLED PLATES

C95 Further information about ladle treatment

ITEM NO.: 01
CALCIUM TREATED

C70-C99 Chemical composition % - Product analysis

B07.2 Heat	B07.1 Test No.	C01	C	SI	MN	P	S	N	CU	MO	NI	CR	V	NB	SN	TI
347418	62978	K1	0,168	0,380	1,18	0,010	0,0009	0,0076	0,028	0,005	0,036	0,040	0,000	0,000	0,000	0,002
347427	37285	K1	0,169	0,346	1,15	0,008	0,0014	0,0065	0,031	0,010	0,041	0,036	0,000	0,000	0,000	0,002

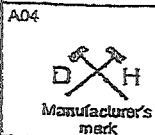
B07.2 Heat	B07.1 Test No.	C01	E	CA	AL-T
347418	62978	K1	0,0001	0,0018	0,031
347427	37285	K1	0,0002	0,0009	0,043

C94 Product analysis Carbon equivalent / Alloying restrictions

B07.2 Heat	B07.1 Test No.	C01	FO-02=	FO-51=	FO-55=
347418	62978	K1	0,38	0,000	0,11
347427	37285	K1	0,37	0,000	0,12

C94 Carbon equivalent formula / Alloying restrictions

FO-02 = C + (MN/6) + (CR+MO+V) / 5 + (NI+CU) / 15
FO-51 = V + NB
FO-55 = CU+MO+NI+CR
FO-78 = CR+MO
FO-91 = MN/C



Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

QMI-System: Certification as per ISO 9001

B. Baldauf

B. BALDAUF
Test House Manager



Inspector's stamp

AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
inspection department

A01

Date 07.07.10

PP 1



DILLINGER HÜTTE

Erklärungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004
INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991
MATERIAL TEST REPORT (MTR)

A10 Advice of dispatch No./
Date of dispatch
364443-07.07.10

A08/ Manufacturer's order/
A03 Certificate No. 355530-001
Sheet 7

A05 Established inspecting body
DH
A06 Purchaser
EDMONTON STEEL, EDMON
Final receiver
EDMONTON STEEL, EDMON
A07.1 No. ED10549-J1010-ER
A07.2 No.

B01 Product
HOT ROLLED PLATES

B07 Steel design SA516-70
B03 Any suppl. ASME-II-A:07+A09 SA20-S5
requirements DIL-HUE-1-R27-2010-01-31

D01 Marking and identification, surface appearance, shape and dimensional properties

ITEM NO.: 01
RESULT OF MARKING, SURFACE, SHAPE AND DIMENSIONS: NO REMARKS
SURFACE AS PER ASME-SA20
THICKNESS AS PER ASME-SA20
LENGTH AND WIDTH AS PER ASME-SA20
FLATNESS AS PER 1/2-ASME-SA20



A04 Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.



QM-System: Certification as per ISO 9001

B. Baldauf
B. BALDAUF
Test House Manager



Inspector's stamp

AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
Inspection department

AG1

Date 07.07.10

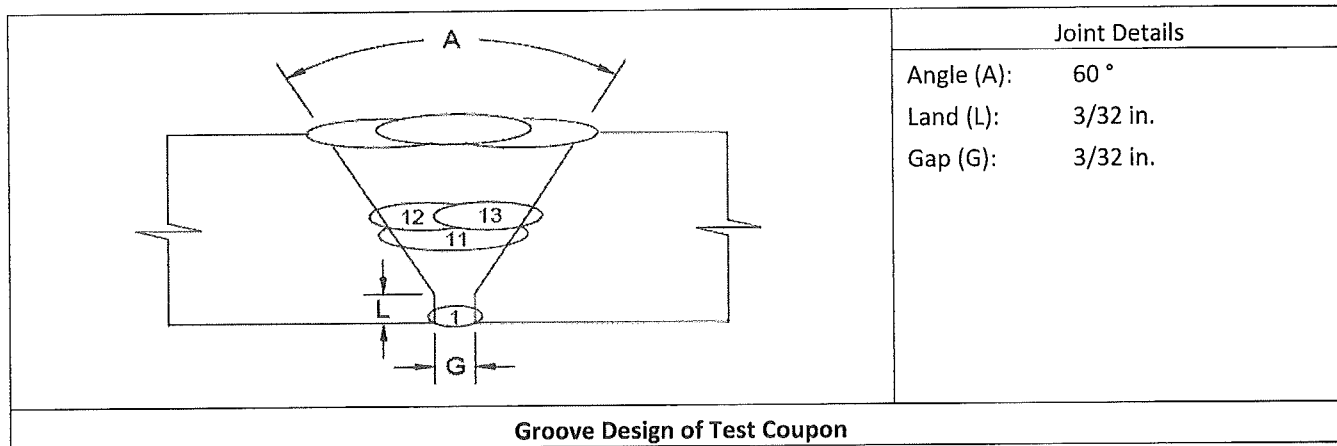
PP 1

Procedure Specification Records (PQR)

Company Name DYNACORP FABRICATORS INC.
 PQR Number DYN-10-7 Revision No. 0 Revision Date December 16, 2014
 WPS Number DYN-10
 Welding Process(es) SMAW / FCAW Type Manual / Semi-automatic

JOINTS (QW-402)

Groove Design Single V-groove, see below Retainers Without
 Backing Without Backing material N/A



BASE METALS (QW-403)

Material Spec. and Type/Grade or UNS Number SA 516 Grade 60/70 to SA 516 Grade 60/70
 P-No. 1 Group No. 1 / 2 to P-No. 1 Group No. 1 / 2
 Diameter of Coupon N/A - plate Thickness of Coupon 1.625 in.
 Maximum Pass Thickness < 0.250 in. Heat Number 383605 - 94410-01
 Other See attached MTR for detail information.

FILLER METALS (QW-404)	SMAW	SMAW	FCAW
SFA Specification	<u>5.1</u>	<u>5.1</u>	<u>5.20</u>
AWS Classification	<u>E6010</u>	<u>E7018-1</u>	<u>E71T-12MJ</u>
Filler Metal F-No.	<u>F-No. 3</u>	<u>F-No. 4</u>	<u>F-No. 6</u>
Weld Metal Analysis A-No.	<u>A-No. 1</u>	<u>A-No. 1</u>	<u>A-No. 1</u>
Size of Filler Metal	<u>QW-409, Recorded Welding Parameters</u>		
Filler Metal Product form	<u>N/A</u>	<u>N/A</u>	<u>Flux cored wire</u>
Supplemental Filler Metal	<u>N/A</u>	<u>N/A</u>	<u>Without</u>
Alloy Elements	<u>N/A</u>	<u>N/A</u>	<u>N/A</u>
Weld Metal Thickness	<u>0.125 in.</u>	<u>0.750 in.</u>	<u>0.750 in.</u>
Filler Metal Trade Name	<u>Lincoln, Fleetweld 5P+</u>	<u>Bohler, E7018-1</u>	<u>Kobelco, DWA-55ESR</u>

POSITIONS (QW-405)

Position(s) of Groove 3G Welding Progression Uphill

PREHEAT (QW-406)

Preheat Temperature 150 °F Interpass Temperature 450 °F
 Preheat Maintenance No

POSTWELD HEAT TREATMENT (QW-407)

P.W.H.T. PWHT below the lower transformation temperature of base metal.
 Temperature 1150 °F Time 9 hours

GAS (QW-408)

	Gas Composition	Flow Rate	Trade Name
Shielding	75% Ar, 25% CO2	35 CFPH	BOC Gas, Argonshield 25C
Trailing	Not used	N/A	N/A
Backing	Not used	N/A	N/A

ELECTRICAL CHARACTERISTICS (QW-409)

Current Direct current (DC) Polarity Reverse - electrode positive (EP)
 Mode of Metal Transfer FCAW: Spray arc
 Maximum Heat Input E6010: 54,519 J/in. E7018-1: 77,214 J/in. FCAW: 62,066 J/in.

Recorded Welding Parameters

Pass No.	Process	Filler Metal		Current		Volts	Travel Speed (in./min.)
		Classification	Size (in.)	Type & Polarity	Amps		
1	SMAW	E6010	1/8	DCEP	85 - 90	26 - 28	2.6
2	SMAW	E7018-1	3/32	DCEP	85 - 90	22 - 24	4.9
3 - 7	SMAW	E7018-1	3/32	DCEP	85 - 90	22 - 24	2.8 - 3.8
8 - 10	SMAW	E7018-1	1/8	DCEP	115 - 120	22 - 24	3.0 - 3.8
8 - 10	SMAW	E7018-1	1/8	DCEP	115 - 120	22 - 24	3.0 - 3.8
11	SMAW	E7018-1	1/8	DCEP	115 - 120	22 - 24	2.1
12 - 15	SMAW	E7018-1	1/8	DCEP	115 - 120	22 - 24	3.0 - 4.8
16 - 17	FCAW	E71T-12MJ	0.045	DCEP	200 - 230	25 - 26	8.6
18 - 24	FCAW	E71T-12MJ	0.045	DCEP	200 - 230	25 - 26	7.2 - 8.0
25 - 26	FCAW	E71T-12MJ	0.045	DCEP	200 - 230	25 - 26	5.5 - 6.0
27	FCAW	E71T-12MJ	0.045	DCEP	200 - 230	25 - 26	5.3

TECHNIQUE (QW-410)

String or Weave Bead SMAW: E6010: String E7018-1: Both FCAW: Both
 Orifice, Gas Cup or Nozzle Size FCAW: 0.750 in.
 Initial and Interpass Cleaning Mechanical - Grinding & power brushing
 Method of Back Gouging Not used
 Oscillation N/A Contact Tube to Work Distance FCAW: 0.500 to 0.625 in.
 Multiple or Single Pass per Side Multiple pass from groove side
 Multiple or Single Electrodes Single Electrode Spacing N/A
 Peening Not used
 Use of Thermal Processes for P-No. 11A & No. 11B Base Metal N/A

Tensile Test (QW-150)

Sample Type: Figure QW-462.1(a) Tension - Reduced Section - Plate

Specimen No.	Width mm	Thickness mm	Area mm ²	Ultimate Load - N	UTS		Type of Fracture / Location
					MPa	ksi	
T1	19.1	41.1	785	386,400	492	71.4	Ductile / Base Metal
T2	19.2	41.1	789	383,690	486	70.5	Ductile / Base Metal

Guided-Bend Tests (QW-160)

Sample Type: Figure QW-462.2 Side Bend

Specimen No.	S1	S2	S3	S4
Bend Type	Side Bend	Side Bend	Side Bend	Side Bend
Results	Pass	Pass	Pass	Pass

Toughness Tests (QW-170)

Specimen Size: 10 x 10 mm (0.394 x 0.394 in.)

Test Temperature: -46 °C (-50 °F)

Specimen No.	Notch Location	Impact Values	
		Joules	ft-lbf
E1	Weld metal within 1.5 mm (1/16 in.) from root weld surface	116	86
E2		60	44
E3		121	89
F1	Weld metal at 1/4t opposite side	102	75
F2		122	90
F3		119	88
G1	HAZ at 1/4t to 1/2t of the root weld surface	130	96
G2		24	18
G3		215	159
H1	HAZ at 1/4t to 1/2t of the opposite weld surface	132	97
H2		>240	>177
H3		>240	>177

Other Tests

Type of Test	Test Report No.
Macro Vickers hardness test (HV10)	L14-34.4

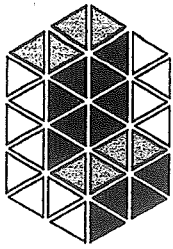
Welder's Name Mathew Carriere ABSA File No. W-22882

Tests Conducted by Lattice Metals & Welding Consulting Ltd. Laboratory Test No. L14-34.4

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code.

Organization DYNACORP FABRICATORS INC.

Date 23 Dec 2014 Certified by *[Signature]*



LATTICE METALS & WELDING CONSULTING LTD.

LABORATORY TEST REPORT

Customer: Dynacorp Fabricators Inc.
5152 - 74th Ave S.E.
Calgary, Alberta
T2C 3C9

LMW File No.: L14-34.4
Date Tested: December 19, 2014
P.O. Number: 6P32814

Contact: Lorne Peers

PQR Number: DYN-10-7
Material: ASME SA 516 Gr. 60 / 70 (Heat No.: 383605 - 94410-01)
Thickness: 41.3 mm (1.625 in.)
Thermal Condition: PWHT @ 621 °C (1150 °F) for 9 hours

Test Code/Standard: ASME Section IX - 2013

TENSILE TEST

Test Equipment: UTM - Model No. WAW-1000D / Serial No. W1403
Sample Type: Figure QW-462.1(a) Tension - Reduced Section - Plate


Specimen No.	Width mm	Thickness mm	Area mm ²	Ultimate Load - N	UTS		Type of Fracture / Location
					MPa	ksi	
T1	19.1	41.1	785	386,400	492	71.4	Ductile / Base Metal
T2	19.2	41.1	789	383,690	486	70.5	Ductile / Base Metal

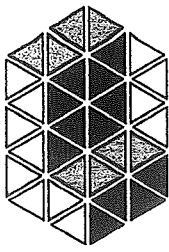
BEND TEST

Sample Type: Figure QW-462.2 Side Bend

Specimen No.	S1	S2	S3	S4
Bend Type	Side Bend	Side Bend	Side Bend	Side Bend
Results	Pass	Pass	Pass	Pass

We certify that the statements in this record are acceptable, in accordance with the requirements of test code/standard listed above.

Test Results Certified By: 
Dan Nguyen, C.E.T.



LATTICE METALS & WELDING CONSULTING LTD.

LABORATORY TEST REPORT

Customer: Dynacorp Fabricators Inc.
5152 - 74th Ave S.E.
Calgary, Alberta
T2C 3C9

LMW File No.: L14-34.4
Date Tested: December 19, 2014
P.O. Number: 6P32814

Contact: Lorne Peers

PQR Number: DYN-10-7
Material: ASME SA 516 Gr. 60 / 70 (Heat No.: 383605 - 94410-01)
Thickness: 41.3 mm (1.625 in.)
Thermal Condition: PWHT @ 621 °C (1150 °F) for 9 hours

Test Code/Standard: ASME Section VIII, Div. 1, UG-84 - 2013

CHARPY V-NOTCH IMPACT TEST

Test Equipment: 300 J Capacity Dial Display Charpy Impact Tester - Model No. JB-300B / Serial No. W1404

Verified Range: 6.3 - 240 Joules (4.6 - 177 ft-lbf)

Specimen Size: 10 x 10 mm (0.394 x 0.394 in.)

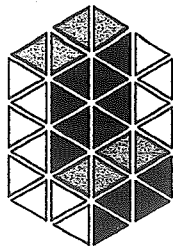
Test Temperature: -46 °C (-50 °F)

Specimen No.	Notch Location	Impact Values	
		Joules	ft-lbf
E1	Weld metal within 1.5 mm (1/16 in.) from root weld surface	116	86
E2		60	44
E3		121	89
F1	Weld metal at 1/4t opposite side	102	75
F2		122	90
F3		119	88
G1	HAZ at 1/4t to 1/2t of the root weld surface	130	96
G2		24	18
G3		215	159
H1	HAZ at 1/4t to 1/2t of the opposite weld surface	132	97
H2*		>240	>177
H3*		>240	>177

* Specimen unbroken per ASTM A370-14 clause 26.4.3.7

We certify that the statements in this record are acceptable, in accordance with the requirements of test code/standard listed above.

Test Results Certified By: 
Dan Nguyen, C.E.T.



LATTICE METALS & WELDING CONSULTING LTD.

LABORATORY TEST REPORT

Customer: Dynacorp Fabricators Inc.
5152 - 74th Ave S.E.
Calgary, Alberta
T2C 3C9

LMW File No.: L14-34.4
Date Tested: December 19, 2014
P.O. Number: 6P32814

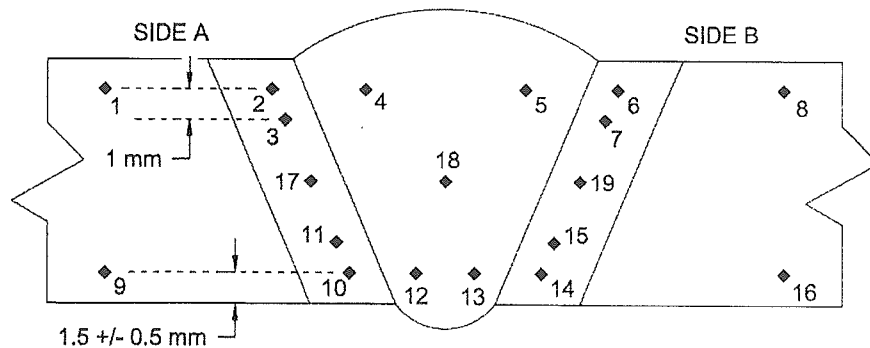
Contact: Lorne Peers

PQR Number: DYN-10-7
Material: ASME SA 516 Gr. 60 / 70 (Heat No.: 383605 - 94410-01)
Thickness: 41.3 mm (1.625 in.)
Thermal Condition: PWHT @ 621 °C (1150 °F) for 9 hours

HARDNESS TEST

Test Code/Standard: ASTM E384-11^{E1}

Instrument: Macro Hardness Tester - Model No. 900-398 / Serial No. PH 10235
Type of Hardness: Macro Vickers 10 kg load - HV10



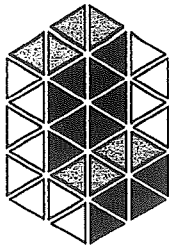
Hardness Survey as per ANSI/NACE MR0175/ISO 15156-2:2009(E) Figure 2

HARDNESS TEST RESULTS									
SIDE A				WELD METAL		SIDE B			
BASE METAL		HAZ				HAZ		BASE METAL	
1	136	2	156	4	190	6	149	8	142
9	135	3	173	5	194	7	172	16	139
		17	160	18	171	19	157		
		11	161	12	158	15	171		
		10	159	13	160	14	171		

We certify that the statements in this record are acceptable, in accordance with the requirements of test code/standard listed above.

Test Results Certified By:


Dan Nguyen, C.E.T.



LATTICE METALS & WELDING CONSULTING LTD.

LABORATORY TEST REPORT

Customer: Dynacorp Fabricators Inc.
5152 - 74th Ave S.E.
Calgary, Alberta
T2C 3C9

LMW File No.: L14-34.4
Date Tested: December 19, 2014
P.O. Number: 6P32814

Contact: Lorne Peers

PQR Number: DYN-10-7
Material: ASME SA 516 Gr. 60 / 70 (Heat No.: 383605 - 94410-01)
Thickness: 41.3 mm (1.625 in.)
Thermal Condition: PWHT @ 621 °C (1150 °F) for 9 hours

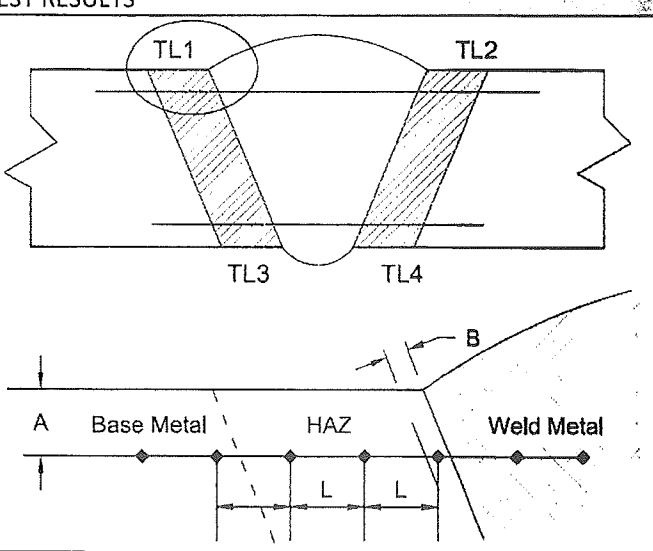
HARDNESS TEST

Test Code/Standard: ASTM E384-11^{E1}

Instrument: Macro Hardness Tester - Model No. 900-398 / Serial No. PH 10235
Type of Hardness: Macro Vickers 10 kg load - HV10


HARDNESS TEST RESULTS				
Test Location	TL1	TL2	TL3	TL4
Weld Metal	190	194	158	160
Weld Metal	192	191	162	163
HAZ within "B" of fusion line	173	172	161	171
HAZ +1 mm from fusion line	156	149	159	171
HAZ +2 mm from fusion line	143	143	153	161
HAZ +3 mm from fusion line	144	139	139	151
HAZ +4 mm from fusion line	---	---	---	---
HAZ +5 mm from fusion line	---	---	---	---
HAZ +6 mm from fusion line	---	---	---	---
Base Metal +1 mm from HAZ	142	140	140	141
Base Metal	136	142	135	139

<p>Note: TL = Test Location Distance A is 1.5 +/- 0.5 mm from surface Distance B is ≤ 0.5 mm from fusion line Distance L is 1 mm between indentations</p>				
---	--	--	--	--



Hardness Survey as per NACE SP0472-2010 Figure 2 & 3

We certify that the statements in this record are acceptable, in accordance with the requirements of test code/standard listed above.

Test Results Certified By: 
Dan Nguyen, C.E.T.

MATERIAL ACCEPTED
 Code Edition used 2C13 Addenda N/A
 for verification 8 18 DEC 2014
 QC date

KOBELCO

INSPECTION CERTIFICATE												CERTIFICATE No. 120146196 ✓	
PURCHASER				FLUX CORED WIRE				DATE OF ISSUE 2014.06.25					
TRADE DESIGNATION		DIMENSION		MFG. No.		APPLICABLE SPECIFICATION AND CLASSIFICATION							
DW-A55ESR		0.045 inch ✓		AW4569		AWS A5.20 E71T-12M-J ASME SFA-5.20 E71T-12M-J ✓							
CHEMICAL COMPOSITION (%)													
ELEMENTS	C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb		
DEPOSITED METAL	0.06 ✓	0.51 ✓	1.34 ✓	0.011 ✓	0.009 ✓	0.02 ✓	0.40 ✓	0.02 ✓	0.01 ✓	<0.01 ✓	<0.01 ✓		
ELEMENTS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
DEPOSITED METAL													
TENSILE TEST OF DEPOSITED METAL						IMPACT TEST OF DEPOSITED METAL			HARDNESS TEST				
YIELD POINT	YIELD STRENGTH AT 0.2% OFFSET	TENSILE STRENGTH		ELONGATION		TEST TEMP.	ABSORBED ENERGY						
- ksi	70 ✓ ksi	82 ✓ ksi		31 ✓ %		-51 ✓ F	AVG. 95 ✓ ft-lbf			97	91	97	-
WELDING CONDITIONS						POST WELD HEAT TREATMENT		DIFFUSIBLE HYDROGEN CONTENT (AWS A4.3-93)					
TYPE OF CURRENT	DCEP	SHIELDING GAS		80%AR 20%CO2		-		GAS CHROMATOGRAPH METHOD (1) 3.4 ml/100g					
AMPERAGE	280 A					- F x - h		DIFFUSIBLE HYDROGEN, ml/100g (2) 3.4 ml/100g					
ARC VOLTAGE	31 V							(3) 3.7 ml/100g					
								(4) 3.8 ml/100g					
								AVERAGE 3.6 ml/100g					
								(WELDING CONDITION : 230A-23V 80%AR-20%CO2)					
WE HEREBY CERTIFY THAT THE ABOVE TEST RESULTS ARE AS DESCRIBED HEREIN AND SATISFY THE REQUIREMENTS OF THE APPLICABLE SPECIFICATION.						KOBESTEEL, LTD. WELDING BUSINESS IBARAKI PLANT							
ACCORDING TO EN10024 3.1						K. Kananiwa		APPROVED BY CHIEF INSPECTOR					

1406261137123725121406811107R2123

REMARKS - CAPITAL LETTERS ARE USED EXCEPT FOR UNIT. APPLICABLE SPECIFICATION / CLASSIFICATION AND ELEMENTS.



P0#6P33198
 P0#6P33066



Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 * AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 451299-05.04.13	A08/ Manufacturer's order/ A03 Certificate No. 382636-001	Sheet 1/...
A05 Established inspecting body DH	A06 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10616-J1010-ER A07.2 No.	B01 Product HEAVY PLATES	
B02/ Steel design. SA516-70	SA20-S5			
B03 Any suppl. requirements	ASME-IIA:2010+ADDENDA-2011A DIL-HUE-3:R32-2012-10-01			



B01-B99 Description of the product

B14 Item No.	B08 Number of pieces	B09 Thickness	B10 Width	B11 Length	B12 Theoretical mass KG	B04 Product delivery condition	B07.2 Heat No.	B07.1 Rolled plate No./ Test No.	A09 Purchaser article number
01	1	1,5000 x	121,00000 x	480,00000	11207	N	383605	94382-02	PL-5 ASME SA516 Gr. 70 HE #: 383605-94410-01 1.625" plate Received by <i>MJ</i> , July 30, 2014 P.O.: P37
01	1	1,5000 x	121,00000 x	480,00000	11207	N	383605	94412-02	
**	2				22414				
02	1	1,5000 x	150,00000 x	450,00000	13025	N	383607	94239-01	
02	1	1,5000 x	150,00000 x	450,00000	13025	N	383607	94240-01	
02	1	1,5000 x	150,00000 x	450,00000	13025	N	383607	94246-01	
**	3				39075				
04	1	1,6250 x	121,00000 x	480,00000	12141	N	383605	94380-01	
04	1	1,6250 x	121,00000 x	480,00000	12141	N	383605	94410-01	
04	1	1,6250 x	121,00000 x	480,00000	12141	N	383607	94238-01	
04	1	1,6250 x	121,00000 x	480,00000	12141	N	383607	94247-01	
**	4				48564				
06	1	1,7500 x	150,00000 x	451,00000	15229	N	383605	94638-01	
07	1	2,0000 x	121,00000 x	480,00000	14943	N	383605	94620-01	
07	1	2,0000 x	121,00000 x	480,00000	14943	N	383605	94621-01	
07	1	2,0000 x	121,00000 x	480,00000	14943	N	383605	94622-01	
**	3				44829				
09	1	2,2500 x	151,00000 x	453,00000	19798	N	383086	93519-01	
***	14				189909				

A04	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.			AG der Dillinger Hüttenwerke Postfach 1580, D-66748 Dillingen/Saar Inspection department	A01
		B. BALDAUF Test House Manager	Inspector's stamp	Date 05.04.13	PP 1



Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 451299-05.04.13	A08/Manufacturer's order/ A03 Certificate No. 382636-001	Sheet 2/...
A05 Established inspecting body DH	A06 Purchaser EDMONTON STEEL, EDMON Final receiver: EDMONTON STEEL, EDMON	A07.1 No. ED10616-J1010-ER	A07.2 No.	
B02/ Steel design. SA516-70	SA20-S5			
B03 Any suppl. requirements	ASME- IIA:2010+ADDENDA-2011A DIL-HUE-3:R32-2012-10-01			

B01 Product
HEAVY PLATES

B04 Product delivery condition

ITEM NO.: 01-02,04,06-07,09
 N: HT: 1670 GR.F +36 -27 GR.F
 SOAKING TIME TO ATTAIN THE TARGET TEMPERATURE OVER THE WHOLE SECTION: 1-1,75 MIN/MM (25-45 MIN/INCH)
 COOLING IN STILL AIR

B06 Marking of the product

ITEM NO.: 01-02,04,06-07,09
 STEEL DESIGNATION SA516 70 MTLTV SA516 60 MTLTV
 HEAT NO. / TRADEMARK / ROLLED PLATE NO.-TEST NO. / INSPECTOR'S STAMP

B07-B99 Further information about the product

ITEM NO.: 01-02,04,06-07,09
 THICKNESS REDUCTION RATIO >= 3,0 IS FULFILLED (CF. A/SA20 PAR. 5.3)

C10-C29 Tensile test

B14 Item No.	B07.2 Heat No.	B07.1 Rol.plate/ Test No.	B05 Reference (heat) treatment	C01 C02/ C01 Temp. GR.F	C03 C10 C11 KSI RP02	C12 RM	C13 A % LO=2IN	C14-C15
01	383605	94382		K1 QV RT	51,8	74,8	35	
01	383605	94412		K1 QV RT	48,3	74,4	37	
02	383607	94239		K1 QV RT	48,9	75,1	37	
02	383607	94240		K1 QV RT	50,0	74,5	36	
02	383607	94246		K1 QV RT	51,8	75,3	35	
04	383605	94380		K1 QV RT	47,0	74,5	36	
04	383605	94410		K1 QV RT	50,3	75,1	39	
04	383607	94238		K1 QV RT	49,6	75,1	35	
04	383607	94247		K1 QV RT	50,2	75,3	36	



Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

B. Baldauf



AG der Dillinger Hüttenwerke
 Postfach 1580, D-66748 Dillingen/Saar
 Inspection department



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A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 451299-05.04.13	A08/ Manufacturer's order/ A03 Certificate No. 382636-001	Sheet 3/...
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A05 Established inspecting body DH	A06 Purchaser EDMONTON STEEL, EDMON	A07.1 No. ED10616-J1010-ER	A07.2 No.	A09 Product HEAVY PLATES
	Final receiver EDMONTON STEEL, EDMON			

B02/ Steel design. SA516-70	SA20-S5
B03 Any suppl. requirements	ASME-IIA:2010+ADDENDA-2011A DIL-HUE-3:R32-2012-10-01

C10-C29 Tensile test

B14 Item No.	B07.2 Heat No.	B07.1 Rol.plate/ Test No.	B05 Reference (heat) treatment	C01	C02/ C01	C03 Temp. GR.F	C10 KSI RP02	C11	C12 RM	C13	A % LD=2IN	C14-C15
06	383605	94638		K1	QV	RT	47,4		73,7		37	
07	383605	94620		K1	QV	RT	47,7		74,1		36	
07	383605	94621		K1	QV	RT	48,4		74,0		35	
07	383605	94622		K1	QV	RT	48,4		74,7		37	
09	383086	93519		K1	QV	RT	49,9		74,7		36	

C30-C39 Hardness test

B14 Item No.	B07.2 Heat No.	B07.1 Rol.plate/ Test No.	B05 Reference (heat) treatment	C01	C02/C01	C03 Temp. GR.F	C30 Method of test	C35	C31 Individual values	C32 Mean value
01	383605	94382		K1	O	RT	HBW 10/3000	HB 141	140	139
01	383605	94412		K1	O	RT	HBW 10/3000	HB 143	143	142
02	383607	94239		K1	O	RT	HBW 10/3000	HB 144	143	142
02	383607	94240		K1	O	RT	HBW 10/3000	HB 144	143	141
02	383607	94246		K1	O	RT	HBW 10/3000	HB 148	142	141
04	383605	94380		K1	O	RT	HBW 10/3000	HB 138	139	139
04	383605	94410		K1	O	RT	HBW 10/3000	HB 144	144	144
04	383607	94238		K1	O	RT	HBW 10/3000	HB 139	139	139
04	383607	94247		K1	O	RT	HBW 10/3000	HB 139	139	139
06	383605	94638		K1	O	RT	HBW 10/3000	HB 137	138	137
07	383605	94620		K1	O	RT	HBW 10/3000	HB 138	138	138
07	383605	94621		K1	O	RT	HBW 10/3000	HB 138	138	137
07	383605	94622		K1	O	RT	HBW 10/3000	HB 139	138	138
09	383086	93519		K1	O	RT	HBW 10/3000	HB 135	137	137



A04 Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

B. Baldauf



A01 AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
Inspection department



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A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A10: Advice of dispatch No./ Date of dispatch 451299-05.04.13	A08: Manufacturer's order/ A03 Certificate No. 382636-001	Sheet 4/...
A05 Established/Inspecting body DH	A06 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10616-J1010-ER	B01 Product HEAVY PLATES	
B02/ Steel design. SA516-70	SA20-S5			
B03 Any suppl. requirements	ASME-IIA:2010+ADDENDA-2011A DIL-HUE-3:R32-2012-10-01			

C40-C49 Impact test

Bt4 Item No.	B07.2 Heat No.	B07.1 Rol.plate/ Test No.	B05 Reference (heat) treatment	C01	C02/ C01	C03 Temp. GR.F	C41 Width of test piece	C40 Type of test piece	C44 Testing method	C46 Energy	C45	C42 Individual values AV=FT.LBF	C43 Mean value	
01	383605	94382		K1	LV	-51		CHP-V			AV 90	96	83	90
01	383605	94412		K1	LV	-51		CHP-V			AV 106	102	117	108
02	383607	94239		K1	LV	-51		CHP-V			AV 49	97	62	69
02	383607	94240		K1	LV	-51		CHP-V			AV 105	99	90	98
02	383607	94246		K1	LV	-51		CHP-V			AV 101	125	72	99
04	383605	94380		K1	LV	-51		CHP-V			AV 98	88	115	100
04	383605	94410		K1	LV	-51		CHP-V			AV 150	101	86	112
04	383607	94238		K1	LV	-51		CHP-V			AV 108	101	102	104
04	383607	94247		K1	LV	-51		CHP-V			AV 106	64	100	90
06	383605	94638		K1	LV	-51		CHP-V			AV 96	111	144	117
07	383605	94620		K1	LV	-51		CHP-V			AV 73	86	49	69
07	383605	94621		K1	LV	-51		CHP-V			AV 93	26	90	70
07	383605	94622		K1	LV	-51		CHP-V			AV 66	76	92	78
09	383086	93519		K1	LV	-51		CHP-V			AV 68	101	142	104

C70-C99 Chemical composition % - Heat analysis

B07.2 Heat	C70	C	SI	MN	P	S	N	CU	MO	NI	CR	V	NB	SN	TI
383086	Y	0,170	0,363	1,18	0,008	0,0005	0,0064	0,025	0,007	0,029	0,223	0,000	0,000	0,001	0,001
383605	Y	0,180	0,354	1,18	0,009	0,0019	0,0062	0,030	0,010	0,041	0,032	0,001	0,000	0,001	0,002
383607	Y	0,186	0,377	1,19	0,008	0,0017	0,0071	0,024	0,005	0,026	0,031	0,001	0,000	0,001	0,002



A04 Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

B. Baldauf



B. BALDAUF
Test House Manager

Inspector's stamp

AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
Inspection department:

Date 05.04.13

PP 1

A01



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A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 451299-05.04.13	A08/Manufacturer's order/ A03 Certificate No. 382636-001	Sheet 5/...
A05 Established inspecting body DH.	A06 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10616-J1010-ER	B01 Product HEAVY PLATES	
B02 Steel design. SA516-70	A07.2 No. SA20-S5			
B03 Any suppl. requirements	ASME-IIA:2010+ADDENDA-2011A DIL-HUE-3:R32-2012-10-01			

C70-C99 Chemical composition % - Heat analysis

B07.2 Heat	C70	B	CA	AL-T
383086	Y	0,0000	0,0018	0,039
383605	Y	0,0000	0,0006	0,043
383607	Y	0,0000	0,0023	0,046

C94 Heat analysis Carbon equivalent / Alloying restrictions

B07.2 Heat	FO-02=	0,42	FO-51=	0,000	FO-55=	0,28	FO-78=	0,23	FO-91=	6,9
383086	FO-02=	0,42	FO-51=	0,000	FO-55=	0,28	FO-78=	0,23	FO-91=	6,9
383605	FO-02=	0,39	FO-51=	0,001	FO-55=	0,11	FO-78=	0,04	FO-91=	6,6
383607	FO-02=	0,40	FO-51=	0,001	FO-55=	0,09	FO-78=	0,04	FO-91=	6,4

C95 Ladle treatment

ITEM NO.: 01-02,04,06-07,09
HEAT OF THE INDICATED ITEM: VACUUM DEGASSED / SULPHIDE SHAPE CONTROL

C95 Further information about ladle treatment

ITEM NO.: 01-02,04,06-07,09
CALCIUM TREATED

C70-C99 Chemical composition % - Product analysis

B07.2 Heat	B07.1 Test No.	C01	C	SI	MN	P	S	N	CU	MO	NI	CR	V	NB	SN	TI
383086	93519	K1	0,171	0,361	1,16	0,008	0,0008	0,0063	0,026	0,005	0,025	0,222	0,000	0,000	0,000	0,001
383605	94410	K1	0,192	0,342	1,16	0,009	0,0022	0,0060	0,030	0,010	0,042	0,033	0,001	0,000	0,001	0,001
383605	94412	K1	0,184	0,379	1,17	0,008	0,0020	0,0066	0,023	0,008	0,035	0,029	0,001	0,000	0,000	0,002
383605	94622	K1	0,186	0,350	1,16	0,008	0,0017	0,0066	0,029	0,010	0,040	0,032	0,001	0,001	0,001	0,001
383605	94638	K1	0,185	0,346	1,16	0,009	0,0024	0,0059	0,031	0,011	0,044	0,032	0,001	0,000	0,001	0,001
383607	94238	K1	0,187	0,381	1,17	0,008	0,0019	0,0068	0,023	0,005	0,023	0,029	0,001	0,000	0,001	0,002

A04 2011/202/203 We hereby certify, that the above-mentioned materials have been delivered in accordance with the terms of order.



B. Baldauf



AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
Inspection department

B. BALDAUF
Test House Manager

Inspector's stamp

Date 05.04.13

PP 1



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A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 451299-05.04.13	A08/ Manufacturer's order/ A03 Certificate No. 382636-001	Sheet 6/...
A05 Established inspecting body. DH	A06 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10616-J1010-ER A07.2 No.		B01 Product HEAVY PLATES
B02/ Steel design. SA516-70	SA20-S5			
B03 Any suppl. requirements	ASME- IIA: 2010+ADDENDA-2011A DIL-HUE-3:R32-2012-10-01			

C70-C99 Chemical composition % - Product analysis

B07.2 Heat	B07.1 Test No.	C01	C	SI	MN	P	S	N	CU	MO	NI	CR	V	NB	SN	TI
383607	94246	K1	0,183	0,346	1,15	0,008	0,0021	0,0065	0,029	0,010	0,039	0,032	0,001	0,000	0,001	0,001

B07.2 Heat	B07.1 Test No.	C01	B	CA	AL-T
383086	93519	K1	0,0000	0,0020	0,039
383605	94410	K1	0,0000	0,0005	0,043
383605	94412	K1	0,0001	0,0013	0,043
383605	94622	K1	0,0001	0,0005	0,043
383605	94638	K1	0,0000	0,0008	0,044
383607	94238	K1	0,0001	0,0023	0,045
383607	94246	K1	0,0000	0,0008	0,043

C94 Product analysis Carbon equivalent / Alloying restrictions

B07.2 Heat	B07.1 Test No.	C01	FO-02=	0,41	FO-51=	0,000	FO-55=	0,28
383086	93519	K1	FO-02=	0,41	FO-51=	0,000	FO-55=	0,28
383605	94410	K1	FO-02=	0,40	FO-51=	0,001	FO-55=	0,12
383605	94412	K1	FO-02=	0,39	FO-51=	0,001	FO-55=	0,10
383605	94622	K1	FO-02=	0,39	FO-51=	0,002	FO-55=	0,11
383605	94638	K1	FO-02=	0,39	FO-51=	0,001	FO-55=	0,12
383607	94238	K1	FO-02=	0,39	FO-51=	0,001	FO-55=	0,08
383607	94246	K1	FO-02=	0,39	FO-51=	0,001	FO-55=	0,11

A04



Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

B. Baldauf

B. BALDAUF
Test House Manager



Inspector's stamp

AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
Inspection department

A01

Date 05.04.13.

PP II



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A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 451299-05.04.13	A08/ Manufacturer's order/ A03 Certificate No. 382636-001	Sheet 7
A05 Established inspecting body DH	A06 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10616-J1010-ER A07.2 No.	B01 Product HEAVY PLATES	
B02/ Steel design. SA516-70	SA20-S5			
B03 Any suppl. requirements	ASME-IIA:2010+ADDENDA-2011A DIL-HUE-3:R32-2012-10-01			

C94 Carbon equivalent formula / Alloying restrictions

FO-02 = $C + (MN/6) + (CR+MO+V) / 5 + (NI+CU) / 15$
 FO-51 = V + NB
 FO-55 = CU+MO+NI+CR
 FO-78 = CR+MO
 FO-91 = MN/C

D01 Marking and Identification, surface appearance, shape and dimensional properties

ITEM NO.: 01-02, 04, 06-07, 09
 EXAMINATION OF MARKING, SURFACE, SHAPE AND DIMENSIONS: THE RESULTS MEET THE REQUIREMENTS.
 SURFACE AS PER ASME-SA20
 THICKNESS AS PER ASME-SA20
 LENGTH AND WIDTH AS PER ASME-SA20
 FLATNESS AS PER 1/2-ASME-SA20



A04

Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.



B. Baldauf



AG der Dillinger Hüttenwerke
 Postfach 1580, D-66748 Dillingen/Saar
 Inspection department

A01

B. BALDAUF
 Test House Manager

Inspector's stamp

Date 05.04.13

PP 1



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A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 451299-05.04.13	A08/ Manufacturer's order/ A03 Certificate No. 382636-001	Sheet 1/...
A05 Established inspecting body DH	A06 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10616-J1010-ER	A07.2 No.	
B02/ Steel design. SA516-60	SA20-S5		B01 Product HEAVY PLATES	
B03 Any suppl. requirements	ASME- IIA:2010+ADDENDA-2011A DIL-HUE-3:R32-2012-10-01		 17826	

B01-B99 Description of the product

B14 Item No.	B08 Number of pieces	B09 Thickness	B10 Width	B11 Length	B12 Theoretical mass KG	B04 Product delivery condition	B07.2 Heat No.	B07.1 Rolled plate No./ Test No.	A09 Purchaser article number
			INCH						
01	1	1,5000 x	121,00000 x	480,00000	11207	N	383605	94382-02	PL-5 ASME SA516 Gr. 60 He. #: 383605-94410-01 1.625" plate Received by AJ, July 30, 2014 P.O.: P37
01	1	1,5000 x	121,00000 x	480,00000	11207	N	383605	94412-02	
**	2				22414				
02	1	1,5000 x	150,00000 x	450,00000	13025	N	383607	94239-01	
02	1	1,5000 x	150,00000 x	450,00000	13025	N	383607	94240-01	
02	1	1,5000 x	150,00000 x	450,00000	13025	N	383607	94246-01	
**	3				39075				
04	1	1,6250 x	121,00000 x	480,00000	12141	N	383605	94380-01	
04	1	1,6250 x	121,00000 x	480,00000	12141	N	383605	94410-01	
04	1	1,6250 x	121,00000 x	480,00000	12141	N	383607	94238-01	
04	1	1,6250 x	121,00000 x	480,00000	12141	N	383607	94247-01	
**	4				48564				
06	1	1,7500 x	150,00000 x	451,00000	15229	N	383605	94638-01	
07	1	2,0000 x	121,00000 x	480,00000	14943	N	383605	94620-01	
07	1	2,0000 x	121,00000 x	480,00000	14943	N	383605	94621-01	
07	1	2,0000 x	121,00000 x	480,00000	14943	N	383605	94622-01	
**	3				44829				
09	1	2,2500 x	151,00000 x	453,00000	19798	N	383086	93519-01	
***	14				189909				

A04	Z01/Z02/Z03: We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.	 B. BALDAUF Test House Manager	 Inspector's stamp	AG der Dillinger Hüttenwerke Postfach 1580, D-66748 Dillingen/Saar Inspection department	A01
		Date 05.04.13	PP	1	





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A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch: 451299-05.04.13	A08/Manufacturer's order/ A03 Certificate No. 382636-001	Sheet: 2/...
A05 Established inspecting body: DH	A06 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10616-J1010-ER A07.2 No.	B01 Product: HEAVY PLATES	
B02/ Steel design. SA516-60	SA20-S5			
B03 Any suppl. requirements	ASME-IIA:2010+ADDENDA-2011A DIL-HUE-3:R32-2012-10-01			

B04 Product delivery condition

ITEM NO.: 01-02,04,06-07,09
 N: HT: 1670 GR.F +36 -27 GR.F
 SOAKING TIME TO ATTAIN THE TARGET TEMPERATURE OVER THE WHOLE SECTION: 1-1,75 MIN/MM (25-45 MIN/INCH)
 COOLING IN STILL AIR

B06 Marking of the product

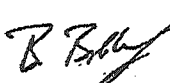


ITEM NO.: 01-02,04,06-07,09
 STEEL DESIGNATION SA516 70 MTLTV SA516 60 MTLTV
 HEAT NO. / TRADEMARK / ROLLED PLATE NO.-TEST NO. / INSPECTOR'S STAMP

B07-B99 Further information about the product

ITEM NO.: 01-02,04,06-07,09
 THICKNESS REDUCTION RATIO >= 3,0 IS FULFILLED (CF. A/SA20 PAR. 5.3)

C10-C29 Tensile test

B14 Item No.	B07.2 Heat No.	B07.1 Rol.plate/ Test No.	B05 Reference (heat) treatment	C01 C02/ C01	C03 Temp. GR.F	C10 C11 KSI RP02	C12 RM	C13	A %	C14-C15 L0=2IN
01	383605	94382		K1	QV RT	51,8	74,8		35	
01	383605	94412		K1	QV RT	48,3	74,4		37	
02	383607	94239		K1	QV RT	48,9	75,1		37	
02	383607	94240		K1	QV RT	50,0	74,5		36	
02	383607	94246		K1	QV RT	51,8	75,3		35	
04	383605	94380		K1	QV RT	47,0	74,5		36	
04	383605	94410		K1	QV RT	50,3	75,1		39	
04	383607	94238		K1	QV RT	49,6	75,1		35	
04	383607	94247		K1	QV RT	50,2	75,3		36	

A04	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.	 B. BALDAUF Test House Manager	 AG der Dillinger Hüttenwerke Postfach 1580, D-66748 Dillingen/Saar Inspection department	A01
		Inspector's stamp	Date 05.04.13	PP 1



Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02: INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 451299-05.04.13	A08/ Manufacturer's order/ A03 Certificate No. 382636-001	Sheet 3/...
A05 Established inspecting body DH	A06 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10616-J1010-ER A07.2 No.	B01 Product HEAVY PLATES	
B02/ Steel design.	SA516-60	SA20-S5		
B03 Any suppl. requirements	ASME-IIA:2010+ADDENDA-2011A DIL-HUE-3:R32-2012-10-01			

C10-C29 Tensile test

B14 Item No.	B07.2 Heat No.	B07.1 Rol. plate/ Test No.	B05 Reference (heat) treatment	C01	C02/ C01	C03 Temp. GR.F	C10 KSI RP02	C11	C12 RM	C13	A % LO=2IN	C14-C15
06	383605	94638		K1	QV	RT	47,4		73,7		37	
07	383605	94620		K1	QV	RT	47,7		74,1		36	
07	383605	94621		K1	QV	RT	48,4		74,0		35	
07	383605	94622		K1	QV	RT	48,4		74,7		37	
09	383086	93519		K1	QV	RT	49,9		74,7		36	

C30-C39 Hardness test

B14 Item No.	B07.2 Heat No.	B07.1 Rol. plate/ Test No.	B05 Reference (heat) treatment	C01	C02/C01	C03 Temp. GR.F	C30 Method of test	C35	C31 Individual values	C32 Mean value
01	383605	94382		K1	O	RT	HBW 10/3000	HB 141	140 139	140
01	383605	94412		K1	O	RT	HBW 10/3000	HB 143	143 142	143
02	383607	94239		K1	O	RT	HBW 10/3000	HB 144	143 142	143
02	383607	94240		K1	O	RT	HBW 10/3000	HB 144	143 141	143
02	383607	94246		K1	O	RT	HBW 10/3000	HB 148	142 141	144
04	383605	94380		K1	O	RT	HBW 10/3000	HB 138	139 139	139
04	383605	94410		K1	O	RT	HBW 10/3000	HB 144	144 144	144
04	383607	94238		K1	O	RT	HBW 10/3000	HB 139	139 139	139
04	383607	94247		K1	O	RT	HBW 10/3000	HB 139	139 139	139
06	383605	94638		K1	O	RT	HBW 10/3000	HB 137	138 137	137
07	383605	94620		K1	O	RT	HBW 10/3000	HB 138	138 138	138
07	383605	94621		K1	O	RT	HBW 10/3000	HB 138	138 137	138
07	383605	94622		K1	O	RT	HBW 10/3000	HB 139	138 138	138
09	383086	93519		K1	O	RT	HBW 10/3000	HB 135	137 137	136

A04

Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.



Manufacturer's mark

B. Baldauf

B. BALDAUF
Test House Manager



Inspector's stamp

AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
inspection department

A01

Date 05.04.13

PP 1



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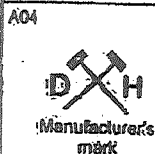
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A05 Established inspecting body DH	A06 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10616-J1010-ER A07.2 No.	B01 Product HEAVY PLATES	
B02/ Steel design. SA516-60	SA20-S5			
B03 Any suppl. requirements	ASME-IIA:2010+ADDENDA-2011A DIL-HUE-3:R32-2012-10-01			

C40-C49 Impact test

B14 Item No.	B07.2 Heat No.	B07.1 Rol.plate/ Test No.	B05 Reference (heat) treatment	C01	C02/ C01	C03 Temp. GR.F	C41 Width of test piece	C40 Type of test piece	C44 Testing method	C46 Energy	C45	C42 Individual values AV=FT.LBF	C43 Mean value	
01	383605	94382		K1	LV	-51		CHP-V			AV 90	96	83	90
01	383605	94412		K1	LV	-51		CHP-V			AV 106	102	117	108
02	383607	94239		K1	LV	-51		CHP-V			AV 49	97	62	69
02	383607	94240		K1	LV	-51		CHP-V			AV 105	99	90	98
02	383607	94246		K1	LV	-51		CHP-V			AV 101	125	72	99
04	383605	94380		K1	LV	-51		CHP-V			AV 98	88	115	100
04	383605	94410		K1	LV	-51		CHP-V			AV 150	101	86	112
04	383607	94238		K1	LV	-51		CHP-V			AV 108	101	102	104
04	383607	94247		K1	LV	-51		CHP-V			AV 106	64	100	90
06	383605	94638		K1	LV	-51		CHP-V			AV 96	111	144	117
07	383605	94620		K1	LV	-51		CHP-V			AV 73	86	49	69
07	383605	94621		K1	LV	-51		CHP-V			AV 93	26	90	70
07	383605	94622		K1	LV	-51		CHP-V			AV 66	76	92	78
09	383086	93519		K1	LV	-51		CHP-V			AV 68	101	142	104

C70-C99 Chemical composition % - Heat analysis

B07.2 Heat	C70	C	SI	MN	P	S	N	CU	MO	NI	CR	V	NB	SN	TI
383086	Y	0,170	0,363	1,18	0,008	0,0005	0,0064	0,025	0,007	0,029	0,223	0,000	0,000	0,001	0,001
383605	Y	0,180	0,354	1,18	0,009	0,0019	0,0062	0,030	0,010	0,041	0,032	0,001	0,000	0,001	0,002
383607	Y	0,186	0,377	1,19	0,008	0,0017	0,0071	0,024	0,005	0,026	0,031	0,001	0,000	0,001	0,002



Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

B. Baldauf



AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
Inspection department

B: BALDAUF
Test House Manager

Inspector's stamp

Date: 05.04.13

pp. 1



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A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 451299-05.04.13	A08/ Manufacturer's order/ A03 Certificate No. 382636-001	Sheet 5/...
A05 Established inspecting body DH	A06 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10616-J1010-ER	A07.2 No.	B01 Product HEAVY PLATES
B02/ Steel design. SA516-60	SA20-S5			
B03 Any suppl. requirements	ASME-IIA:2010+ADDENDA-2011A DIL-HUE-3:R32-2012-10-01			

C70-C99 Chemical composition % - Heat analysis

B07.2 Heat	C70	B	CA	AL-T
383086	Y	0,0000	0,0018	0,039
383605	Y	0,0000	0,0006	0,043
383607	Y	0,0000	0,0023	0,046

C94 Heat analysis Carbon equivalent / Alloying restrictions

B07.2 Heat	FO-02=	0,42	FO-51=	0,000	FO-55=	0,28	FO-78=	0,23	FO-91=	6,9
383086	FO-02=	0,39	FO-51=	0,001	FO-55=	0,11	FO-78=	0,04	FO-91=	6,6
383605	FO-02=	0,40	FO-51=	0,001	FO-55=	0,09	FO-78=	0,04	FO-91=	6,4
383607	FO-02=	0,40	FO-51=	0,001	FO-55=	0,09	FO-78=	0,04	FO-91=	6,4

C95 Ladle treatment

ITEM NO.: 01-02,04,06-07,09
HEAT OF THE INDICATED ITEM: VACUUM DEGASSED / SULPHIDE SHAPE CONTROL

C95 Further information about ladle treatment

ITEM NO.: 01-02,04,06-07,09
CALCIUM TREATED

C70-C99 Chemical composition % - Product analysis

B07.2 Heat	B07.1 Test No.	C01	C	SI	MN	P	S	N	CU	MO	NI	CR	V	NE	SN	TI
383086	93519	K1	0,171	0,361	1,16	0,008	0,0008	0,0063	0,026	0,005	0,025	0,222	0,000	0,000	0,000	0,001
383605	94410	K1	0,192	0,342	1,16	0,009	0,0022	0,0060	0,030	0,010	0,042	0,033	0,001	0,000	0,001	0,001
383605	94412	K1	0,184	0,379	1,17	0,008	0,0020	0,0066	0,023	0,008	0,035	0,029	0,001	0,000	0,000	0,002
383605	94622	K1	0,186	0,350	1,16	0,008	0,0017	0,0066	0,029	0,010	0,040	0,032	0,001	0,001	0,001	0,001
383605	94638	K1	0,185	0,346	1,16	0,009	0,0024	0,0059	0,031	0,011	0,044	0,032	0,001	0,000	0,001	0,001
383607	94238	K1	0,187	0,381	1,17	0,008	0,0019	0,0068	0,023	0,005	0,023	0,029	0,001	0,000	0,001	0,002

A04

Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.



B. Baldauf



AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
Inspection department

A01

B. BALDAUF
Test House Manager

Inspector's stamp

Date 05.04.13

PP 1



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A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 451299-05.04.13	A08/Manufacturer's order/ A03 Certificate No.: 382636-001	Sheet 6/...
A05 Established inspecting body DH	A06 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10616-J1010-ER	A07.2 No.	
B02/ Steel design. SA516-60	SA20-S5			
B03 Any suppl. requirements	ASME- IIA: 2010+ADDENDA-2011A DIL-HUE-3:R32-2012-10-01			

B01 Product
HEAVY PLATES

C70-C99 Chemical composition % - Product analysis

B07.2 Heat	B07.1 Test No.	C01	C	SI	MN	P	S	N	CU	MO	NI	CR	V	NB	SN	TI
383607	94246	K1	0,183	0,346	1,15	0,008	0,0021	0,0065	0,029	0,010	0,039	0,032	0,001	0,000	0,001	0,001

B07.2 Heat	B07.1 Test No.	C01	B	CA	AL-T
383086	93519	K1	0,0000	0,0020	0,039
383605	94410	K1	0,0000	0,0005	0,043
383605	94412	K1	0,0001	0,0013	0,043
383605	94622	K1	0,0001	0,0005	0,043
383605	94638	K1	0,0000	0,0008	0,044
383607	94238	K1	0,0001	0,0023	0,045
383607	94246	K1	0,0000	0,0008	0,043

C94 Product analysis Carbon equivalent / Alloying restrictions

B07.2 Heat	B07.1 Test No.	C01	FO-02=	FO-51=	FO-55=
383086	93519	K1	0,41	0,000	0,28
383605	94410	K1	0,40	0,001	0,12
383605	94412	K1	0,39	0,001	0,10
383605	94622	K1	0,39	0,002	0,11
383605	94638	K1	0,39	0,001	0,12
383607	94238	K1	0,39	0,001	0,08
383607	94246	K1	0,39	0,001	0,11

A04



Manufacturer's mark

Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

B. Baldauf

B. BALDAUF
Test House Manager



Inspector's stamp

AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
Inspection department

A01

Date: 05.04.13

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A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 451299-05.04.13	A08/ Manufacturer's order/ A03 Certificate No. 382636-001	Sheet 7
A05 Established inspecting body DH	A06 Purchaser EDMONTON STEEL, EDMON Final receiver EDMONTON STEEL, EDMON	A07.1 No. ED10616-J1010-ER A07.2 No.		B01 Product HEAVY PLATES
B02 Steel design. SA516-60	SA20-S5			
B03 Any suppl. requirements	ASME-IIA:2010+ADDENDA-2011A DIL-HUE-3:R32-2012-10-01			




C94 Carbon equivalent formula / Alloying restrictions

- FO-02 = $C + (Mn/6) + (Cr+Mo+V) / 5 + (Ni+Cu) / 15$
- FO-51 = $V + Nb$
- FO-55 = $Cu+Mo+Ni+Cr$
- FO-78 = $Cr+Mo$
- FO-91 = Mn/C

D01 Marking and identification, surface appearance, shape and dimensional properties

ITEM NO.: 01-02, 04, 06-07, 09
 EXAMINATION OF MARKING, SURFACE, SHAPE AND DIMENSIONS: THE RESULTS MEET THE REQUIREMENTS.
 SURFACE AS PER ASME-SA20
 THICKNESS AS PER ASME-SA20
 LENGTH AND WIDTH AS PER ASME-SA20
 FLATNESS AS PER 1/2-ASME-SA20



A04  Manufacturer's mark	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.	 B. BALDAUF Test House Manager	 Inspector's stamp	AG der Dillinger Hüttenwerke Postfach 1580, D-66748 Dillingen/Saar Inspection department	A01
		Date 05.04.13	PP 1		

Welding Procedure Specification (WPS) Qualified in Accordance with ASME BPVC Section IX

WPS No.: WOM-2 Revision No.: 4
 Supporting PQR No.(s): WOM-2-3, DYN-10-4, DYN-10-7
 Process (es): SMAW P.W.H.T.: Yes

WPS SUMMERY

Qualified	Normal Appl.	-50°F Notch Toughness Appl.*
ASME Section IX Base Metal	P-No. 1 to P-No. 1	P-No. 1 Grp 1/2 to P-No. 1 Grp. 1/2
Base Metal Thickness (Groove)	0.062 to 8.00 in.	0.118 to 8.00 in.
Filler Metal	E6010, E7018, E7018-1	E6010 (root pass only), E7018-1
Weld Metal Deposited Thickness	F-No. 3: 0.250 in. maximum	F-No. 4: 8.00 in. maximum

* With control of the supplementary-essential variables as specified in this WPS, this WPS is qualified for use where proven notch toughness properties are specified to -50 °F and warmer.

This WPS is qualified in accordance with ASME section IX, and it shall be applied in conjunction with relevant code of construction/standard/specification.

RECORD OF REVISION

Revision	Date (dd-mm-yyyy)	Revision Description
4	19-12-2014	Replaced PQR's DYN-10-3 and DYN-10-5 with PQR DYN-10-7.
3	18-10-2012	Replaced existing PQR's with PQR's WOM-2-3, DYN-10-3, DYN-10-4 and DYN-10-5 to increase P.W.H.T. time.
2	08-08-1994	Addition of PQR's.

PROVINCIAL REGISTRATION

ABSA

SAFETY CODES ACT - PROVINCE OF ALBERTA
WELDING PROCEDURE

Reg. No. WP. 1073.2

Spec No. WOM-2 (rev 4)

Weld Process SMAW

Matl. Gr. P No. 1Gr 1+2 to P No. 1Gr 1+2

Elect Gr. F No. 3+4 A No. 1

Th. Qual For 203mm P.W.H.T. YES

MIN TH QUAL 3.0mm, CVN -46°C

Yr. 15 Mo. 1 Day 5 Signed JRH
JASON REINHART, PENG.
WELDING SPECIALIST

WELDING PROCEDURE SPECIFICATION (WPS)

Company Name DYNACORP FABRICATORS INC.
 WPS No. WOM-2 Revision No. 4 Date December 19, 2014
 Supporting PQR No. (s) WOM-2-3, DYN-10-4, DYN-10-7
 Welding Process (es) SMAW Type (s) Manual

JOINTS (QW-402)

Joint Design All ASME joint designs, reference construction drawing for joint details. Where joint details are not specified, refer to typical joint detail sheet attached.
 Backing With or without (Permanent backing strip may only be used with design approval).
 Backing material (Type) Qualified base metal / weld metal.
 Root Spacing 0 - 0.250 in.
 Retainers Not allowed

BASE METALS (QW-403)

	Normal Appl.	Notch Toughness Appl.
Base Metal P-No., Group No.	P-No. 1 to P-No. 1	P-No. 1, Grp. 1/2 to P-No. 1, Grp. 1/2
Base metal thickness	Groove Weld	0.062 to 8.00 in.
	Fillet Weld	All base metal thickness
Maximum Thickness per Pass	0.375 in.	0.188 in.

FILLER METALS (QW-404)

Specification No. (SFA) 5.1 5.1
 AWS No. (Class) Normal Appl.: E6010 E7018, E7018-1
Notch Toughness Appl.: E6010 (root pass only) E7018-1
 F-No. F-No. 3 F-No. 4
 A-No. A-No. 1 A-No. 1
 Size of Filler Metal 3/32 to 5/32 in. 3/32 to 1/4 in.
 Weld Metal Deposited Thickness
 Groove 0.250 in. maximum 8.00 maximum
 Fillet All Fillet size All Fillet size

POSITIONS (QW-405)

Position(s) of Groove All Positions Position(s) of Fillet All Positions
 Welding Progression F-No. 3: Uphill or downhill F-No. 4: Uphill

PREHEAT (QW-406)

Minimum Preheat Temperature 50 °F. If base metal and/or ambient temperatures below 32 °F, the weld joint and adjacent areas shall be heated to 65 °F, prior to the start of welding.
 Interpass Temperature Normal Appl.: 50 - 600 °F Notch Toughness Appl.: 50 - 450 °F
If welding is interrupted, the weld joint and adjacent areas shall be reheated the minimum preheat temperature.
 Preheat Maintenance Not required

Note Preheating temperatures, Interpass temperature and preheat maintenance to be used may be superseded but not outside the range specified. Ensure temperatures are adequate per job specification and code of constructions.

POSTWELD HEAT TREATMENT (QW-407)

P.W.H.T. PWHT below the lower transformation temperature of base metal being welded.
 Temperature Range Typically 1100 - 1200 °F
 Time Range Normal Appl.: No maximum limit Notch Toughness Appl.: See table below

Base Metal Thickness (in.)	Maximum PWHT time for Notch Toughness Appl.
0.118 ≤ T < 0.625	9.375 hours maximum
0.625 ≤ T ≤ 8.00	11.25 hours maximum

Note Reference to relevant construction code/standard/specification for supplementary restriction.

ELECTRICAL CHARACTERISTICS (QW-409)

Current Direct current (DC) Polarity Reverse - electrode positive (EP)
 Maximum Heat Input Normal Appl.: N/A Notch Toughness Appl.: See table below

Base Metal Thickness (in.)	E6010 (J/in.)	E7018-1 (J/in.)
0.118 ≤ T < 0.625	60,000	42,429
0.625 ≤ T ≤ 8.00	60,000	77,214

Typical Welding Parameters ^{(1) (2)}

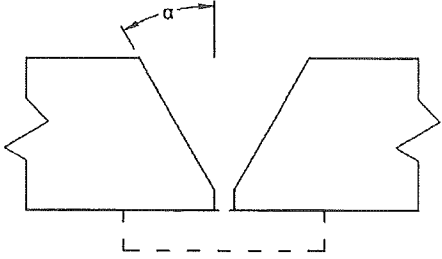
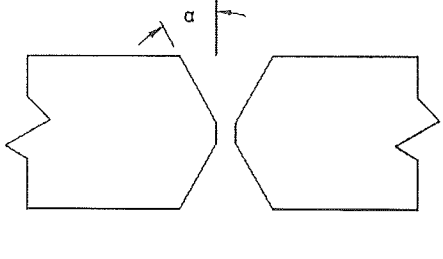
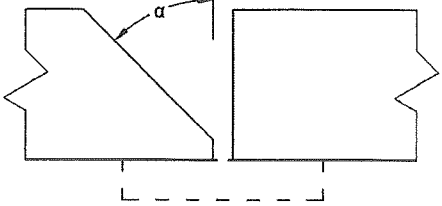
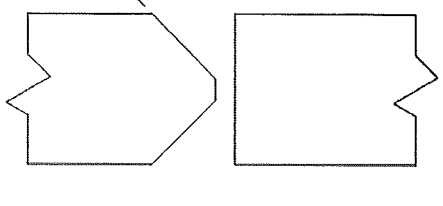
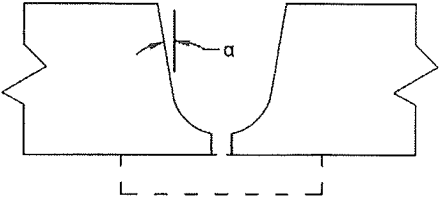
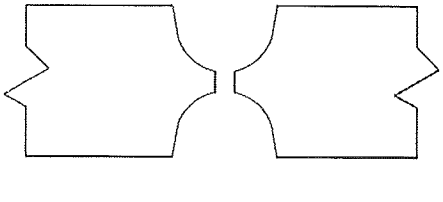
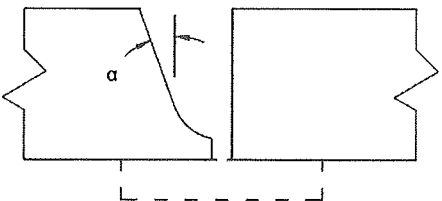
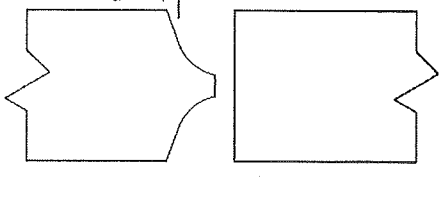
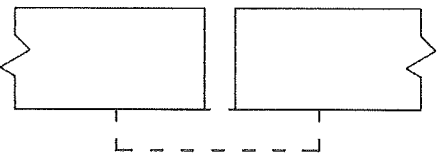
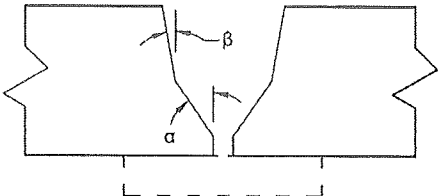
Process	Filler Metal		Current		Volts	Travel Speed (in./min.)
	Classification ⁽³⁾	Size (in.)	Type & Polarity	Amps		
SMAW	E6010	3/32	DCEP	40 - 80	18 - 28	1.0 - 12
SMAW	E6010	1/8	DCEP	70 - 130	19 - 30	1.5 - 14
SMAW	E6010	5/32	DCEP	90 - 165	21 - 31	2.0 - 16
SMAW	E7018/E7018-1	3/32	DCEP	50 - 120	18 - 26	1.0 - 12
SMAW	E7018/E7018-1	1/8	DCEP	80 - 150	19 - 28	1.5 - 15
SMAW	E7018/E7018-1	5/32	DCEP	100 - 200	20 - 30	3.0 - 16
SMAW	E7018/E7018-1	3/16	DCEP	150 - 270	22 - 31	4.0 - 18
SMAW	E7018/E7018-1	1/4	DCEP	215 - 360	23 - 32	5.0 - 20

Note: ⁽¹⁾ Welding parameters will vary with position, joint configuration, consumable brand, etc. Welding consumable manufacturer's recommendations should be followed.
⁽²⁾ Notch Toughness Appl.: Combination of welding parameters shall be adjusted to insure that the specified maximum heat input is not exceeded.
⁽³⁾ Notch Toughness Appl.: F-No. 3 electrodes to be limited to root pass only, F-No. 4 electrodes to be limited to E7018-1 only.

TECHNIQUE (QW-410)

String or Weave Bead F-No. 3: String F-No. 4: Either
 Initial and Interpass Cleaning Mechanical - grinding, power brush, chipping, etc.
 Method of Back Gouging Grinding or air carbon arc, etc., if required. Grind to clean metal where thermal process is used.
 Multiple or Single Pass per Side Normal Appl.: Either Notch Toughness Appl.: Multiple
 Peening Not allowed
 Use of Thermal Processes for P-No. 11A & P-No. 11B Base Metal N/A

TYPICAL JOINT DESIGNS

 <p>$\alpha = 30^\circ, \pm 7.5^\circ$ Single V Groove</p>	 <p>$\alpha = 30^\circ, \pm 7.5^\circ$ Double V Groove</p>
 <p>$\alpha = 45^\circ, \pm 10^\circ$ Single Bevel Groove</p>	 <p>$\alpha = 45^\circ, \pm 10^\circ$ Double Bevel Groove</p>
 <p>$\alpha = 10^\circ, +20^\circ / -5^\circ$ Single U Groove</p>	 <p>$\alpha = 10^\circ, +20^\circ / -5^\circ$ Double U Groove</p>
 <p>$\alpha = 20^\circ, +10^\circ / -5^\circ$ Single J Groove</p>	 <p>$\alpha = 20^\circ, +10^\circ / -5^\circ$ Double J Groove</p>
 <p>Square Groove</p>	 <p>$\alpha = 35^\circ, \pm 5^\circ$ $\beta = 10^\circ, +20^\circ / -5^\circ$ Modified Single V Groove</p>

Note: Permanent backing strip may only be used with design approval. Retainer is not allowed.

QW-483 WELDING PROCEDURE RECORD (PQR)

Dynacorp Fabricators Inc.

Procedure Qualification Record No. WOM-2-3 Date October 2, 2012
Welding Procedure Specification No. WOM-2 (Rev. 3)
Welding Process(es) SMAW Type(s) Manual

JOINTS (QW-402)

Type Butt joint, single vee groove, see next page

BASE METALS (QW-403)

Material Spec. SA 333 to SA 350 Type or Grade Gr. 6 to Gr. LF2
P-No. P1 Grp.1 To P-No. P1 Grp.2 Thickness 6.02 mm (0.237 in.)
Diameter 114.3 mm (4.50 in.) O.D. Other Schedule 40
Heat No. 117100 to 11/36089
Deposited Weld Metal (Per pass) Did not exceed 12.7 mm (0.500 in.)

FILLER METALS (QW-404)

Specification No. (SFA) SFA 5.1 SFA 5.1
AWS No. (Class) E6010 E7018-1
Filler Metal F-No. F3 F4
Filler Metal A-No. A1 A1
Size of Electrode See attached sketch
Deposited Weld Metal Thickness 2.39 mm (0.094 in.) 3.65 mm (0.143 in.)
Trade Name Lincoln Fleetweld 5P+ Air Liquide Blueshield LA 18 Plus

POSITION (QW-405)

Position of Groove 5G
Weld Progression Vertical Up

PREHEAT (QW-406)

Preheat Temperature 10°C (50°F) Interpass Temp. (Max.) 232°C (450°F)

POSTWELD HEAT TREATMENT (QW-407)

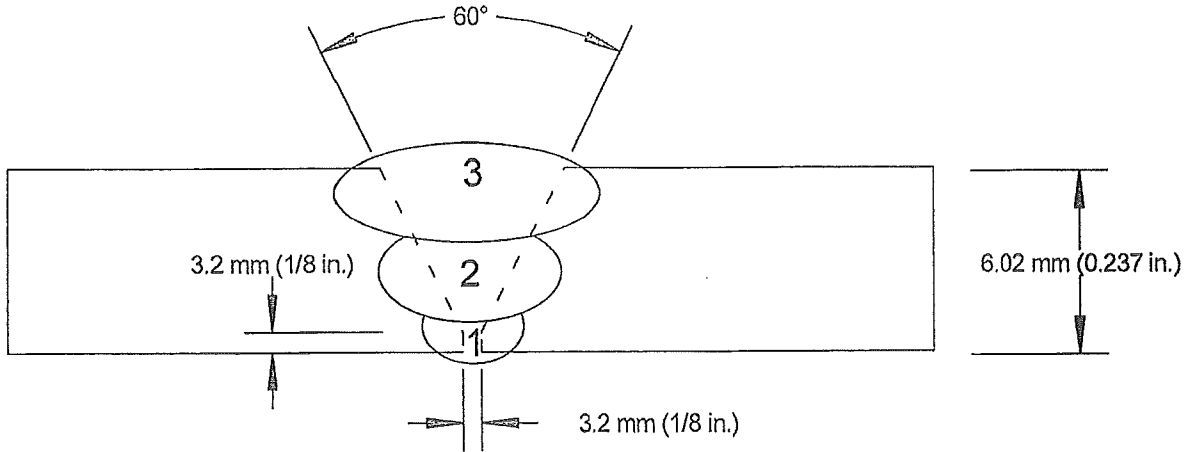
Temperature 621°C (1150°F) Time 7.5 hours

ELECTRICAL CHARACTERISTICS (QW-409)

Current Direct Polarity Reverse, electrode positive
Amps See next page Volts See next page
Heat Input F3: 2.94 kJ/mm (74,571 J/in.) max. F4: 1.67 kJ/mm (42,429 J/ in.) max.

TECHNIQUE (QW-410)

String or Weave F3: String F4: Weave Travel Speed See next page
Initial & Interpass Cleaning Brushing, chipping or grinding to remove slag
Method of Back Gouging Not used Multiple or Single Pass Per Side Multiple
Multiple or Single Electrodes Single Electrode Spacing N/A
Use of Thermal Processes N/A Peening None



Pass	Process	Filler Metal	Diameter mm (in.)	Current & Polarity	Amperage Range	Voltage Range	Travel Speed mm/min (i.p.m.)
1	SMAW	E6010	3.2 (1/8)	DCRP	85 - 95	28 - 30	53 (2.1)
2	SMAW	E7018-1	2.4 (3/32)	DCRP	85 - 95	21 - 23	104 (4.1)
3	SMAW	E7018-1	2.4 (3/32)	DCRP	85 - 95	21 - 23	71 (2.8)

TENSILE TEST (QW-150)

Specimen No.	Width mm (in.)	Thickness mm (in.)	Area Sq. mm (Sq. in.)	Ultimate Load N (lbs.)	Ultimate Stress MPa (psi)	Character & Fracture Location
T1	19.1 (0.752)	4.13 (0.163)	78.9 (0.122)	39 200 (8,810)	497 (72,100)	Partial Cup & Cone Parent Metal (Gr. 6)
T2	19.1 (0.752)	3.92 (0.154)	74.9 (0.116)	37 122 (8,350)	496 (71,900)	Partial Cup & Cone Parent Metal (Gr. 6)

GUIDED BEND TEST (QW-160)

Type & Figure No.	Result	Type & Figure No.	Result
QW-462.3a, TRB - R1	Pass	QW-462.3a, TFB - F1	Pass
QW-462.3a, TRB - R2	Pass	QW-462.3a, TFB - F2	Pass

CHARPY IMPACT TOUGHNESS

Type of Test Charpy V Notch Orientation Transverse
 Test Temperature -46°C (-50°F) Specimen Size 10 x 5 mm (0.394 x 0.197 in.)

Specimen No.	Notch Location	Impact Values J (ft. lbs)
A2.1	Weld Metal	13.0 (9.6)
A2.2	within 1/16 in.	36.3 (26.8)
A2.3	of root	13.6 (10.0)
A3.1	Gr. 6 - HAZ	27.7 (20.4)
A3.2	Gr. 6 - HAZ	44.3 (32.8)
A3.3	Gr. 6 - HAZ	27.1 (20.0)
B3.1	Gr. LF2 - HAZ	61.3 (45.2)
B3.2	Gr. LF2 - HAZ	19.5 (14.4)
B3.3	Gr. LF2 - HAZ	40.1 (29.6)

OTHER TESTS

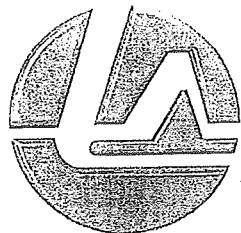
Vicker's Hardness - see attached laboratory test report # C12-1494.2

Welders Name Eli Copeland Certificate File No. W-13917
 Tests Conducted By Ludwig Associates Ltd.
 Laboratory Test No. C12-1494.2

We certify the statements in this record are correct and that the test welds were prepared, welded and tested in accordance with the requirements of Section IX of the ASME Code.

Manufacturer DYNACORP FABRICATORS INC.

Date 22 Oct 12 Certified by [Signature]



LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: Dynacorp Fabricators Inc.
5152 – 74th Avenue S.E.
Calgary, Alberta
T2C 3C9

Laboratory Test No.: C12-1494.2
Date: October 12, 2012
P.O. No.: 6P17902

Attention: Lorne Peers

PQR Number: WOM-2-3
Material: SA 333 Gr. 6 to SA 350 Gr. LF2 (Heat No.: 117100 to 11/36089)
Size: 114.3 mm (4.50 in.) O.D. x 6.02 mm (0.237 in.) w.t.
Thermal Condition: PWHT @ 621°C (1150°F) for 450 minutes

TENSILE TEST QW-150


SAMPLE NUMBER	T1 QW-462.1(b)	T2 QW-462.1(b)
WIDTH mm (in)	19.1 (0.752)	19.1 (0.752)
THICKNESS mm (in)	4.13 (0.163)	3.92 (0.154)
AREA sq mm (sq in)	78.9 (0.122)	74.9 (0.116)
ULT. LOAD N (lbf)	39 200 (8,810)	37 122 (8,350)
UTS MPa (psi)	497 (72,100)	496 (71,900)
FRACTURE TYPE	Partial Cup & Cone	Partial Cup & Cone
FRACTURE LOCATION	Parent Metal (SA 333 Gr. 6)	Parent Metal (SA 333 Gr. 6)

GUIDED-BEND TEST QW-160

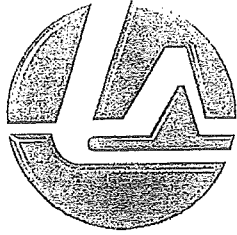
SAMPLE WIDTH:	19.1 mm (0.750 in.)	SAMPLE THICKNESS:	6.02 mm (0.237 in.)
PLUNGER SIZE:	19.1 mm (0.750 in.)	YOKE SIZE:	39.4 mm (1.55 in.)
QW-462.3(a)	Root Bend	Root Bend	Face Bend
SAMPLE NUMBER(S)	R1	R2	F1
RESULTS	Pass	Pass	Pass

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section IX, 2010 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. Samples associated with this report will be discarded in 45 days.

Laboratory Test Conducted By: _____


Michelle Marien, T.T. / Steve Rieberger, C.E.T.





LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: Dynacorp Fabricators Inc.
5152 – 74th Avenue S.E.
Calgary, Alberta
T2C 3C9

Laboratory Test No.: C12-1494.2
Date: October 11, 2012
P.O. No.: 6P17902

Attention: Lorne Peers

PQR Number: WOM-2-3
Material: SA 333 Gr. 6 to SA 350 Gr. LF2 (Heat No.: 117100 to 11/36089)
Size: 114.3 mm (4.50 in.) O.D. x 6.02 mm (0.237 in.) w.t.
Thermal Condition: PWHT @ 621°C (1150°F) for 450 minutes

CHARPY V-NOTCH IMPACT TEST

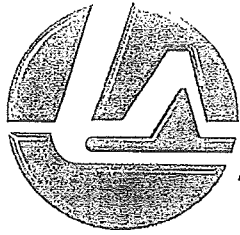
Machine: Satec, SI-1C SN:1363 **Specimen Size:** 10 x 5 mm (0.394 x 0.197 in.)
Capacity: 325 J (240 ft-lbf) **Orientation:** Transverse
Verified Range: 1.7 - 141.3 J (1.3 - 104.2 ft-lbf) **Test Temp.:** -46°C (-50°F)

Specimen Number	Notch Location	Impact Values	
		Joules	(ft-lbf)
A2.1	Weld Metal within 1/16 in. of root	13.0	(9.6)
A2.2		36.3	(26.8)
A2.3		13.6	(10.0)
A3.1	Gr. 6 - HAZ	27.7	(20.4)
A3.2		44.3	(32.8)
A3.3		27.1	(20.0)
B3.1	Gr. LF2 - HAZ	61.3	(45.2)
B3.2		19.5	(14.4)
B3.3		40.1	(29.6)

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section VIII, Div. 1, UG-84 – 2010 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. **Samples associated with this report will be discarded in 45 days.**

Laboratory Test Conducted By: 
Xin (Vincent) Su, T.T. / Steve Rieberger, C.E.T.





LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: Dynacorp Fabricators Inc.
5152 - 74th Avenue S.E.
Calgary, Alberta
T2C 3C9

Laboratory Test No.: C12-1494.2
Date: October 15, 2012
P.O. No.: 6P17902

Attention: Lorne Peers

PQR Number: WOM-2-3

Material: SA 333 Gr. 6 to SA 350 Gr. LF2 (Heat No.: 117100 to 11/36089)

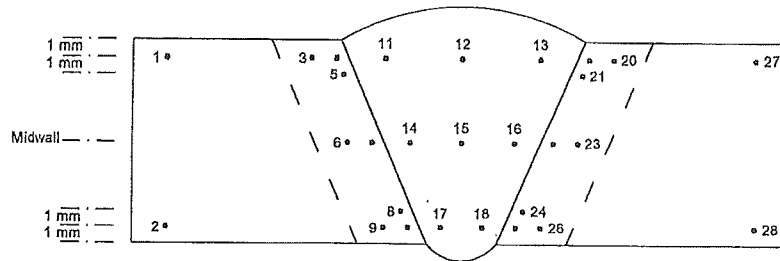
Size: 114.3 mm (4.50 in.) O.D. x 6.02 mm (0.237 in.) w.t.

Thermal Condition: PWHT @ 621°C (1150°F) for 450 minutes

HARDNESS TEST

Type of Test: Vickers 10 kg (HV10)

Instrument: Mitutoyo Macroickers 5112

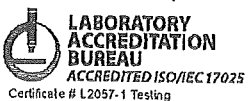


SA 350 Gr. LF2				Weld Metal		SA 333 Gr. 6			
Parent Metal		HAZ				HAZ		Parent Metal	
1	155	3	153	11	174	19	172	27	150
2	156	4	166	12	166	20	156	28	149
		5	164	13	173	21	165		
		6	155	14	162	22	159		
		7	162	15	160	23	153		
		8	164	16	152	24	162		
		9	158	17	161	25	149		
		10	184	18	156	26	156		

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASTM E384-10² and ANSI/NACE MR0175/ISO 15156-2:2009(E). The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. **Samples associated with this report will be discarded in 45 days.**

Laboratory Test Conducted By: _____


Michelle Marien, T.T. / Steve Rieberger, C.E.T.





STAZ/PAGGIO A CALDO DI ACCIAI COMUNI - LEGATI E INOSSIDABILI

SALA PROVE E ANALISI MATERIALI / MATERIAL TEST DEPARTMENT

SEDE AMMINISTRATIVA E STABILIMENTO:
23851 CESANA BRIANZA (LC) - Italy
Via G. Parini, 28
Tel. +39 031.655441
Fax +39 031.655149
quality.mff@farmas.com

COMPANY WITH QUALITY MANAGEMENT
SYSTEM CERTIFIED BY DNV
= ISO 9001:2008 =

CERTIFICATO DI COLLAUDO SECONDO EN 10204 - 3.1 INSPECTION CERTIFICATE

Certif. N. 1139	Del/Dated 07.03.2012	Fattura / Invoice N. 122	Del/Dated 16.01.2012
DDT / Del Note N. 158	Del/Dated 16.01.2012	Ns.Ord. / Our ref. N.	Del/Dated
FORGED FLANGES & FITTINGS LTD		Dest.: F.F.F. C/O MIDLAND FITTINGS LTD	
CASTLE HOUSE - STATION ROAD EN5 1PE NEW BARNET/HERTFORD... GB		UNIT 5, STATION ROAD INDUSTRIAL ESTATE B65 0JY ROWLEY REGIS, WEST M... GB	

4890902-00

Pag. 1 - 1

COD. COL. COLATA POS. VS.ORDINE	HEAT CODE HEAT ITEM YOUR REFERENCE	Q.TA' Q.TY DESCRIPTION	7586867														DIM.IN ACC. A DIM. ACCORDANCE TO ASME/ANSI B16.5-2009	VISIVO E DIMENS. VIS. & DIMENS. SATISFACTORY			
11/36089	105	3801	148,00	W/N 300 RF 4" STD	LF2CL1																
MATERIALE / MATERIAL		ASTM A350 LF2 CL1/2		C%	Si%	Mn%	S%	P%	Cr%	Ni%	Mo%	Ti%	Cu%	V%	Nb%	N%	Al%	C.E.%			
				0,200	0,220	1,050	0,008	0,010	0,080	0,050	0,010	0,014	0,150	0,000	0,000	0,000	0,025	0,405			
PROVETTA / TEST SPECIMEN		FORMA SHAPE		SNERVAMENTO YIELD POINT		ROTTURA TENSILE STRENGTH		ALLUNGAMENTO ELONGATION		CONTRAZIONE REDUCTION OF AREA		DUREZZA HARDNESS		RESILLENZA / IMPACT TEST - JOULE/cm2				SNERVAMENTO YIELD POINT		No. RI. OUR REF.	
SEZ. mm2 LUNG. mm		1=O 2=□		N/mm2 >=0,2%		N/mm2		%20%		%70%		HBW		TPO / TYPE 10x10mm °C				N/mm2 >=1,0%			
126,60 50,80		1		345,0		543,0		30,0		60,0		164,0 / 166,0		-50 1 64 2 64 3 70				0,0			
MATERIALE IN ACCORDO A / MATERIAL IN ACC. TO		ASTM/ASME A 350/SA 350 M - 11 ASME CODE SECT. II, PART A, ED. 2010		TRATTAMENTO TERMICO / HEAT TREATMENT		NORMALIZED AT 930 C - COOLED IN STILL AIR		FORNO / FURNACE		ELECTRIC FURNACE		ORIGINE / ORIGIN		EUROPE							

47.2 47.2 51.6

LUDWIG:
Wom2 Rev2
TEST COUPON

MATERIAL ACCEPTED
Code Edition used for verification: 2A Addenda: Zolla
Date: Oct 2/12
CKD

NOTE LF2: CHARPY TEST SPECIMEN RESULT AS 10X10mm NOTES MATERIAL IN ACCORDANCE WITH NACE MR-0175/2003 ISO 15156-2009	UFFICIO CONTROLLO QUALITA' QUALITY CONTROL DEPARTEMENT	ENTE UFFICIALE DI COLLAUDO INSPECTION AUTHORITY	MARCHIO PRODUZIONE MANUFACTURER'S SYMBOL
	<i>S. Corti</i> <i>Carlo Sergio</i>		

Welding Procedure Specification FC1
Flux Core Arc Welding

National Process Equipment
#5, 3401 – 19 Street N.E.
Calgary, Alberta T2E 6S8

WELDING PROCEDURE SPECIFICATION FC1
Flux Core Arc Welding (FCAW)

1. **SCOPE**


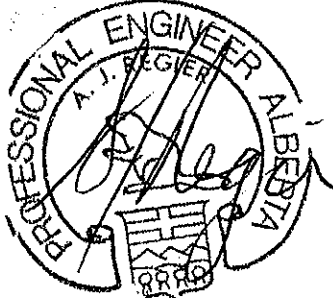
This welding procedure specification covers welding and related operations in accordance with CSA Standard W59, latest edition and CSA Standard W47.1., latest edition.

A change in any of the essential variables contained in the succeeding paragraphs or detailed on applicable Welding Procedure Data Sheets will require a new Welding Procedure Specification and/or new or revised Data Sheets.

2. **WELDING PROCEDURE**

The welding shall be done semi-automatically using a Flux Cored Arc Welding process.

The joints shall be made by single or multiple passes from one or both sides as specified on the welding procedure data sheets.

CWB APPROVAL	ENGINEERS STAMP
<p>CWB Accepted</p> <p></p> <p>Sep 15, 2006</p> <p>PAGE 1 TO 6</p>	<p></p>

Welding Procedure Specification FC1
Flux Core Arc Welding

3. **BASE METAL**

The base metal shall conform to the specifications for Groups 1, 2 & 3 steel as shown in Table 11.1 and 12.1 of CSA W59

4. **BASE METAL THICKNESS**

Base metal thickness from 3.2mm (1/8") to unlimited thickness may be welded under this specification.

5. **FILLER METAL**

The filler metal shall be certified by the CWB as conforming to CSA Standard W48.5 "Mild Steel Electrodes for Flux Core Arc Welding".

6. **SHIELDING GAS**

The shielding gas shall conform to the following nominal composition: 100% Carbon dioxide or a mixture of Argon and Carbon dioxide and with a dew point of – 40 °F or lower with a flow rate of 40 CF/hr. The gas/electrode combination shall be certified by the Canadian Welding Bureau.

7. **POSITION**

The welding shall be done preferably in the flat position; however other positions such as horizontal, vertical and overhead are permissible providing the appropriate data sheets are supplied and approved.

8. **PREHEAT AND INTERPASS TEMPERATURE**

Preheat prior to welding is to be as per Table 5.3 CSA W59.1. Welding to be done with sufficient speed such that the minimum preheat is maintained or exceeded.

If welding is interrupted so that the temperature of the base metal falls below the minimum preheat temperatures then the joint shall be reheated to the recommended temperature prior to recommencing welding.

The completed weld shall be allowed to cool to the ambient temperature without external quench media being applied.

Welding Procedure Specification FC1
Flux Core Arc Welding

9. **HEAT TREATMENT AND STRESS RELIEVING**

Heat treatment and stress relieving are normally not applicable to structures welded under this specification.

10. **ELECTRICAL CHARACTERISTICS**

The power source shall be of the constant voltage type

The welding current shall be DCEP

11. **WELDING TECHNIQUE**

- a) The maximum tolerances on amperage listed on the procedure data sheet referring to this specification shall be $\pm 10\%$.
- b) The maximum tolerance on voltage listed on the procedure sheets referring to this specification shall be $\pm 7\%$.
- c) The maximum thickness of layers shall be 6 mm.
- d) The maximum single-pass fillet weld size shall be 12 mm for the flat position, 10 mm for the horizontal position and 8 mm for the overhead position.
- e) The maximum thickness of layers shall be 6 mm for all passed of groove welds. When the root opening of a groove weld is 12 mm or greater, a multiple pass split-layer technique shall be used with the exception of the finishing weld layers. The split-layer technique shall also be used in making all multiple pass welds when the width of the layer exceeds 22 mm.
- f) Welding shall be done in the following manner:

The welding power source shall be set at the proper amperage and voltage as indicated on the approved weld procedure data sheet pertaining to the proper joint configuration and position. The wire shall be cut to the proper stick-out length and the shielding gas flow set as per the approved welding procedure data sheet.

The electrode angle should be as shown below in Figure 11. With groove Welds the electrode should be perpendicular to the sides of the joint and Slanted from 2° to 15° in the direction of travel. The leading angle results in

Welding Procedure Specification FC1
Flux Core Arc Welding

"lagging" gas shield with much of the gas flowing back over the nearly deposited weld metal. With a fillet weld, the electrode should be dropped off centre of the joint approximately half the diameter of the electrode as shown in the figure, and a leading angle of 2° to 15° used.

A travel speed of between 300 mm per minute to 750 mm per minute should be used, as indicated on the approved weld procedure data sheet. A nozzle-to-the-work distance of between 12mm to 20mm should be used.

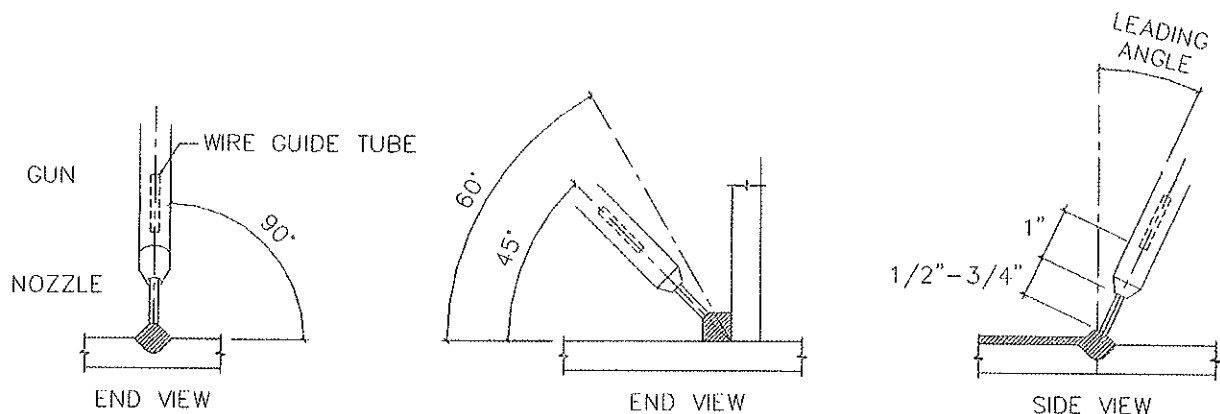


FIGURE 11

12. PREPARATION OF BASE MATERIAL

The edges or surfaces of the parts to be joined by welding shall be prepared by shearing, grinding, chipping, machining, air-carbon-arc or oxygen cutting or gouging. Surfaces and edges to be welded shall be smooth, uniform, and free from fins, tears, cracks, or other defects that would adversely affect the quality or strength of the weld. Surfaces to be welded shall also be free, within 50 mm of any

Welding Procedure Specification FC1
Flux Core Arc Welding

weld location, from loose or thick scale (except for tightly adhering islands of scale) slag, rust, paint, grease, moisture and all other foreign material that will prevent proper welding or produce objectionable fumes.

13. **QUALITY**

Cracks or blowholes that appear on the surface of any pass shall be removed before depositing the next covering pass. The procedure and technique shall be such that undercutting the base metal or adjacent passes is minimized.

All welds subject to visual inspection only shall be acceptable if visual inspection shows:

1. no surface cracks, craters or lack of fusion between the weld metal and base material.
2. weld profiles in accordance with Clause 5.9, CSA W59.
3. that, in statically loaded structures, the sum of the diameters of visible porosity does not exceed 10 mm in any 25 mm length of weld and does not exceed 20 mm in any 300 mm length of weld
4. that undercut does not exceed the values of Table 11.4, CSA W59.
5. that, in dynamically loaded structures, the frequency of visible porosity in fillet welds does not exceed one in each 100 mm of length and the maximum diameter does not exceed 2.5 mm; that groove welds have no visible porosity; that undercut does not exceed 0.25 mm deep in when the direction is transverse to the primary stress in the part that is under, or 1 mm deep when its direction is parallel to the primary stress in the part that is undercut.
6. Welds subject to non-destructive examination must meet the requirements of Clauses 11.5.4.3 to 11.5.4.6 inclusive, CSA W59, as applicable, for dynamically loaded structures and Clauses 12.5.4.3 to 12.5.4.6 inclusive, CSA W59, as applicable, for dynamically loaded structures.

14. **WELD METAL CLEANING**

Slag or flux remaining after a pass shall be removed before applying the next covering pass and from all finished welds. All tack welds shall be cleaned of slag

Welding Procedure Specification FC1
Flux Core Arc Welding

before welding of a covering pass.

15. **TREATMENT OF UNDERSIDE OF WELDING GROOVE**

Prior to depositing weld metal on the underside of a welding groove, the root shall be backgouged, to sound metal unless otherwise specified on the applicable data sheet.

Back-gouging shall produce a groove contour substantially conforming to the pre-qualified single U-joint, and its depth shall be adequate to ensure complete penetration into the previously deposited weld metal for the welding process being used. Machining, air carbon-arc or oxygen gouging, chipping, or grinding may be used for back gouging or the removal of defective work or material.

16. **DATA SHEETS**

The welding procedure data sheets attached referenced as Welding Procedure Specification No FC1 form an integral part of this specification.



WELDING PROCEDURE DATA SHEET

CWB Form 180E/91-9

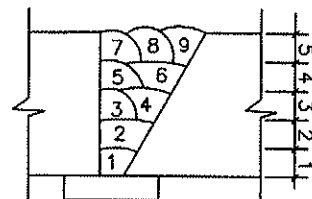
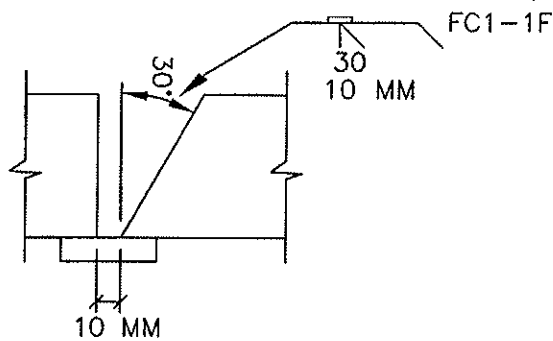
No. **FC1-1F**

DATE **08 21 06**
MONTH DAY YEAR

W47.1

Company Name NATIONAL PROCESS EQUIPMENT		Wldg. Procedure Specification No. FC1
Address #5, 3401 - 19 STREET N.E., CALGARY, ALBERTA, T2E 6S8		Applicable Standards W47.1 & W59
Welding Process <input checked="" type="checkbox"/> Shielded Metal Arc (SMAW) <input type="checkbox"/> Gas Metal Arc (GMAW) <input type="checkbox"/> Gas Tungsten Arc (GTAW) <input checked="" type="checkbox"/> Flux-Core Arc (FCAW) <input type="checkbox"/> Submerged Arc (SAW) <input type="checkbox"/> Other	Filler Metal Classification E491T-9M-H8 Shielding Gas or Flux 75%AR, 25%CO2	
Process Mode <input type="checkbox"/> Manual <input type="checkbox"/> Machine <input checked="" type="checkbox"/> Semi-Automatic <input type="checkbox"/> Automatic	Tungsten Type	Preheat Temp. Table 5.3
Material Designation Steel in Groups 1,2 or 3 Table 11-1 & 12-1 W59 EXCEPT WEATHERING STEELS	Tungsten Size	Min. Interpass Temp. _____
	Welding Position FLAT	Max. Interpass Temp. _____

(Show Welding Symbol with Data Sheet No. in tail)



SKETCH OF TYPICAL JOINT PREPARATION

TYPICAL PASS AND LAYER SEQUENCE

COMPLETE JOINT PENETRATION GROOVE WELD <input type="checkbox"/> Back-gouge to sound metal <input type="checkbox"/> Welded both sides without backing <input checked="" type="checkbox"/> Welded onto steel backing <input type="checkbox"/> Welded onto other than steel backing <input type="checkbox"/> Welded from one side without backing		<input type="checkbox"/> Partial Joint Penetration Groove Weld (Specify Effective Throat) <input type="checkbox"/> Fillet Weld	JOINT TYPE <input checked="" type="checkbox"/> BUTT <input type="checkbox"/> TEE <input type="checkbox"/> CORNER <input type="checkbox"/> EDGE <input type="checkbox"/> LAP
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Mat'l Thk.	Weld Size/ETT	Side No.	Layer	Pass Number	Filler Metal Size	Current Polarity	Amperes	Automatic, Semi-Automatic or Machine		
								Electrical Stickout 25	Shielding Gas Flow rate 30 CFH	Arc Travel Speed
								Wire Feed Speed	Volts	
10	10	1	1-2	1-2	1.2	DCEP	270	184	28	2.4
12	12	1	1-3	1-4	1.2	DCEP	270	184	28	3.9
16	16	1	1-4	1-6	1.2	DCEP	270	184	28	4.0
20	20	1	1-4	1-6	1.2	DCEP	270	184	28	3.0
22	22	1	1-5	1-9	1.2	DCEP	270	184	28	3.9
25	23	1	1-5	1-9	1.2	DCEP	270	184	28	3.3
								mm/sec		mm/sec

Revision	Date	Initials	Explanation	CWB Approval	* Engineer's Seal
			PREQUALIFIED F4-2		

* Division 1 or 2 Companies: Engineers seal and signature. For Division 3 Companies; Name and signature of Welding Supervisor

"QUALITY THROUGH CERTIFICATION"

FC1-1F



WELDING PROCEDURE DATA SHEET

CWB Form 180E/91-9

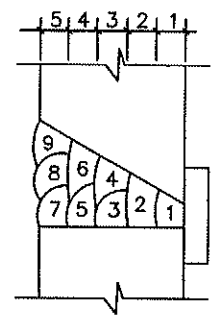
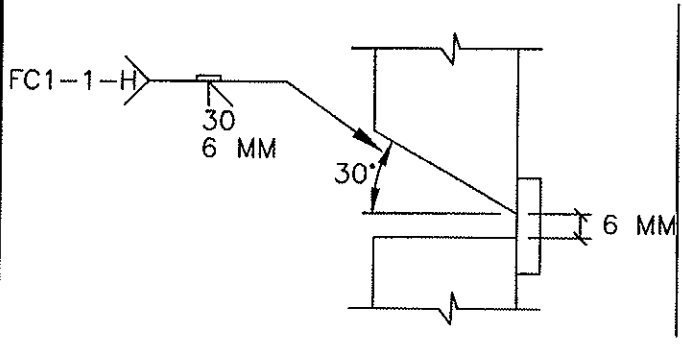
No. **FC1-1-H**

DATE **08/21/06**
MONTH DAY YEAR

W47.1

Company Name NATIONAL PROCESS EQUIPMENT		Wldg. Procedure Specification No. FC1
Address #5, 3401 - 19 STREET N.E., CALGARY, ALBERTA, T2E 6S8		Applicable Standards W47.1 & W59
Welding Process <input checked="" type="checkbox"/> Shielded Metal Arc (SMAW) <input type="checkbox"/> Gas Metal Arc (GMAW) <input type="checkbox"/> Gas Tungsten Arc (GTAW) <input checked="" type="checkbox"/> Flux-Core Arc (FCAW) <input type="checkbox"/> Submerged Arc (SAW) <input type="checkbox"/> Other	Filler Metal Classification E491T-9M-H8	
Process Mode <input type="checkbox"/> Manual <input type="checkbox"/> Machine <input checked="" type="checkbox"/> Semi-Automatic <input type="checkbox"/> Automatic	Tungsten Type	Shielding Gas or Flux 75%AR, 25%CO2
Material Designation Steel in Groups 1,2 or 3 Table 11-1 & 12-1 W59 EXCEPT WEATHERING STEELS	Tungsten Size	Preheat Temp. Table 5.3
	Welding Position HORIZONTAL	Min. Interpass Temp. _____
		Max. Interpass Temp. _____

(Show Welding Symbol with Data Sheet No. in tail)



SKETCH OF TYPICAL JOINT PREPARATION

TYPICAL PASS AND LAYER SEQUENCE

COMPLETE JOINT PENETRATION GROOVE WELD		<input type="checkbox"/> Partial Joint Penetration Groove Weld (Specify Effective Throat) <input type="checkbox"/> Fillet Weld	JOINT TYPE	
<input type="checkbox"/> Back-gouge to sound metal <input checked="" type="checkbox"/> Welded onto steel backing <input type="checkbox"/> Welded from one side without backing	<input type="checkbox"/> Welded both sides without backing <input type="checkbox"/> Welded onto other than steel backing		<input checked="" type="checkbox"/> BUTT <input type="checkbox"/> TEE <input type="checkbox"/> CORNER <input type="checkbox"/> EDGE <input type="checkbox"/> LAP	

Mat'l Thk.	Weld Size/ETT	Side No.	Layer	Pass Number	Filler Metal Size	Current Polarity	Amperes	Automatic, Semi-Automatic or Machine		
								Electrical Stickout 25	Shielding Gas Flow rate 30 CFH	
								Wire Feed Speed	Volts	Arc Travel Speed
10	10	1	1-2	1-2	1.2	DCEP	270	184	28	2.4
12	12	1	1-3	1-4	1.2	DCEP	270	184	28	3.9
16	16	1	1-4	1-6	1.2	DCEP	270	184	28	4.0
20	20	1	1-4	1-6	1.2	DCEP	270	184	28	3.0
22	22	1	1-5	1-9	1.2	DCEP	270	184	28	3.9
25	23	1	1-5	1-9	1.2	DCEP	270	184	28	3.3
								mm/sec		mm/sec

Revision Date <small>MONTH DAY YEAR</small>	Initials	Explanation PREQUALIFIED F4-2	CWB Approval <div style="border: 1px solid black; padding: 5px; text-align: center;"> <p style="font-size: 1.2em; font-weight: bold;">CWB Accepted</p> <p>Sep 15, 2006</p> <p style="font-size: 0.8em;">Valid only if welding consumables are certified by the CWB</p> </div>	* Engineer's Seal
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* Division 1 or 2 Companies: Engineers seal and signature. For Division 3 Companies; Name and signature of Welding Supervisor

"QUALITY THROUGH CERTIFICATION"

FC1-1-H



CANADIAN WELDING BUREAU

WELDING PROCEDURE DATA SHEET

CWB Form 180E/91-9

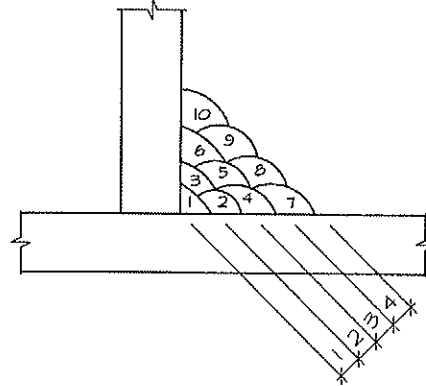
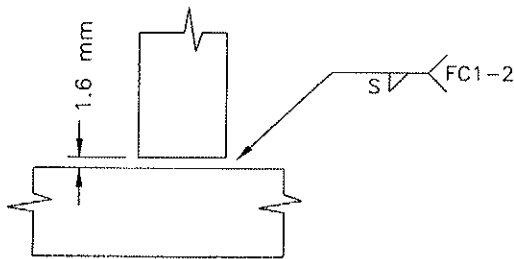
No. FC1-2

DATE 08/21/06
MONTH DAY YEAR

W47.1

Company Name	NATIONAL PROCESS EQUIPMENT		Wldg. Procedure Specification No.	FC1
Address	#5, 3401 - 19 STREET N.E., CALGARY, ALBERTA, T2E 6S8		Applicable Standards	W47.1 & W59
Welding Process	<input checked="" type="checkbox"/> Shielded Metal Arc (SMAW) <input type="checkbox"/> Gas Metal Arc (GMAW) <input type="checkbox"/> Gas Tungsten Arc (GTAW)	<input type="checkbox"/> Flux-Core Arc (FCAW) <input type="checkbox"/> Submerged Arc (SAW) <input type="checkbox"/> Other	Filler Metal Classification	E491T-9M-H8
Process Mode	<input type="checkbox"/> Manual <input type="checkbox"/> Machine	<input checked="" type="checkbox"/> Semi-Automatic <input type="checkbox"/> Automatic	Shielding Gas or Flux	75%AR, 25%CO2
Material Designation	Steel in Groups 1,2 or 3 Table 11-1 & 12-1 W59 EXCEPT WEATHERING STEELS		Preheat Temp.	Table 5.3
	Tungsten Type		Min. Interpass Temp.	
	Tungsten Size		Max. Interpass Temp.	
	Welding Position	HORIZONTAL		

(Show Welding Symbol with Data Sheet No. in tail)



SKETCH OF TYPICAL JOINT PREPARATION

TYPICAL PASS AND LAYER SEQUENCE

<input type="checkbox"/> Back-gouge to sound metal <input checked="" type="checkbox"/> Welded onto steel backing <input type="checkbox"/> Welded from one side without backing		<input type="checkbox"/> Welded both sides without backing <input type="checkbox"/> Welded onto other than steel backing		<input type="checkbox"/> Partial Joint Penetration Groove Weld (Specify Effective Throat) <input checked="" type="checkbox"/> Fillet Weld	JOINT TYPE <input checked="" type="checkbox"/> BUTT <input checked="" type="checkbox"/> TEE <input checked="" type="checkbox"/> CORNER <input type="checkbox"/> EDGE <input type="checkbox"/> LAP
--	--	---	--	--	---

Mat'l Thk.	Weld Size/ETT	Side No.	Layer	Pass Number	Filler Metal Size	Current Polarity	Amperes	Automatic, Semi-Automatic or Machine		
								Electrical Stickout	Shielding Gas Flow rate	Arc Travel Speed
5	5	1	1	1	1.2	DCRP	225	12	40-45 CFH	9.3 mm/sec
6	6	1	1	1	1.2	DCRP	225	110 mm/sec	24	6.5 mm/sec
8	8	1	1-2	1-3	1.2	DCRP	225	110 mm/sec	24	10.8 mm/sec
10	10	1	1-2	1-3	1.2	DCRP	225	110 mm/sec	24	7.0 mm/sec
13	13	1	1-2	1-3	1.2	DCRP	225	110 mm/sec	24	6.2 mm/sec
16	16	1	1-3	1-6	1.2	DCRP	225	110 mm/sec	24	5.3 mm/sec
19	19	1	1-3	1-6	1.2	DCRP	225	110 mm/sec	24	5.3 mm/sec
25	25	1	1-3	1-6	1.2	DCRP	225	110 mm/sec	24	5.3 mm/sec

Revision	Date	Initials	Explanation	CWB Approval	Engineer's Seal
			PREQUALIFIED W59-03 10.4.3.		

* Division 1 or 2 Companies: Engineers seal and signature. For Division 3 Companies; Name and signature of Welding Supervisor

"QUALITY THROUGH CERTIFICATION"

FC1-2



CANADIAN WELDING BUREAU

WELDING PROCEDURE DATA SHEET

CWB Form 180E/91-9

No. FC1-4

DATE 08/21/06 MONTH DAY YEAR

W47.1

Company Name NATIONAL PROCESS EQUIPMENT

Address #5, 3401 - 19 STREET N.E., CALGARY, ALBERTA, T2E 6S8

Welding Process Shielded Metal Arc (SMAW) Flux-Core Arc (FCAW) Gas Metal Arc (GMAW) Submerged Arc (SAW) Gas Tungsten Arc (GTAW) Other

Process Mode Manual Semi-Automatic Machine Automatic Tungsten Type

Material Designation Steel in Groups 1,2 or 3 Table 11-1 & 12-1 W59 EXCEPT WEATHERING STEELS Tungsten Size Welding Position HORIZONTAL

Wldg. Procedure Specification No. FC1

Applicable Standards W47.1 & W59

Filler Metal Classification E491T-9M-H8

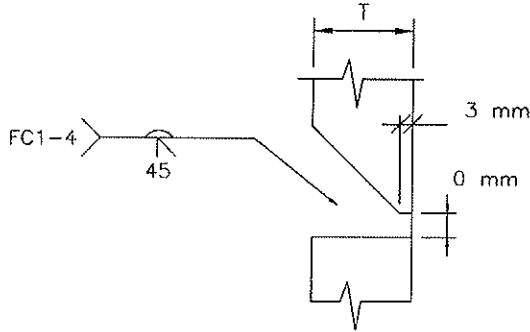
Shielding Gas or Flux 75%AR, 25%CO2

Preheat Temp. Table 5.3

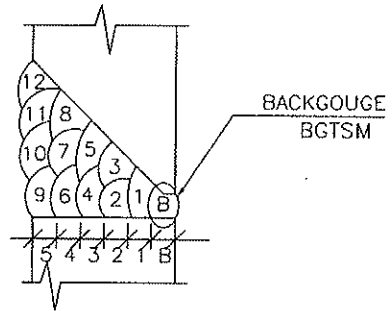
Min. Interpass Temp.

Max. Interpass Temp.

(Show Welding Symbol with Data Sheet No. in tail)



SKETCH OF TYPICAL JOINT PREPARATION



TYPICAL PASS AND LAYER SEQUENCE

COMPLETE JOINT PENETRATION GROOVE WELD

- Back-gouge to sound metal
Welded onto steel backing
Welded from one side without backing
Welded both sides without backing
Welded onto other than steel backing

- Partial Joint Penetration Groove Weld (Specify Effective Throat)
Fillet Weld

- JOINT TYPE
BUTT
CORNER
LAP
TEE
EDGE

Table with 11 columns: Mat'l Thk., Weld Size/ETT, Side No., Layer, Pass Number, Filler Metal Size, Current Polarity, Amperes, Electrical Stickout, Wire Feed Speed, Shielding Gas Flow rate, Volts, Arc Travel Speed.

Revision table with columns: Revision, Date (Month, Day, Year), Initials, Explanation.

Explanation: PREQUALIFIED F4-1P

CWB Approval section containing 'CWB Accepted' logo, date 'Sep 15, 2006', and a note: 'Valid only if welding consumables are certified by the CWB'.

Professional Engineer's Seal for Alberta, featuring a circular logo with 'PROFESSIONAL ENGINEER ALBERTA' and a signature.

* Division 1 or 2 Companies: Engineers seal and signature. For Division 3 Companies; Name and signature of Welding Supervisor



WELDING PROCEDURE DATA SHEET

CWB Form 180E/91-9

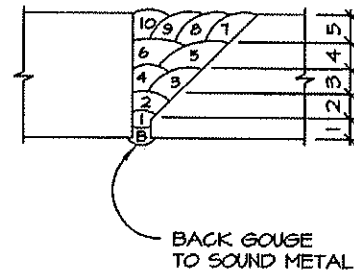
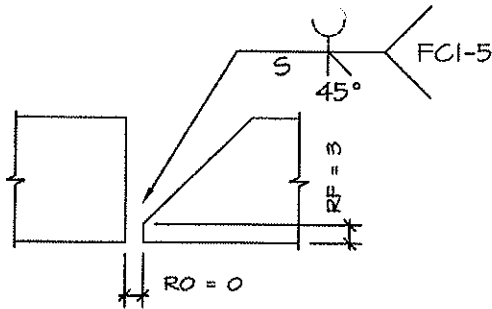
No. **FC1-5**

DATE **082106**
MONTH DAY YEAR

W47.1

Company Name NATIONAL PROCESS EQUIPMENT		Wldg. Procedure Specification No. FC1
Address #5, 3401 - 19 STREET N.E., CALGARY, ALBERTA, T2E 6S8		Applicable Standards W47.1 & W59
Welding Process <input type="checkbox"/> Shielded Metal Arc (SMAW) <input type="checkbox"/> Gas Metal Arc (GMAW) <input type="checkbox"/> Gas Tungsten Arc (GTAW) <input checked="" type="checkbox"/> Flux-Core Arc (FCAW) <input type="checkbox"/> Submerged Arc (SAW) <input type="checkbox"/> Other	Filler Metal Classification E491T-9M-H8	Shielding Gas or Flux 75%AR, 25%CO2
Process Mode <input type="checkbox"/> Manual <input type="checkbox"/> Machine <input checked="" type="checkbox"/> Semi-Automatic <input type="checkbox"/> Automatic	Tungsten Type	Preheat Temp. Table 5.3
Material Designation Steel in Groups 1,2 or 3 Table 11-1 & 12-1 W59 Except Weathering Steels	Tungsten Size	Min. Interpass Temp. _____
	Welding Position FLAT	Max. Interpass Temp. _____

(Show Welding Symbol with Data Sheet No. in tail)



SKETCH OF TYPICAL JOINT PREPARATION

TYPICAL PASS AND LAYER SEQUENCE

COMPLETE JOINT PENETRATION GROOVE WELD <input checked="" type="checkbox"/> Back-gouge to sound metal <input type="checkbox"/> Welded both sides without backing <input type="checkbox"/> Welded onto steel backing <input type="checkbox"/> Welded onto other than steel backing <input type="checkbox"/> Welded from one side without backing		<input type="checkbox"/> Partial Joint Penetration Groove Weld (Specify Effective Throat) <input type="checkbox"/> Fillet Weld	JOINT TYPE <input checked="" type="checkbox"/> BUTT <input type="checkbox"/> TEE <input type="checkbox"/> CORNER <input type="checkbox"/> EDGE <input type="checkbox"/> LAP
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Mat'l Thk. mm	Weld Size/ETT mm	Side No.	Layer	Pass Number	Filler Metal Size mm ϕ	Current Polarity	Amperes	Automatic, Semi-Automatic or Machine		
								Electrical Stickout 20	Shielding Gas Flow rate 35 CFH	
								WFS mm/sec	Volts	ATS mm/sec
10	10	1	1-2	1-2	1.2	DCRP	225	110	24	13.7
13	12	1	1-3	1-4	1.2	DCRP	225	110	24	13.5
16	16	1	1-3	1-4	1.2	DCRP	225	110	24	8.0
19	20	1	1-4	1-6	1.2	DCRP	225	110	24	7.9
25	25	1	1-5	1-10	1.2	DCRP	225	110	24	7.0
ALL	ALL	2	B	B	1.2	DCRP	225	110	24	13.0

Revision Date			Initials	Explanation	CWB Approval	* Engineer's Seal
MONTH	DAY	YEAR				
				PREQUALIFIED F4-1	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <p style="font-weight: bold; font-size: 1.2em;">CWB Accepted</p> <p style="font-size: 0.8em;">Sep 15, 2006</p> <p style="font-size: 0.7em;">Valid only if welding consumables are certified by the CWB</p> </div>	

* Division 1 or 2 Companies: Engineers seal and signature. For Division 3 Companies; Name and signature of Welding Supervisor

"QUALITY THROUGH CERTIFICATION"

FC1-5



CANADIAN WELDING BUREAU

WELDING PROCEDURE DATA SHEET

CWB Form 150E/91-9

No. **FC1-8**

DATE **08/21/06**
MONTH DAY YEAR

W47.1

Company Name **NATIONAL PROCESS EQUIPMENT**
Address **#5, 3401 - 19 STREET N.E., CALGARY, ALBERTA, T2E 6S8**

Wldg. Procedure Specification No. **FC1**
Applicable Standards **W47.1 & W59**

Welding Process Shielded Metal Arc (SMAW) Gas Metal Arc (GMAW) Gas Tungsten Arc (GTAW)
 Flux-Core Arc (FCAW) Submerged Arc (SAW) Other

Filler Metal Classification **E491T-9M-H8**
Shielding Gas or Flux **75%AR, 25%CO2**

Process Mode Manual Machine Semi-Automatic Automatic

Tungsten Type _____
Tungsten Size _____

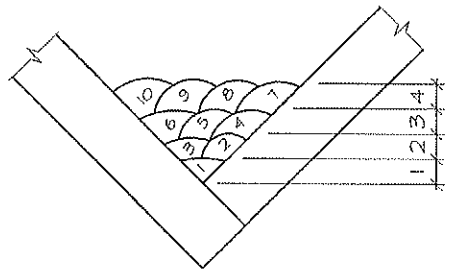
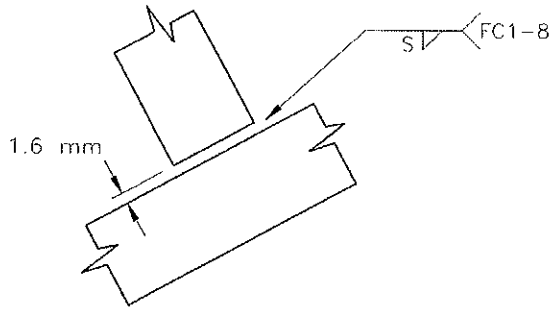
Preheat Temp. **Table 5.3**

Material Designation **Steel in Groups 1,2 or 3 Table 11-1 & 12-1 W59 EXCEPT WEATHERING STEELS**

Welding Position **FLAT**

Min. Interpass Temp. _____
Max. Interpass Temp. _____

(Show Welding Symbol with Data Sheet No. in tail)



SKETCH OF TYPICAL JOINT PREPARATION

TYPICAL PASS AND LAYER SEQUENCE

COMPLETE JOINT PENETRATION GROOVE WELD

- Back-gouge to sound metal
- Welded both sides without backing
- Welded onto steel backing
- Welded onto other than steel backing
- Welded from one side without backing

- Partial Joint Penetration Groove Weld (Specify Effective Throat)
- Fillet Weld

JOINT TYPE

- BUTT
- CORNER
- TEE
- EDGE
- LAP

Mat'l Thk.	Weld Size/ETT	Side No.	Layer	Pass Number	Filler Metal Size	Current Polarity	Amperes	Automatic, Semi-Automatic or Machine		
								Electrical Stickout 12	Shielding Gas Flow rate 30 CFH	Wire Feed Speed
5	5	1	1	1	1.2	DCRP	225	110 mm/sec	24	11.5 mm/sec
6	6	1	1	1	1.2	DCRP	225	110 mm/sec	24	8.6 mm/sec
8	8	1	1-2	1-3	1.2	DCRP	225	110 mm/sec	24	5.8 mm/sec
10	10	1	1-2	1-3	1.2	DCRP	225	110 mm/sec	24	4.0 mm/sec
13	13	1	1-2	1-3	1.2	DCRP	225	110 mm/sec	24	6.2 mm/sec
16	16	1	1-3	1-6	1.2	DCRP	225	110 mm/sec	24	5.3 mm/sec
19	19	1	1-3	1-6	1.2	DCRP	225	110 mm/sec	24	5.3 mm/sec
25	19	1	1-3	1-6	1.2	DCRP	225	110 mm/sec	24	5.3 mm/sec

Revision Date			Initials	Explanation
MONTH	DAY	YEAR		
				PREQUALIFIED W59-03 10.4.3.

CWB Approval

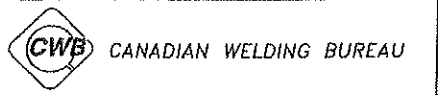
CWB Accepted

Sep 28, 2006

Valid only if welding consumables are certified by the CWB

* Engineer's Seal

* Division 1 or 2 Companies: Engineers seal and signature. For Division 3 Companies; Name and signature of Welding Supervisor



WELDING PROCEDURE DATA SHEET

CWB Form 180E/91-9

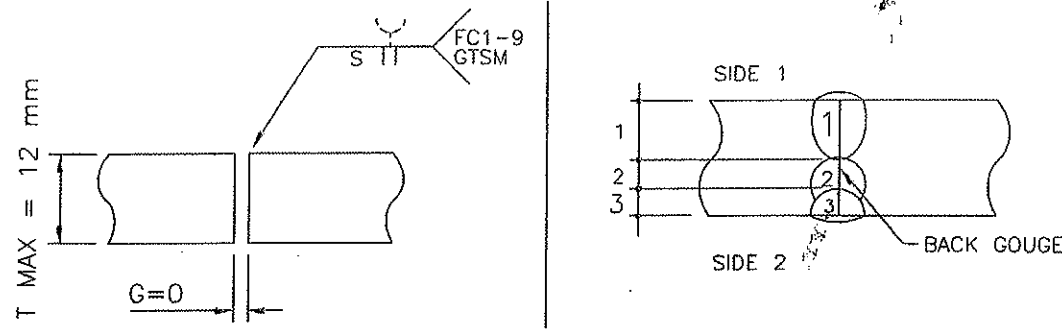
No. **FC1-9**

DATE **10/27/10**
MONTH DAY YEAR

W47.1

Company Name NATIONAL PROCESS EQUIPMENT Address #5, 3401 - 19 STREET N.E., CALGARY, ALBERTA, T2E 6S8	Wldg. Procedure Specification No. FC1 Applicable Standards W47.1 & W59
Welding Process <input type="checkbox"/> SMAW <input type="checkbox"/> GMAW <input type="checkbox"/> GTAW <input checked="" type="checkbox"/> Flux-Core Arc (FCAW) <input type="checkbox"/> SAW <input type="checkbox"/> Other	Filler Metal Classification E491T-9M-H8 Shielding Gas or Flux 75%Ar, 25%CO2
Process Mode <input type="checkbox"/> Manual <input type="checkbox"/> Machine <input checked="" type="checkbox"/> Semi-Automatic <input type="checkbox"/> Automatic	Preheat Temp. Table 5.3 Min. Interpass Temp. Table 5.3 Max. Interpass Temp. _____
Material Designation Steel in Groups 1,2 or 3 Table 11-1 & 12-1 W59	Tungsten Type _____ Tungsten Size _____ Welding Position FLAT

(Show Welding Symbol with Data Sheet No. in tail)

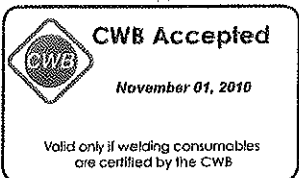
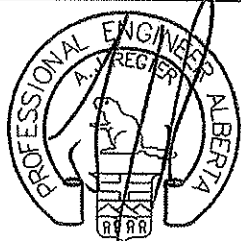


SKETCH OF TYPICAL JOINT PREPARATION

TYPICAL PASS AND LAYER SEQUENCE

COMPLETE JOINT PENETRATION GROOVE WELD <input checked="" type="checkbox"/> Back-gouge to sound metal <input type="checkbox"/> Welded both sides without backing <input type="checkbox"/> Welded onto steel backing <input type="checkbox"/> Welded onto other than steel backing <input type="checkbox"/> Welded from one side without backing				<input type="checkbox"/> Partial Joint Penetration Groove Weld (Specify Effective Throat) _____ <input type="checkbox"/> Fillet Weld		JOINT TYPE <input checked="" type="checkbox"/> BUTT <input type="checkbox"/> TEE <input type="checkbox"/> CORNER <input type="checkbox"/> EDGE <input type="checkbox"/> LAP	
--	--	--	--	---	--	---	--

Mat'l Thk.	Weld Size/ETT	Side No.	Layer	Pass Number	Filler Metal Size	Current Polarity	Amperes	Automatic, Semi-Automatic or Machine		
								Electrical Stickout 12mm	Shielding Gas Flow rate	30 CFH
mm	mm				mm ϕ			Wire Feed Speed	Volts	Arc Travel Speed
								mm/sec		mm/sec
6	6	1-2	1-2	1-2	1.2	DCRP	225	130	25	15
10	10	1-2	1-2	1-2	1.2	DCRP	225	130	25	14
12	12	1-2	1-3	1-3	1.2	DCRP	225	130	25	15

Revision Date <small>MONTH DAY YEAR</small>	Initials	Explanation	CWB Approval	* Engineer's Seal
				



CANADIAN WELDING BUREAU

WELDING PROCEDURE DATA SHEET

CWB Form 180E/01-9

No. FC1-11

DATE 08 21 06
MONTH DAY YEAR

W47.1

Company Name NATIONAL PROCESS EQUIPMENT
Address #5, 3401 - 19 STREET N.E., CALGARY, ALBERTA, T2E 6S8

Wldg. Procedure Specification No. FC1
Applicable Standards W47.1 & W59

Welding Process Shielded Metal Arc (SMAW) Gas Metal Arc (GMAW) Gas Tungsten Arc (GTAW)
 Flux-Core Arc (FCAW) Submerged Arc (SAW) Other

Filler Metal Classification E491T-9M-H8
Shielding Gas 75%AR, 25%CO2

Process Mode Manual Machine
 Semi-Automatic Automatic

Tungsten Type

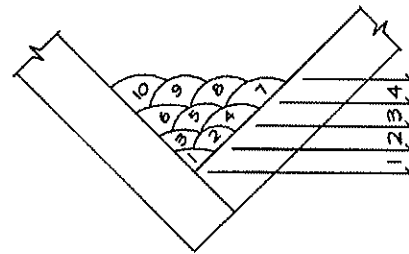
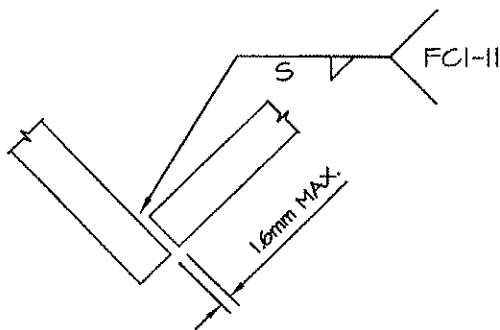
Material Designation Steel in Groups 1,2 or 3
Table 11-1 & 12-1 W59
Except Weathering Steels

Tungsten Size

Welding Position VERTICAL UP

Preheat Temp. Table 5.3
Min. Interpass Temp. _____
Max. Interpass Temp. _____

(Show Welding Symbol with Data Sheet No. in tail)



SKETCH OF TYPICAL JOINT PREPARATION

TYPICAL PASS AND LAYER SEQUENCE

COMPLETE JOINT PENETRATION GROOVE WELD

- Back-gouge to sound metal
- Welded onto steel backing
- Welded from one side without backing
- Welded both sides without backing
- Welded onto other than steel backing

- Partial Joint Penetration Groove Weld (Specify Effective Throat)
- Fillet Weld

- JOINT TYPE
- BUTT
 - CORNER
 - EDGE
 - LAP
 - TEE

Mat'l Thk. mm	Weld Size/ETI mm	Side No.	Layer	Pass Number	Filler Metal Size mm Ø	Current Polarity	Amperes	Automatic, Semi-Automatic or Machine		
								Electrical Stickout 10	Shielding Gas Flow rate 40 CFH	
								WFS mm/sec	Volts	ATS mm/sec
5	5	1	1	1	1.2	DCEP	200	110	24	5.4-6.4
6	6	1	1	1	1.2	DCEP	200	110	24	3.7-4.4
8	8	1	1	1	1.2	DCEP	200	110	24	2.1-2.5
10	10	1	1-2	1-3	1.2	DCEP	200	110	24	3.4-4.2
13	13	1	1-2	1-3	1.2	DCEP	200	110	24	2.0-2.5
16	16	1	1-3	1-6	1.2	DCEP	200	110	24	2.7-3.3
19	19	1	1-3	1-6	1.2	DCEP	200	110	24	1.9-2.3
25	19	1	1-3	1-6	1.2	DCEP	200	110	24	1.9-2.3

Revision Date			Initials	Explanation
MONTH	DAY	YEAR		

CWB Approval

CWB Accepted

Sep 15, 2006

Valid only if welding consumables are certified by the CWB

* Engineer's Seal

* Division 1 or 2 Companies: Engineers seal and signature. For Division 3 Companies; Name and signature of Welding Supervisor



CANADIAN WELDING BUREAU

WELDING PROCEDURE DATA SHEET

CWB Form 180E/91-9

No. FC1-14

DATE 08 21 06
MONTH DAY YEAR

W47.1

Company Name NATIONAL PROCESS EQUIPMENT
Address #5, 3401 - 19 STREET N.E., CALGARY, ALBERTA, T2E 6S8

Wldg. Procedure Specification No. FC1
Applicable Standards W47.1 & W59

Welding Process Shielded Metal Arc (SMAW) Gas Metal Arc (GMAW) Gas Tungsten Arc (GTAW)
 Flux-Core Arc (FCAW) Submerged Arc (SAW) Other

Filler Metal Classification E491T-9M-H8
Shielding Gas or Flux 75%Ar, 25%CO2

Process Mode Manual Machine
 Semi-Automatic Automatic

Tungsten Type

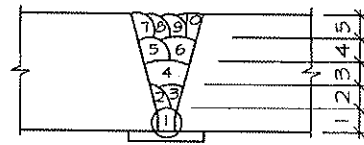
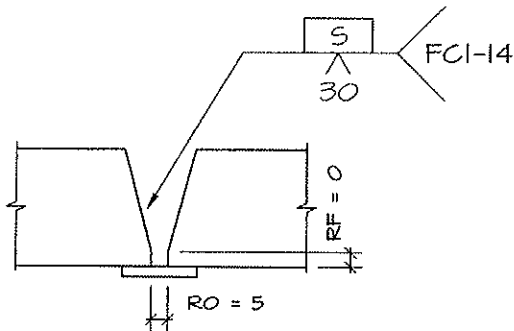
Material Designation Steel in Groups 1,2 or 3
Table 11-1 & 12-1 W59
Except Weathering Steels

Tungsten Size

Welding Position FLAT

Preheat Temp. Table 5.3
Min. Interpass Temp. _____
Max. Interpass Temp. _____

(Show Welding Symbol with Data Sheet No. in tail)



SKETCH OF TYPICAL JOINT PREPARATION

TYPICAL PASS AND LAYER SEQUENCE

COMPLETE JOINT PENETRATION GROOVE WELD

- Back-gauge to sound metal
- Welded onto steel backing
- Welded from one side without backing
- Welded both sides without backing
- Welded onto other than steel backing

- Partial Joint Penetration Groove Weld (Specify Effective Throat)
- Fillet Weld

JOINT TYPE

- BUTT
- TEE
- CORNER
- EDGE
- LAP

Mat'l Thk. mm	Weld Size/ETT mm	Side No.	Layer	Pass Number	Filler Metal Size mm ø	Current Polarity	Amperes	Automatic, Semi-Automatic or Machine		
								Electrical Stickout 12	Shielding Gas Flow rate	
								WFS mm/sec	Volts	ATS mm/sec
5	5	1	1	1	1.2	DCRP	225	110	24	2.7
6	6	1	1	1	1.2	DCRP	225	110	24	4.3
8	8	1	1-2	1-3	1.2	DCRP	225	110	24	3.0
10	10	1	1-2	1-3	1.2	DCRP	225	110	24	3.3
13	13	1	1-3	1-4	1.2	DCRP	225	110	24	3.1
16	16	1	1-4	1-6	1.2	DCRP	225	110	24	2.9
19	19	1	1-4	1-6	1.2	DCRP	225	110	24	2.7
25	25	1	1-5	1-10	1.2	DCRP	225	110	24	2.9

Revision Date			Initials	Explanation
MONTH	DAY	YEAR		
				PREGUALIFIED F2-2

CWB Approval

CWB Accepted

Sep 15, 2006

Valid only if welding consumables are certified by the CWB

* Engineer's Seal

* Division 1 or 2 Companies: Engineers seal and signature. For Division 3 Companies; Name and signature of Welding Supervisor



WELDING PROCEDURE DATA SHEET

CWB Form 180F/91-9

No. **FC1-17**

DATE **10 05 10**
MONTH DAY YEAR

W47.1

Company Name **NATIONAL PROCESS EQUIPMENT**
 Address **#5, 3401 - 19 STREET N.E., CALGARY, ALBERTA, T2E 6S8**

Wldg. Procedure Specification No. **FC1**
 Applicable Standards **W47.1 & W59**

Welding Process Shielded Metal Arc (SMAW) Gas Metal Arc (GMAW) Gas Tungsten Arc (GTAW)
 Flux-Core Arc (FCAW) Submerged Arc (SAW) Other

Filler Metal Classification **E491T-9M-H8**
 Shielding Gas or Flux **75%Ar, 25%CO2**

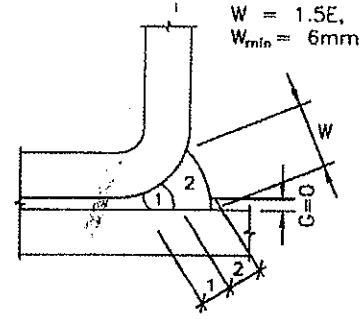
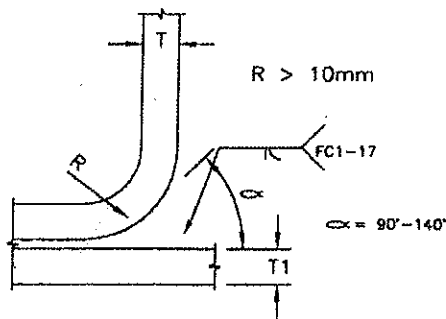
Process Mode Manual Machine Semi-Automatic Automatic

Tungsten Type _____
 Tungsten Size _____
 Welding Position **FLAT & HORIZ**

Preheat Temp. **Table 5.3**
 Min. Interpass Temp. _____
 Max. Interpass Temp. _____

Material Designation **Steel in Groups 1,2 or 3
 Table 11-1 & 12-1 W59
 EXCEPT WEATHERING STEELS**

(Show Welding Symbol with Data Sheet No. in tail)



SKETCH OF TYPICAL JOINT PREPARATION

TYPICAL PASS AND LAYER SEQUENCE

- COMPLETE JOINT PENETRATION GROOVE WELD**
- Back-gouge to sound metal
 - Welded onto steel backing
 - Welded from one side without backing
 - Welded both sides without backing
 - Welded onto other than steel backing

- Partial Joint Penetration Groove Weld**
 (Specify Effective Throat) _____
- Fillet Weld

- JOINT TYPE**
- BUTT
 - TEE
 - CORNER
 - EDGE
 - LAP

Mat'l Thk.	Weld Size/ETT	Side No.	Layer	Pass Number	Filler Metal Size	Current Polarity	Amperes	Automatic, Semi-Automatic or Machine		
								Electrical Stickout 25	Shielding Gas Flow rate 45 CFH	Wire Feed Speed
6.4	4.8	1-2	1	1	1.2	DCRP	200	110 mm/sec	24	4.4 mm/sec
9.5	6.4	1-2	1-2	1-2	1.2	DCRP	200	110 mm/sec	24	2.1-2.9 mm/sec

Revision Date			Initials	Explanation
MONTH	DAY	YEAR		
				F10-1P

CWB Approval

CWB Accepted
 October 08, 2010

Valid only if welding consumables are certified by the CWB

* Engineer's Seal

* Division 1 or 2 Companies: Engineers seal and signature. For Division 3 Companies: Name and signature of Welding Supervisor

"QUALITY THROUGH CERTIFICATION"



CANADIAN WELDING BUREAU

WELDING PROCEDURE DATA SHEET

CWB Form 180E/91-9

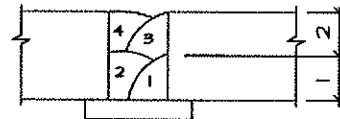
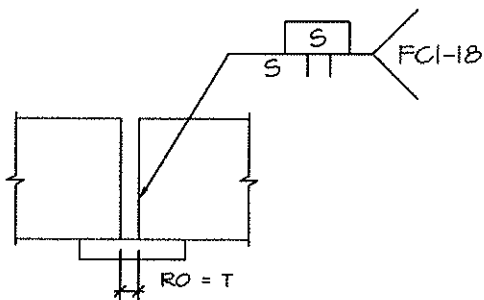
No. FC1-18

DATE 08 21 06 MONTH DAY YEAR

W47.1

Company Name NATIONAL PROCESS EQUIPMENT Wldg. Procedure Specification No. FC1
 Address #5, 3401 - 19 STREET N.E., CALGARY, ALBERTA, T2E 6S8 Applicable Standards W47.1 & W59
 Welding Process Shielded Metal Arc (SMAW) Gas Metal Arc (GMAW) Gas Tungsten Arc (GTAW) Filler Metal Classification E491T-9M-H8
 Flux-Core Arc (FCAW) Submerged Arc (SAW) Other Shielding Gas or Flux 75%AR, 25%CO2
 Process Mode Manual Machine Tungsten Type _____
 Semi-Automatic Automatic Tungsten Size _____
 Material Designation Steel in Groups 1,2 or 3 Table 11-1 & 12-1 W59 Except Weathering Steels Welding Position FLAT Preheat Temp. Table 5.3
 Min. Interpass Temp. _____
 Max. Interpass Temp. _____

(Show Welding Symbol with Data Sheet No. in tail)



SKETCH OF TYPICAL JOINT PREPARATION

TYPICAL PASS AND LAYER SEQUENCE

COMPLETE JOINT PENETRATION GROOVE WELD
 Back-gouge to sound metal Welded both sides without backing
 Welded onto steel backing Welded onto other than steel backing
 Welded from one side without backing
 Partial Joint Penetration Groove Weld (Specify Effective Throat)
 Fillet Weld
 JOINT TYPE
 BUTT TEE
 CORNER EDGE
 LAP

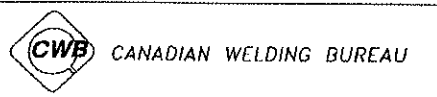
Mat'l Thk. mm	Weld Size/ETI mm	Side No.	Layer	Pass Number	Filler Metal Size mm Ø	Current Polarity	Amperes	Automatic, Semi-Automatic or Machine		
								Electrical Stickout 20 WFS mm/sec	Shielding Gas Flow rate Volts	35 CFH ATS mm/sec
3.2	3.2	1	1	1	1.2	DCRP	225	110	24	5.9
4.8	4.8	1	1	1	1.2	DCRP	225	110	24	4.7
6.4	6.4	1	1	1-2	1.2	DCRP	225	110	24	4.2
8	8	1	1	1-2	1.2	DCRP	225	110	24	3.0
10	10	1	1-2	1-4	1.2	DCRP	225	110	24	3.8

Revision Date			Initials	Explanation	CWB Approval	* Engineer's Seal
MONTH	DAY	YEAR				
				PREQUALIFIED FI-1		

* Division 1 or 2 Companies: Engineers seal and signature. For Division 3 Companies; Name and signature of Welding Supervisor

"QUALITY THROUGH CERTIFICATION"

FC1-18



WELDING PROCEDURE DATA SHEET

CWB Form 180E/91-9

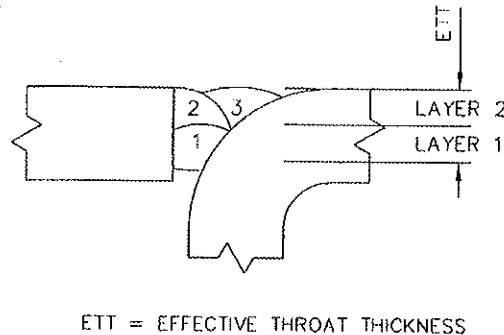
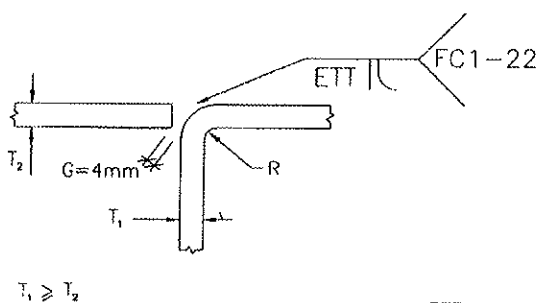
No. **FC1-22**

DATE **10 05 10**
MONTH DAY YEAR

W47.1

Company Name NATIONAL PROCESS EQUIPMENT		Wldg. Procedure Specification No. FC1
Address #5, 3401 - 19 STREET N.E., CALGARY, ALBERTA, T2E 6S8		Applicable Standards W47.1 & W59
Welding Process <input type="checkbox"/> SMAW <input type="checkbox"/> GMAW <input type="checkbox"/> GTAW <input checked="" type="checkbox"/> Flux-Core Arc (FCAW) <input type="checkbox"/> SAW <input type="checkbox"/> Other	Filler Metal Classification E491T-9M-H8	Shielding Gas or Flux 75%AR, 25%CO2
Process Mode <input type="checkbox"/> Manual <input type="checkbox"/> Machine <input checked="" type="checkbox"/> Semi-Automatic <input type="checkbox"/> Automatic	Tungsten Type _____	Preheat Temp. Table 5.3
Material Designation Steel in Groups 1,2 or 3 Table 11-1 & 12-1 W59 EXCEPT WEATHERING STEELS	Tungsten Size _____	Min. Interpass Temp. _____
	Welding Position FLAT & HORIZ	Max. Interpass Temp. _____

(Show Welding Symbol with Data Sheet No. in tail)



SKETCH OF TYPICAL JOINT PREPARATION

TYPICAL PASS AND LAYER SEQUENCE

COMPLETE JOINT PENETRATION GROOVE WELD <input type="checkbox"/> Back-gauge to sound metal <input type="checkbox"/> Welded onto steel backing <input type="checkbox"/> Welded from one side without backing		<input type="checkbox"/> Welded both sides without backing <input type="checkbox"/> Welded onto other than steel backing	<input checked="" type="checkbox"/> Partial Joint Penetration Groove Weld (Specify Effective Throat) <input type="checkbox"/> Fillet Weld	JOINT TYPE <input checked="" type="checkbox"/> BUTT <input type="checkbox"/> TEE <input type="checkbox"/> CORNER <input type="checkbox"/> EDGE <input type="checkbox"/> LAP
--	--	---	--	---

Mat'l Thk.	Weld Size/ETT	Side No.	Layer	Pass Number	Filler Metal Size	Current Polarity	Amperes	Automatic, Semi-Automatic or Machine		
								Electrical Stickout 25	Shielding Gas Flow rate 40 CFH	Wire Feed Speed
R=13 T=5	3	1	1	1	1.2	DCEP	200	110 mm/s	24	13.2 mm/s
R=16 T=6	3.6	1	1	1	1.2	DCEP	200	110 mm/s	24	9.1 mm/s
R=19 T=10	6	1	1	1	1.2	DCEP	200	110 mm/s	24	9.9 mm/s
	6	1	2	2-3	1.2	DCEP	200	110 mm/s	24	9.0 mm/s

Revision Date				Initials	Explanation
MONTH	DAY	YEAR			
					F11-1P
1	0	0	8	10	WP REVISD AS CWB COMMENTS

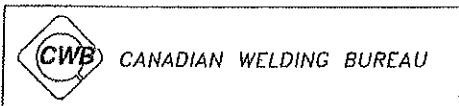
CWB Approval

CWB Accepted

Oct 15, 2010

Valid only if welding consumables are certified by the CWB

* Engineer's Seal



WELDING PROCEDURE DATA SHEET

CWB Form 180E/B1-1

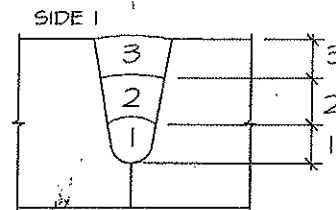
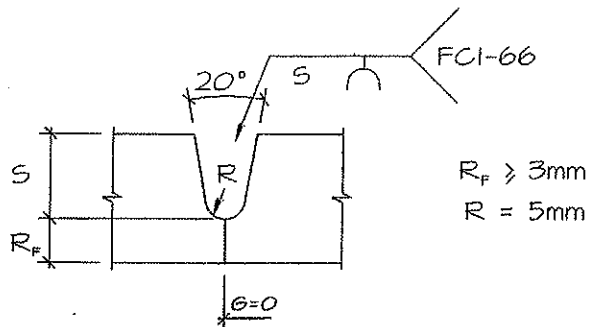
No. **FC1-66**

DATE **10 05 10**
MONTH DAY YEAR

W47.1

Company Name NATIONAL PROCESS EQUIPMENT		Wldg. Procedure Specification No. FC1
Address #5, 3401 - 19 STREET N.E., CALGARY, ALBERTA, T2E 6S8		Applicable Standards W47.1 & W59
Welding Process <input type="checkbox"/> Shielded Metal Arc (SMAW) <input type="checkbox"/> Gas Metal Arc (GMAW) <input type="checkbox"/> Gas Tungsten Arc (GTAW) <input checked="" type="checkbox"/> Flux-Core Arc (FCAW) <input type="checkbox"/> Submerged Arc (SAW) <input type="checkbox"/> Other	Filler Metal Classification E491T-9M-H8	Shielding Gas or Flux 75%AR, 25%CO2
Process Mode <input type="checkbox"/> Manual <input type="checkbox"/> Machine <input checked="" type="checkbox"/> Semi-Automatic <input type="checkbox"/> Automatic	Tungsten Type	Preheat Temp. Table 5.3
Material Designation Steel in Groups 1, 2 or 3 Table 11-1 & 12-1 W59 Except Weathering Steels	Tungsten Size	Min. Interpass Temp. _____
	Welding Position FLAT	Max. Interpass Temp. _____

(Show Welding Symbol with Data Sheet No. in tail)



SKETCH OF TYPICAL JOINT PREPARATION

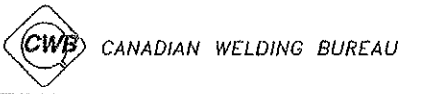
TYPICAL PASS AND LAYER SEQUENCE

COMPLETE JOINT PENETRATION GROOVE WELD <input type="checkbox"/> Back-gouge to sound metal <input type="checkbox"/> Welded both sides without backing <input type="checkbox"/> Welded onto steel backing <input type="checkbox"/> Welded onto other than steel backing <input type="checkbox"/> Welded from one side without backing		<input checked="" type="checkbox"/> Partial Joint Penetration Groove Weld (Specify Effective Throat) <input type="checkbox"/> Fillet Weld	JOINT TYPE <input checked="" type="checkbox"/> BUTT <input type="checkbox"/> TEE <input type="checkbox"/> CORNER <input type="checkbox"/> EDGE <input type="checkbox"/> LAP
---	--	--	---

Mat'l Thk. mm	Weld Size/ETI mm	Side No.	Layer	Pass Number	Filler Metal Size mm Ø	Current Polarity	Amperes	Automatic, Semi-Automatic or Machine		
								Electrical Stickout	Shielding Gas Flow rate	
								WFS mm/sec	Volts	ATS mm/sec
6.4	3.4	1	1	1	1.2	DCRP	210	125	25	5.2
9.5	6	1	1-2	1-2	1.2	DCRP	210	125	25	5.0
12	9	1	1-2	1-2	1.2	DCRP	210	125	25	3.5
16	12	1	1-3	1-3	1.2	DCRP	210	125	25	2.2
20	15	1	1-3	1-3	1.2	DCRP	210	125	25	2.0

Revision Date MONTH DAY YEAR			Initials	Explanon	CWB Approval	* Engineer's Seal			
1	0	2					8	1	0

* Division 1 or 2 Companies: Engineers seal and signature. For Division 3 Companies; Name and signature of Welding Supervisor



WELDING PROCEDURE DATA SHEET

CWB Form 180E/01-9

No. **FC1-69**

DATE **100510**
MONTH DAY YEAR

W47.1

Company Name **NATIONAL PROCESS EQUIPMENT**

Wldg. Procedure Specification No. **FC1**

Address **#5, 3401 - 19 STREET N.E., CALGARY, ALBERTA, T2E 6S8**

Applicable Standards **W47.1 & W59**

Welding Process Shielded Metal Arc (SMAW) Gas Metal Arc (GMAW) Gas Tungsten Arc (GTAW)
 Flux-Core Arc (FCAW) Submerged Arc (SAW) Other

Filler Metal Classification **E491T-9M-H8**
 Shielding Gas **75%AR, 25%CO2** or Flux

Process Mode Manual Machine
 Semi-Automatic Automatic

Tungsten Type _____

Tungsten Size _____

Welding Position **FLAT**

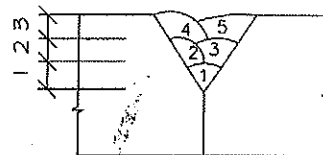
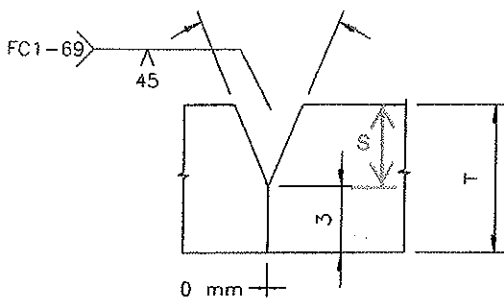
Preheat Temp. **TABLE 5.3**

Material Designation **Steel in Groups 1,2 or 3**
Table 11-1 & 12-1 W59
EXCEPT WEATHERING STEELS

Min. Interpass Temp. _____

Max. Interpass Temp. _____

(Show Welding Symbol with Data Sheet No. in tail)
 45 DEG



SKETCH OF TYPICAL JOINT PREPARATION

TYPICAL PASS AND LAYER SEQUENCE

COMPLETE JOINT PENETRATION GROOVE WELD

- Back-gouge to sound metal
- Welded both sides without backing
- Welded onto steel backing
- Welded onto other than steel backing
- Welded from one side without backing

- Partial Joint Penetration Groove Weld (Specify Effective Throat)
- Fillet Weld

JOINT TYPE

- BUTT TEE
- CORNER EDGE
- LAP

S	Weld Size/ETT	Side No.	Layer	Pass Number	Filler Metal Size	Current Polarity	Amperes	Automatic, Semi-Automatic or Machine		
								Electrical Stickout 12	Shielding Gas Flow rate 40-45 CFH	
								Wire Feed Speed	Volts	Arc Travel Speed
16	13	1	1-2	1-3	1.2	DCRP	210	130 mm/sec	26	6.9
20	17	1	1-3	1-5	1.2	DCRP	210	130 mm/sec	26	6.4

Revision Date			Initials	Explanation	CWB Approval	* Engineer's Seal	
MONTH	DAY	YEAR					
					<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <p style="font-weight: bold; font-size: 1.2em;">CWB Accepted</p> <p style="font-size: 0.8em;">Oct 15, 2010</p> <p style="font-size: 0.7em;">Valid only if welding consumables are certified by the CWB</p> </div>		
1	0	08	10	WP			REVISED AS CWB COMMENTS

* Division 1 or 2 Companies: Engineers seal and signature. For Division 3 Companies: Name and signature of Welding Supervisor



CANADIAN WELDING BUREAU

WELDING PROCEDURE DATA SHEET

CWB Form 180E/91-9

No. FC1-83

DATE 12 02 11
MONTH DAY YEAR

W47.1

Company Name NATIONAL PROCESS EQUIPMENT

Wldg. Procedure Specification No. FC1

Address #5, 3401 - 19 STREET N.E., CALGARY, ALBERTA, T2E 6S8

Applicable Standards W47.1 & W59

Welding Process Shielded Metal Arc (SMAW) Gas Metal Arc (GMAW) Gas Tungsten Arc (GTAW)
 Flux-Core Arc (FCAW) Submerged Arc (SAW) Other

Filler Metal Classification E491T-9M-H8
Shielding Gas or Flux 75%AR25%CO2

Process Mode Manual Machine Semi-Automatic Automatic

Tungsten Type

Preheat Temp. Table 5.3

Material Designation 350WT to Steel in Groups 1,2 or 3
Table 11-1 & 12-1 W59
EXCEPT WEATHERING STEELS

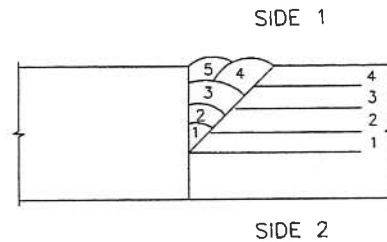
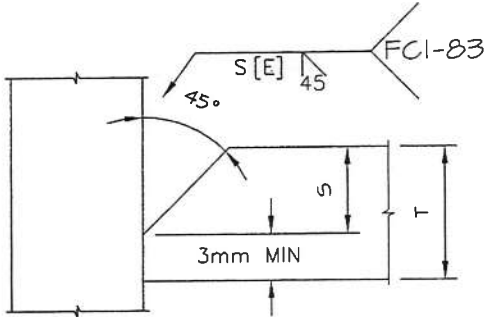
Tungsten Size

Min. Interpass Temp.

Welding Position FLAT

Max. Interpass Temp.

(Show Welding Symbol with Data Sheet No. in tail)



SKETCH OF TYPICAL JOINT PREPARATION

TYPICAL PASS AND LAYER SEQUENCE

COMPLETE JOINT PENETRATION GROOVE WELD

- Back-gouge to sound metal
- Welded onto steel backing
- Welded from one side without backing
- Welded both sides without backing
- Welded onto other than steel backing

- Partial Joint Penetration Groove Weld (Specify Effective Throat)
- Fillet Weld

- JOINT TYPE
- BUTT
 - CORNER
 - TEE
 - EDGE
 - LAP

Mat'l Thk.	Weld Size/ETT	Side No.	Layer	Pass Number	Filler Metal Size	Current Polarity	Amperes	Automatic, Semi-Automatic or Machine		
								Electrical Stickout 20	Shielding Gas Flow rate 40-CFH	Arc Travel Speed
								Wire Feed Speed	Volts	
12	6	1	1-2	1-2	1.2	DCRP	210	130	26	4.0
16	10	1	1-3	1-3	1.2	DCRP	210	130	26	4.0
20	14	1	1-4	1-5	1.2	DCRP	210	130	26	4.0

Revision Date			Initials	Explanation
MONTH	DAY	YEAR		
				F4-IP

CWB Approval

CWB Accepted

Jan 18, 2012

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* Engineer's Seal

* Division 1 or 2 Companies: Engineers seal and signature. For Division 3 Companies; Name and signature of Welding Supervisor



WELDING PROCEDURE DATA SHEET

CWB Form 180E/91-9

No. **FC1-84**

DATE **1 2 0 2 1 1**
MONTH DAY YEAR

W47.1

Company Name **NATIONAL PROCESS EQUIPMENT**
 Address **#5, 3401 - 19 STREET N.E., CALGARY, ALBERTA, T2E 6S8**

Wldg. Procedure Specification No. **FC1**
 Applicable Standards **W47.1 & W59**

Welding Process Shielded Metal Arc (SMAW) Gas Metal Arc (GMAW) Gas Tungsten Arc (GTAW)
 Flux-Core Arc (FCAW) Submerged Arc (SAW) Other

Filler Metal Classification **E491T-9M-H8**
 Shielding Gas or Flux **75%AR25%CO2**

Process Mode Manual Machine
 Semi-Automatic Automatic

Tungsten Type _____
 Tungsten Size _____

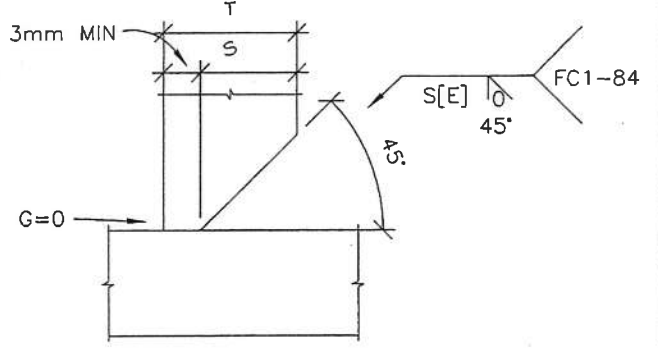
Preheat Temp. **Table 5.3**

Material Designation **350WT to Steel in Groups 1,2 or 3
 Table 11-1 & 12-1 W59
 EXCEPT WEATHERING STEELS**

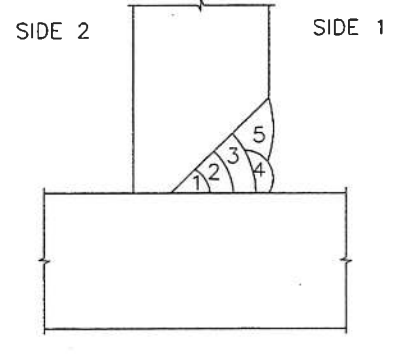
Welding Position **HORIZONTAL**

Min. Interpass Temp. _____
 Max. Interpass Temp. _____

(Show Welding Symbol with Data Sheet No. in tail)



SKETCH OF TYPICAL JOINT PREPARATION



TYPICAL PASS AND LAYER SEQUENCE

- COMPLETE JOINT PENETRATION GROOVE WELD**
- Back-gouge to sound metal
 - Welded both sides without backing
 - Welded onto steel backing
 - Welded onto other than steel backing
 - Welded from one side without backing

- Partial Joint Penetration Groove Weld**
 (Specify Effective Throat)
- Fillet Weld

- JOINT TYPE**
- BUTT
 - TEE
 - CORNER
 - EDGE
 - LAP

Mat'l Thk.	Weld Size/ETT	Side No.	Layer	Pass Number	Filler Metal Size	Current Polarity	Amperes	Automatic, Semi-Automatic or Machine		
								Electrical Stickout 20	Shielding Gas Flow rate 40-CFH	Arc Travel Speed
								Wire Feed Speed	Volts	
12	6	1	1-2	1-2	1.2	DCRP	210	130	26	4.0
16	10	1	1-3	1-3	1.2	DCRP	210	130	26	4.0
20	14	1	1-4	1-5	1.2	DCRP	210	130	26	4.0

Revision Date			Initials	Explanation
MONTH	DAY	YEAR		
				Prequalified: F4-IP

CWB Approval

CWB Accepted

Jan 18, 2012

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* Engineer's Seal



CANADIAN WELDING BUREAU

WELDING PROCEDURE DATA SHEET

CWB Form 180E/91-9

No. **FC1-85**

DATE **1 2 0 2 1 1**
MONTH DAY YEAR

W47.1

Company Name **NATIONAL PROCESS EQUIPMENT**
Address **#5, 3401 - 19 STREET N.E., CALGARY, ALBERTA, T2E 6S8**

Wldg. Procedure Specification No. **FC1**
Applicable Standards **W47.1 & W59**

Welding Process Shielded Metal Arc (SMAW) Gas Metal Arc (GMAW) Gas Tungsten Arc (GTAW)
 Flux-Core Arc (FCAW) Submerged Arc (SAW) Other

Filler Metal Classification **E491T-9M-H8**
Shielding Gas or Flux **75%AR, 25%CO2**

Process Mode Manual Machine
 Semi-Automatic Automatic

Tungsten Type _____
Tungsten Size _____

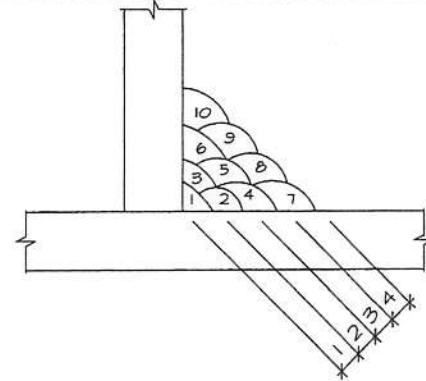
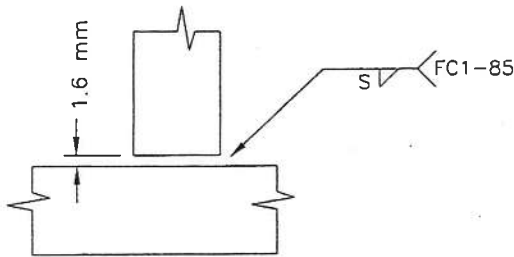
Preheat Temp. **Table 5.3**

Material Designation **350WT to Steel in Groups 1,2 or 3
Table 11-1 & 12-1 W59
EXCEPT WEATHERING STEELS**

Welding Position **HORIZONTAL**

Min. Interpass Temp. _____
Max. Interpass Temp. _____

(Show Welding Symbol with Data Sheet No. in tail)



SKETCH OF TYPICAL JOINT PREPARATION

TYPICAL PASS AND LAYER SEQUENCE

COMPLETE JOINT PENETRATION GROOVE WELD

- Back-gouge to sound metal
- Welded onto steel backing
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- Partial Joint Penetration Groove Weld (Specify Effective Throat)
- Fillet Weld

JOINT TYPE

- BUTT
- CORNER
- TEE
- EDGE
- LAP

Mat'l Thk.	Weld Size/ETT	Side No.	Layer	Pass Number	Filler Metal Size	Current Polarity	Amperes	Automatic, Semi-Automatic or Machine		
								Electrical Stickout	Shielding Gas Flow rate	Arc Travel Speed
5	5	1	1	1	1.2	DCRP	225	12	40-45 CFH	9.3 mm/sec
6	6	1	1	1	1.2	DCRP	225	110 mm/sec	24	6.5 mm/sec
8	8	1	1-2	1-3	1.2	DCRP	225	110 mm/sec	24	10.8 mm/sec
10	10	1	1-2	1-3	1.2	DCRP	225	110 mm/sec	24	7.0 mm/sec
13	13	1	1-2	1-3	1.2	DCRP	225	110 mm/sec	24	6.2 mm/sec
16	16	1	1-3	1-6	1.2	DCRP	225	110 mm/sec	24	5.3 mm/sec
19	19	1	1-4	1-10	1.2	DCRP	225	110 mm/sec	24	6.3 mm/sec
25	25	1	1-4	1-10	1.2	DCRP	225	110 mm/sec	24	3.7 mm/sec

Revision Date			Initials	Explanation
MONTH	DAY	YEAR		
				PREQUALIFIED W59-03 10.4.3.

CWB Approval

CWB Accepted

Jan 18, 2012

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* Engineer's Seal

* Division 1 or 2 Companies: Engineers seal and signature. For Division 3 Companies; Name and signature of Welding Supervisor



CANADIAN WELDING BUREAU

WELDING PROCEDURE DATA SHEET

CWB Form 180E/91-9

No. **FC1-86**

DATE **1 2 0 2 1 1**
MONTH DAY YEAR

W47.1

Company Name **NATIONAL PROCESS EQUIPMENT**
Address **#5, 3401 - 19 STREET N.E., CALGARY, ALBERTA, T2E 6S8**

Wldg. Procedure Specification No. **FC1**
Applicable Standards **W47.1 & W59**

Welding Process Shielded Metal Arc (SMAW) Gas Metal Arc (GMAW) Gas Tungsten Arc (GTAW)
 Flux-Core Arc (FCAW) Submerged Arc (SAW) Other

Filler Metal Classification **E491T-9M-H8**
Shielding Gas or Flux **75%AR, 25%CO2**

Process Mode Manual Machine
 Semi-Automatic Automatic

Tungsten Type _____
Tungsten Size _____

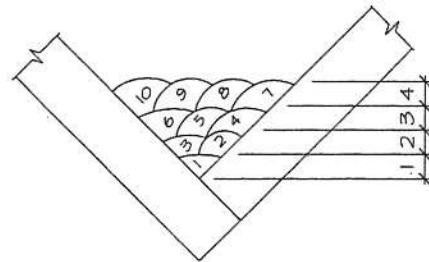
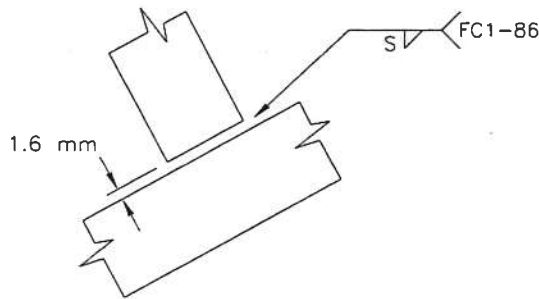
Preheat Temp. **Table 5.3**

Material Designation **350WT to Steel in Groups 1,2 or 3**
Table 11-1 & 12-1 W59
EXCEPT WEATHERING STEELS

Welding Position **FLAT**

Min. Interpass Temp. _____
Max. Interpass Temp. _____

(Show Welding Symbol with Data Sheet No. in tail)



SKETCH OF TYPICAL JOINT PREPARATION

TYPICAL PASS AND LAYER SEQUENCE

COMPLETE JOINT PENETRATION GROOVE WELD

- Back-gouge to sound metal
- Welded both sides without backing
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- Welded from one side without backing

- Partial Joint Penetration Groove Weld (Specify Effective Throat)
- Fillet Weld

JOINT TYPE

- BUTT
- CORNER
- TEE
- EDGE
- LAP

Mat'l Thk.	Weld Size/ETT	Side No.	Layer	Pass Number	Filler Metal Size	Current Polarity	Amperes	Automatic, Semi-Automatic or Machine		
								Electrical Stickout	Shielding Gas Flow rate	Arc Travel Speed
								12	30 CFH	
								Wire Feed Speed	Volts	Arc Travel Speed
5	5	1	1	1	1.2	DCRP	225	110 mm/sec	24	11.5 mm/sec
6	6	1	1	1	1.2	DCRP	225	110 mm/sec	24	8.6 mm/sec
8	8	1	1-2	1-3	1.2	DCRP	225	110 mm/sec	24	5.8 mm/sec
10	10	1	1-2	1-3	1.2	DCRP	225	110 mm/sec	24	4.0 mm/sec
13	13	1	1-2	1-3	1.2	DCRP	225	110 mm/sec	24	6.2 mm/sec
16	16	1	1-3	1-6	1.2	DCRP	225	110 mm/sec	24	5.3 mm/sec
19	19	1	1-3	1-6	1.2	DCRP	225	110 mm/sec	24	5.3 mm/sec
25	19	1	1-3	1-6	1.2	DCRP	225	110 mm/sec	24	5.3 mm/sec

Revision Date			Initials	Explanation
MONTH	DAY	YEAR		
				PREQUALIFIED W59-03 10.4.3.

CWB Approval

CWB Accepted

Jan 18, 2012

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* Division 1 or 2 Companies: Engineers seal and signature. For Division 3 Companies; Name and signature of Welding Supervisor

WELDING PROCEDURE SPECIFICATION NO.: NPE-4

WELDING PROCEDURE QUALIFICATION RECORD NO.(S): NPE-4-1, NPE-4-2
NPE-4-3, NPE-1-1

QUALIFIED FOR

Base Metal (Typical): Std. Appl.: P1 to P1
Notch Appl.: P1 Groups 1 & 2 to P1 Groups 1 & 2
(SA 333 Gr. 6, SA 350 Gr. LF2, SA 420 WPL6, SA 516 Gr. 70, etc.)
Process(es): GMAW / SMAW / FCAW Position: ALL POSITIONS, See QW-405
Weld Types: GROOVE & FILLET Diameter: ALL DIAMETERS
Filler Metal: Std. Appl.: GMAW: ER70S-2 SMAW: E7018, E7018-1 FCAW: E71T-12MJ
Notch Appl.: GMAW: ER70S-2 SMAW: E7018-1 FCAW: E71T-12MJ

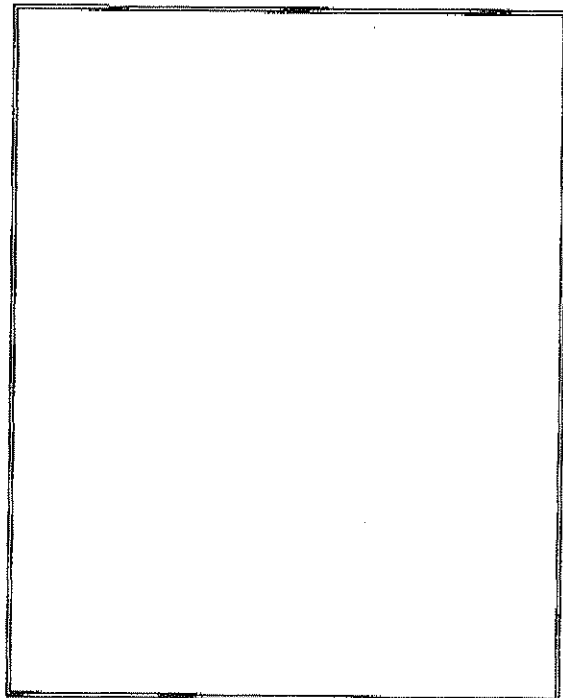
BASE METAL CONDITIONS & GROOVE THICKNESS RANGE QUALIFIED:
STANDARD APPLICATIONS AS WELDED
NOTCH TOUGHNESS APPLICATIONS TO -46°C (-50°F) AS WELDED

BASE METAL THICKNESS RANGE
ASME SECTION IX 4.8 to 203 mm (0.188 to 8.00 in.) inclusive

COMBINED DEPOSITED WELD METAL THICKNESS
ASME B31.1 / B31.3 19.1 mm (0.750 in.) maximum
ASME SECT. VIII, DIV.1 38.1 mm (1.50 in.) maximum
CSA Z662 FABRICATION 31.8 mm (1.25 in.) maximum

ASMA	
SAFETY CODES ACT - PROVINCE OF ALBERTA WELDING PROCEDURE	
Reg. No. WP	<u>3101.2</u>
Spec. No.	<u>NPE-4</u>
Weld Process	<u>GMAW / SMAW / FCAW</u>
Matl. Gr. P No.	<u>1 Gr 1+2</u> to P No. <u>1 Gr 1+2</u>
Elec. Gr. F No.	<u>6+4+6</u> ANo. <u>1</u>
Th. Qual. For	<u>203 mm P.W.M.T.</u> <u>NO</u>
N/A. Th. Qual.	<u>4.8 mm, CVN -46°</u>
W. <u>13</u> Mo. <u>6</u> Day <u>17</u> Signed <u>[Signature]</u>	
R. ROSENBERG, P. ENG. WELDING SPECIALIST	

PROVINCIAL REGISTRATION



QW-482 WELDING PROCEDURE SPECIFICATION (WPS)

National Process Equipment Inc.

Welding Procedure Specification No. NPE-4 Date June 2, 2012
Supporting PQR No.(s) NPE-4-1, NPE-4-2, NPE-4-3, NPE-1-1
Welding Process(es) GMAW / SMAW / FCAW Type(s) Semi-auto. / Manual / Semi-auto.

JOINTS (QW-402)

Joint Design All ASME groove & fillet, reference construction drawing for joint details.
Where joint details are not specified, see figures 1 to 15 attached
Root Opening As per attached typical groove designs, see figures 1 to 15 attached
Backing With or without Retainers Not required

BASE METALS (QW-403)

P-Number Std. Appl.: P1 To P-Number P1
P-Number Notch Appl.: P1 Groups 1 & 2 To P-Number P1 Groups 1 & 2
Thickness Range: Groove See cover page for thickness qualified by governing code
Fillet All base metal thicknesses
Base Metal 4.8 to 203 mm (0.188 to 8.00 in.) inclusive
Pipe Diameter Ranges: Groove All diameters Fillet All diameters
Deposited Weld Metal (Per Pass) GMAW: 3.50 mm (0.138 in.) maximum
SMAW & FCAW: 9.52 mm (0.375 in.) maximum
Other Carbon equivalent: 0.45 maximum for CSA Z662 fabrication

FILLER METALS (QW-404)		GMAW	SMAW	FCAW
Specification No. (SFA)		<u>SFA 5.18</u>	<u>SFA 5.1</u>	<u>SFA 5.20</u>
AWS No. (Class)	<u>Std. Appl.: ER70S-2</u>	<u>E7018, E7018-1</u>	<u>E71T1-12MJ</u>	<u>E71T1-12MJ</u>
	<u>Notch Appl.: ER70S-2</u>	<u>E7018-1</u>	<u>E71T1-12MJ</u>	
F-No.	<u>F6</u>	<u>F4</u>	<u>F6</u>	
A-No.	<u>A1</u>	<u>A1</u>	<u>A1</u>	
Size	<u>See Table #1</u>	<u>See Table #1</u>	<u>See Table #1</u>	
Filler Metal Product Form	<u>Solid wire</u>	<u>N/A</u>	<u>Flux cored wire</u>	
Supplementary Fillers	<u>Without</u>	<u>N/A</u>	<u>Without</u>	
Deposited Weld Metal Thickness Range:				
Groove mm (in.)	<u>3.50 (0.138) max.*</u>	<u>38.1 (1.50) max.*</u>	<u>38.1 (1.50) max.*</u>	
Fillet	<u>- - -</u>	<u>All fillet sizes</u>	<u>All fillet sizes</u>	
Other	<u>* Combined deposited weld metal thickness shall not exceed 19.1 mm (0.750 in.) for ASME B31.1 & B31.3, 38.1 mm (1.50 in.) for ASME Section VIII, Div.1 and 31.8 mm (1.25 in.) CSA Z662 fabrication</u>			

POSITION (QW-405)

Position of Groove & Fillet Std. Appl.: All positions
Notch Appl.: GMAW & SMAW: All positions
FCAW: Flat & Horizontal
Weld Progression Std. Appl.: GMAW: Vertical up or down SMAW & FCAW: Vertical up
Notch Appl.: GMAW: Vertical down SMAW: Vertical up FCAW: N/A

PREHEAT (QW-406)

Preheat Temperature (Minimum) See attached preheat sheet
Interpass Temperature (Maximum) Std. Appl.: 315°C (600°F) Notch Appl.: 232°C (450°F)
Preheat Maintenance See attached preheat sheet prior to welding. Preheat maintenance is not required if welding is interrupted or after the completion of welding unless required by the code of construction.

POST WELD HEAT TREATMENT (QW-407)

Temperature None Time N/A

GAS (QW-408)

Specification No. (SFA) SFA 5.32 AWS No. (Class) SG-AC-25
 Shielding GMAW: 75% Argon, 25% CO₂, 10 - 25 liters per minute (20 - 50 cfph)
 FCAW: 75% Argon, 25% CO₂, 12.5 - 30 liters per minute (25 - 60 cfph)
 Backing None Trailing Not Required

ELECTRICAL CHARACTERISTICS (QW-409)

Current Direct Polarity Reverse, electrode positive
 Amps See Table #1 Volts See Table #1
 Electrode Wire Feed Speed Amperage controlled, see Table #1

Maximum Heat Input For Notch Toughness Applications Only

Base Metal Thickness Range mm (in.)	GMAW kJ/mm (J/in.)	SMAW kJ/mm (J/in.)	FCAW kJ/mm (J/in.)
4.8 (0.188) ≤ T < 12.7 (0.500)	0.86 (21,895)	2.54 (64,421)	1.41 (35,725)
12.7 (0.500) ≤ T < 15.9 (0.625)	1.22 (31,000)	2.54 (64,421)	2.34 (59,423)
15.9 (0.625) ≤ T ≤ 203 (8.00)	1.22 (31,000)	3.36 (85,263)	2.34 (59,423)

Mode of Metal Transfer GMAW: Short circuiting, Waveform controlled (Miller RMD)
 FCAW: Spray or globular

Other Formula for GMAW (short circuiting, waveform controlled):
 Heat Input kJ/mm (J/in.) = Power (J/s) x Arc time (s) / Weld Bead Length mm (in.)
 Formula for SMAW & FCAW:
 Heat Input kJ/mm (J/in.) = Amps x Volts x 60 / Travel speed mm/min. (ipm)

TECHNIQUE (QW-410)

String or Weave Either Travel Speed See Table #1
 Orifice or Gas Cup Size GMAW: 9.52 to 19.1 mm (0.375 to 0.750 in.) inclusive
 FCAW: 9.52 to 25.4 mm (0.375 to 1.00 in.) inclusive
 Initial & Interpass Cleaning Brushing, chipping or grinding as required
 Method of Back Gouging Air carbon arc, back-grind as required
 Oscillation N/A
 Contact Tube to Work Distance GMAW: 6.35 to 19.1 mm (0.250 to 0.750 in.) inclusive
 FCAW: 9.52 to 25.4 mm (0.375 to 1.00 in.) inclusive
 Multiple or Single Pass Per Side Std. Appl.: Either Notch Appl.: Multiple
 Multiple or Single Electrodes Single
 Electrode Spacing N/A
 Peening Not permitted
 Use of Thermal Processes N/A

TABLE 1 - WELDING PARAMETERS**Standard Applications**

Process	Filler Metal	Diameter mm (in.)	Current & Polarity	Amps	Wire Feed Speed (ipm)	Power kJ/sec.	Volts	Travel Speed mm/min (i.p.m.)
*GMAW	ER70S-2	0.8 (0.030)	DCRP	70 - 130	80 - 250	1.0 - 2.5	13 - 21	64 - 254 (2.5 - 10)
*GMAW	ER70S-2	0.9 (0.035)	DCRP	80 - 180	150 - 350	1.5 - 3.5	14 - 22	89 - 381 (3.5 - 15)
*GMAW	ER70S-2	1.1 (0.045)	DCRP	110 - 220	200 - 500	1.8 - 4.0	15 - 23	102 - 625 (4.0 - 25)
SMAW	E7018, E7018-1	2.4 (3/32)	DCRP	60 - 110	---	---	18 - 26	18 - 300 (0.7 - 12)
SMAW	E7018, E7018-1	3.2 (1/8)	DCRP	90 - 150	---	---	19 - 28	28 - 350 (1.1 - 14)
SMAW	E7018, E7018-1	4.0 (5/32)	DCRP	110 - 220	---	---	20 - 28	36 - 400 (1.4 - 16)
SMAW	E7018, E7018-1	5.0 (3/16)	DCRP	160 - 320	---	---	21 - 30	56 - 500 (2.2 - 20)
SMAW	E7018, E7018-1	5.5 (7/32)	DCRP	240 - 350	---	---	22 - 32	86 - 550 (3.4 - 22)
SMAW	E7018, E7018-1	6.4 (1/4)	DCRP	300 - 400	---	---	22 - 32	107 - 550 (4.2 - 22)
FCAW	E71T-12MJ	1.1 (0.045)	DCRP	120 - 250	200 - 300	---	22 - 32	89 - 400 (3.5 - 16)
FCAW	E71T-12MJ	1.3 (0.052)	DCRP	150 - 300	220 - 330	---	23 - 33	102 - 500 (4.0 - 20)
FCAW	E71T-12MJ	1.6 (1/16)	DCRP	180 - 350	250 - 360	---	24 - 34	122 - 550 (4.5 - 22)

Note: 1) * Short circuiting, Waveform controlled (Miller RMD)
2) Size of electrode, filler metal, number of passes, voltage, amperage, and travel speed will vary with position, joint thickness, joint type etc.

Notch Toughness Applications

Process	Filler Metal	Diameter mm (in.)	Current & Polarity	Amps	Wire Feed Speed (ipm)	Power kJ/sec.	Volts	Travel Speed mm/min (i.p.m.)
*GMAW	ER70S-2	0.8 (0.030)	DCRP	70 - 130	80 - 250	1.0 - 2.5	13 - 21	64 - 254 (2.5 - 10)
*GMAW	ER70S-2	0.9 (0.035)	DCRP	80 - 180	150 - 350	1.5 - 3.5	14 - 22	89 - 381 (3.5 - 15)
*GMAW	ER70S-2	1.1 (0.045)	DCRP	110 - 220	200 - 500	1.8 - 4.0	15 - 23	102 - 625 (4.0 - 25)
SMAW	E7018-1	2.4 (3/32)	DCRP	60 - 110	---	---	18 - 26	20 - 300 (0.8 - 12)
SMAW	E7018-1	3.2 (1/8)	DCRP	90 - 150	---	---	19 - 28	33 - 350 (1.3 - 14)
SMAW	E7018-1	4.0 (5/32)	DCRP	110 - 220	---	---	20 - 28	41 - 400 (1.6 - 16)
SMAW	E7018-1	5.0 (3/16)	DCRP	160 - 320	---	---	21 - 30	61 - 500 (2.4 - 20)
SMAW	E7018-1	5.5 (7/32)	DCRP	240 - 350	---	---	22 - 32	97 - 550 (3.8 - 22)
SMAW	E7018-1	6.4 (1/4)	DCRP	300 - 400	---	---	22 - 32	119 - 550 (4.7 - 22)
FCAW	E71T-12MJ	1.1 (0.045)	DCRP	120 - 250	200 - 300	---	22 - 32	89 - 400 (3.5 - 16)
FCAW	E71T-12MJ	1.3 (0.052)	DCRP	150 - 300	220 - 330	---	23 - 33	102 - 500 (4.0 - 20)
FCAW	E71T-12MJ	1.6 (1/16)	DCRP	180 - 350	250 - 360	---	24 - 34	122 - 550 (4.5 - 22)

Note: 1) * Short circuiting, Waveform controlled (Miller RMD)
2) Welding parameters shall be adjusted to insure that the maximum heat input value specified in QW-409 above is not exceeded.

TYPICAL JOINT DESIGNS

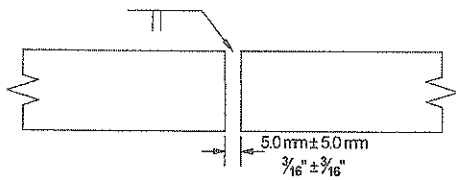


Fig. 1 Single Square Butt

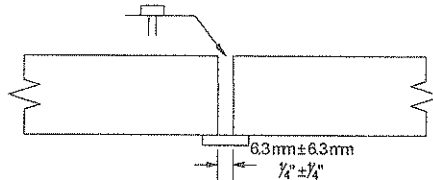


Fig. 2 Single Square Butt with Backing Strip

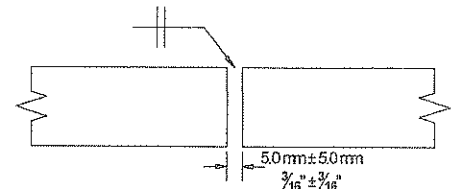


Fig. 3 Double Square Butt

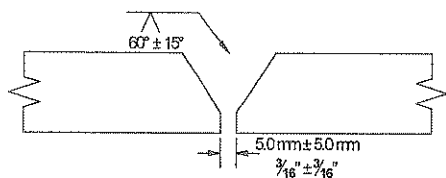


Fig. 4 Single Vee Butt

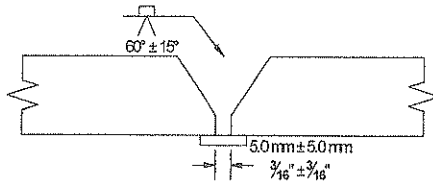


Fig. 5 Single Vee Butt with Backing Strip

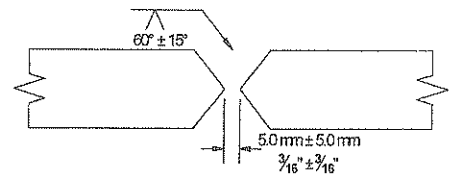


Fig. 6 Double Vee Butt

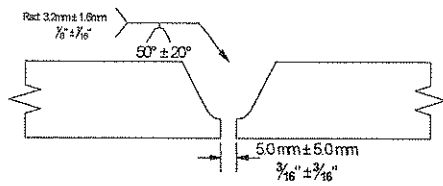


Fig. 7 Single U Butt

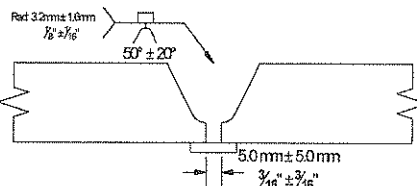


Fig. 8 Single U Butt with Backing Strip

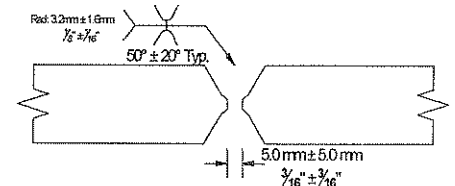


Fig. 9 Double U Butt

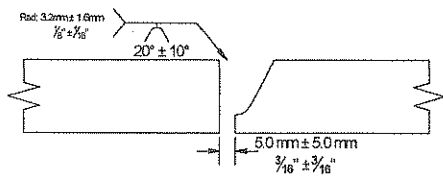


Fig. 10 Single J Butt

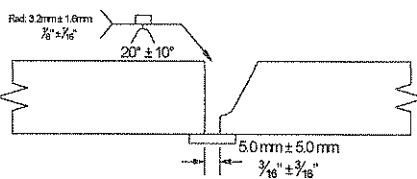


Fig. 11 Single J Butt with Backing Strip

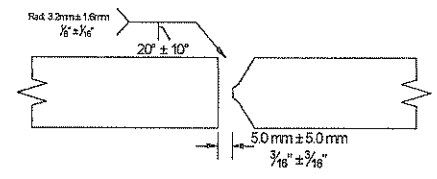


Fig. 12 Double J Butt

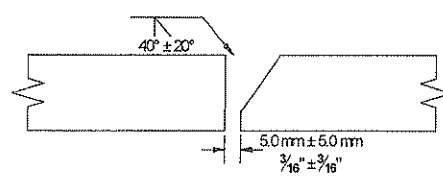


Fig. 13 Single Bevel Butt

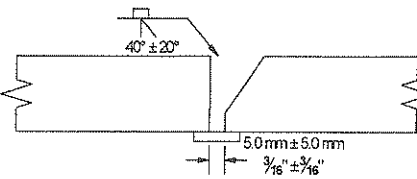


Fig. 14 Single Bevel Butt with Backing Strip

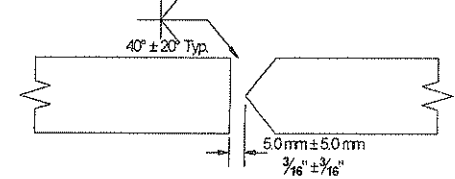


Fig. 15 Double Bevel Butt

Additional joint designs and internal misalignment on circumferential welds shall be within the dimensional limits stated on the approved construction drawing and / or the engineering design.

PREHEAT

P-No. 1

1. Welds joining pressure parts or attachments shall be preheated to not less than the minimum preheat temperatures stated in paragraph 5.
2. The preheat temperature shall be maintained during welding.
3. If welding is interrupted, the weld joint and adjacent areas shall be reheated to the minimum preheat temperature stated in paragraph 5, prior to the start of welding.
4. Preheat temperatures shall be checked by the welder or inspector, using temperature indicating crayons or other reputable methods.
5. Minimum preheating temperatures shall be as follows:

PRESSURE VESSELS IN ACCORDANCE WITH ASME SECTION VIII, DIV. 1

NOMINAL WALL THICKNESS	MINIMUM PREHEAT TEMPERATURE
0 to 31.8 mm (0 to 1.25 in.)	10°C (50°F)
Over 31.8 mm (Over 1.25 in.)	93°C (200°F)
Over 25.4 mm (1.0 in.) & specified maximum carbon content in excess of 0.30%.	80°C (175°F)

- The conditions of UW-30 shall apply for base metal temperatures below 0°C (32°F).
- The preheat zone shall extend at least 50.8 mm (2.0 in.) beyond each edge of the weld.

PROCESS PIPING IN ACCORDANCE WITH ASME B31.3

NOMINAL WALL THICKNESS	MINIMUM SPECIFIED BASE METAL TENSILE STRENGTH	MINIMUM PREHEAT TEMPERATURE
< 25.4 mm (1.0 in.)	≤ 490 MPa (71 ksi)	10°C (50°F)
≥ 25.4 mm (1.0 in.)	All	80°C (175°F)
All	> 490 MPa (71 ksi)	80°C (175°F)

- The preheat zone shall extend at least 25.4 mm (1.0 in.) beyond each edge of the weld.
- The interruption of welding shall be subject to the requirements of paragraph 330.2.4.

POWER PIPING IN ACCORDANCE WITH ASME B31.1

NOMINAL WALL THICKNESS	MINIMUM PREHEAT TEMPERATURE
Over 25.4 mm (1.0 in.) & specified maximum carbon content in excess of 0.30%.	80°C (175°F)
All others	10°C (50°F)

- The preheat zone shall extend beyond each edge of the weld for at least 76.2 mm (3.0 in.) or 1.5 times the base metal thickness (as defined in paragraph 131.4.1), whichever is greater.

FABRICATION WELDS IN ACCORDANCE WITH CSA Z662-11

NOMINAL WALL THICKNESS	MINIMUM PREHEAT TEMPERATURE
< 25.4 mm (1.0 in.)	10°C (50°F)
≥ 25.4 mm (1.0 in.)	80°C (175°F)

- The preheat zone shall extend beyond each edge of the weld for at least 50.8 mm (2.0 in.) and around the full pipe circumference.

QW-483 PROCEDURE QUALIFICATION RECORD (PQR)

National Process Equipment Inc.

Procedure Qualification Record No. NPE-4-1 Date May 28, 2012
Welding Procedure Specification No. NPE-4
Welding Process(es) GMAW / FCAW Type(s) Semi-automatic

JOINTS (QW-402)

Type Butt joint, single vee groove, see next page

BASE METALS (QW-403)

Material Spec. SA 333 to SA 350 Type or Grade Gr. 6 to Gr. LF2
P-No. P1 Grp. 1 To P-No. P1 Grp. 2 Thickness 6.32 mm (0.249 in.)
Diameter 168.3 mm (6.625 in.) O.D. Other Schedule 40 m/c to 0.249 in.
Heat Number 84680 to 12/30011 Carbon Equivalent 0.224 to 0.388
Deposited Weld Metal (Per pass) Did not exceed 12.7 mm (0.500 in.)
C.E. formula per CSA Z662-11: $C + F(Mn/6 + Si/24 + Cu/15 + Ni/20 + Cr/5 + Mo/5 + V/5 + Cb/5 + 5B)$

FILLER METALS (QW-404)

	<u>GMAW</u>	<u>FCAW</u>
Specification No. (SFA)	<u>SFA 5.18</u>	<u>SFA 5.20</u>
AWS No. (Class)	<u>ER70S-2</u>	<u>E71T-12MJ</u>
Filler Metal F-No.	<u>F6</u>	<u>F6</u>
Filler Metal A-No.	<u>A1</u>	<u>A1</u>
Filler Metal Product Form	<u>Solid wire</u>	<u>Flux cored wire</u>
Supplementary Fillers	<u>Without</u>	<u>Without</u>
Size of Electrode	<u>See attached sketch</u>	
Deposited Weld Metal Thickness	<u>3.18 mm (0.125 in.)</u>	<u>3.15 mm (0.124 in.)</u>
Trade Name	<u>Bonarc ER70S-2</u>	<u>Kobelco DW-A55ESR</u>

POSITION (QW-405)

Position of Groove GMAW: Pipe rolled with nozzle tip at 30° from top FCAW: 1G (Rolled)
Weld Progression GMAW: Vertical down FCAW: N/A

PREHEAT (QW-406)

Preheat Temperature 10°C (50°F) Interpass Temp. (Max.) 232°C (450°F)

POSTWELD HEAT TREATMENT (QW-407)

Temperature Range None Time Range N/A

GAS (QW-408)

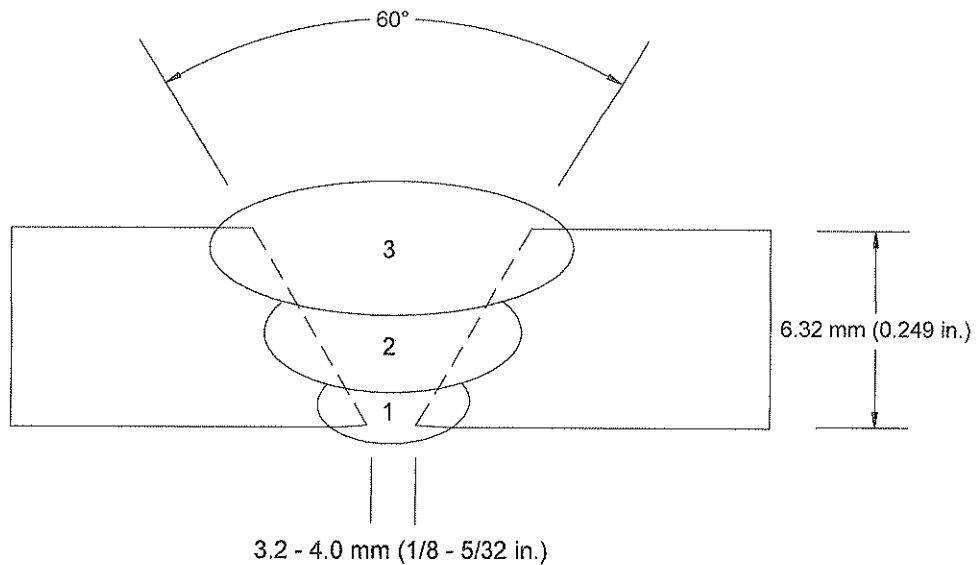
Specification No. (SFA) SFA 5.32 AWS No. SG-AC-25
Shielding GMAW: 75% Argon, 25% CO₂, 15 liters per minute (30 cfph)
FCAW: 75% Argon, 25% CO₂, 17.5 liters per minute (35 cfph)
Backing None Trailing Without

ELECTRICAL CHARACTERISTICS (QW-409)

Current Direct Polarity Reverse, electrode positive
Amps See next page Volts See next page
Maximum Heat Input GMAW: 0.86 kJ/mm (21,895 J/in.) FCAW: 1.41 kJ/mm (35,725 J/in.)
Mode of Metal Transfer GMAW: Short circuiting, waveform controlled (Miller RMD)
Mode of Metal Transfer FCAW: Spray
Other Formula for GMAW (short circuiting, waveform controlled):
Heat Input kJ/mm (J/in.) = Power (J/s) x Arc time (s) / Weld Bead Length mm (in.)
Formula for FCAW:
Heat Input kJ/mm (J/in.) = Amps x Volts x 60 / Travel speed mm/min. (ipm)

TECHNIQUE (QW-410)

String or Weave	<u>Weave</u>	Travel Speed	<u>See below</u>
Orifice or Gas Cup Size	<u>GMAW: 9.52 mm (0.375 in.)</u>	FCAW:	<u>15.9 mm (0.625 in.)</u>
Initial & Interpass Cleaning	<u>Brushing, chipping & grinding to remove slag</u>		
Method of Back Gouging	<u>Not used</u>	Oscillation	<u>N/A</u>
Contact Tube to Work Distance	<u>GMAW: 9.52 mm (0.375 in.)</u>		
	<u>FCAW: 12.7 to 19.1 mm (0.500 to 0.750 in.)</u>		
Multiple or Single Pass Per Side	<u>Multiple</u>	Multiple or Single Electrodes	<u>Single</u>
Electrode Spacing	<u>N/A</u>	Peening	<u>None</u>
Use of Thermal Processes:	<u>N/A</u>		



Pass	Process	Filler Metal	Diameter mm (in.)	Current & Polarity	Amperage Range	Voltage Range	Travel Speed mm/min.(i.p.m.)
1	*GMAW	ER70S-2	0.9 (0.035)	DCRP	125 - 135	18 - 19	168 (6.6)
2	**FCAW	E71T-12MJ	1.1 (0.045)	DCRP	235 - 245	25	302 (11.9)
3	**FCAW	E71T-12MJ	1.1 (0.045)	DCRP	250 - 270	30	333 (13.1)

* Short circuiting - Waveform controlled (Miller RMD)

** Wire Feed Speed for FCAW: 320 -330 ipm.

***GMAW (Miller RMD) Heat Input Parameters**

Pass	Power kJ/sec.	Arc Time Sec.	Weld Bead Length mm (in.)	Heat Input kJ/mm (Joule/in.)	Wire Feed Speed i.p.m.
1	2.3 - 2.5	130	362 (14.25)	0.86 (21,895)	235

CHARPY IMPACT TOUGHNESS

Type of Test Charpy V-Notch Orientation Transverse
 Test Temperature -48°C (-55°F) Specimen Size 10 X 5 mm (0.394 X 0.197 in.)

Specimen No.	Notch Location	Impact Values J (ft. lbs)
J2.1	Weld Metal	18.4 (13.6)
J2.2	within 1/16 in.	78.9 (58.2)
J2.3	of root	23.3 (17.2)
J3.1	Gr. 6 - HAZ	55.9 (41.2)
J3.2	Gr. 6 - HAZ	>141 (>104)
J3.3	Gr. 6 - HAZ	38.5 (28.4)
K3.1	Gr. LF2 - HAZ	22.0 (16.2)
K3.2	Gr. LF2 - HAZ	37.1 (27.4)
K3.3	Gr. LF2 - HAZ	39.6 (29.2)

OTHER TESTS

Vickers Hardness - see attached laboratory test report # C12-810.7

Welders Name Donald Kennedy Certificate File No. W-7153
 Tests Conducted By Ludwig Associates Ltd.
 Laboratory Test No. C12-810.7

We certify the statements in this record are correct and that the test welds were prepared, welded and tested in accordance with the requirements of Section IX of the ASME Code.

Manufacturer NATIONAL PROCESS EQUIPMENT INC.

Date June 11/12 Certified by [Signature]



LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: National Process Equipment Inc.
5049 - 74th Avenue S.E.
Calgary, Alberta
T2C 3H2

Laboratory Test No.: C12-810.7
Date: May 29, 2012

Attention: Rick St. Louis

PQR Number: NPE-4-1

Material: SA 333 Gr. 6 to SA 350 Gr. LF2 (Heat No.: 84680 to 12/30011)

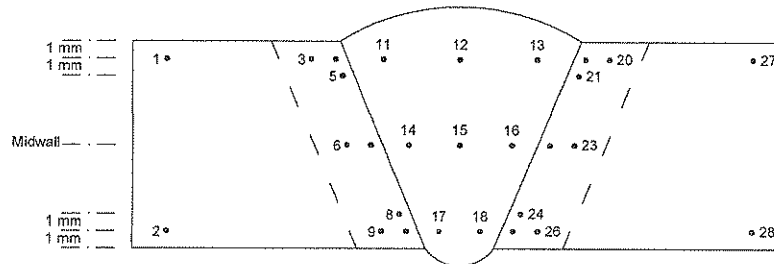
Size: 168.3 mm (6.625 in.) O.D. x 6.32 mm (0.249 in.) w.t.

Thermal Condition: As welded

HARDNESS TEST

Type of Test: Vickers 10 kg (HV10)

Instrument: Mitutoyo AVK-C1



SA 333 Gr. 6				Weld Metal		SA 350 Gr. LF2			
Parent Metal		HAZ				HAZ		Parent Metal	
1	164	3	160	11	156	19	182	27	151
2	164	4	176	12	172	20	164	28	148
		5	184	13	162	21	182		
		6	172	14	157	22	176		
		7	177	15	165	23	171		
		8	167	16	161	24	176		
		9	166	17	150	25	172		
		10	168	18	149	26	165		

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASTM E384-10^{e2} and ANSI/NACE MR0175/ISO 15156-2:2009(E). The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. **Samples associated with this report will be discarded in 45 days.**

Laboratory Test Conducted By: _____

Michelle Marien, T.T. / Steve Rieberger, C.E.T.





INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1B: 1991)

Number / Número: **635625**
Page / Página: **1 / 8**

Date / Día: **December 14, 2013**

Customer's Reference / Ref. del Cliente: **435697408**

Manufacturer's Works Order N° / Confirmación del Fabricante: **5088874**

Surface / Superficie: **INT BARE (EXT VARNISHED)**

Ends / Extremos: **REVELLED AT 30 DEG. ASTM**

Normal Weight / Peso Nominal: **18.97 LB/FT
28.28 KG/3M**

Customer / Cliente: **VAN LEEUWEN PIPE & TUBE (CANADA) IN**

Customer's Order Item / Orden Cliente - Item: **45001406-00021**

Product Type / Tipo de Producto: **CARBON STEEL FOR LOW TEMPERATURE SERVICE**

Steel Grade / Grado de acero: **1/8"359 CAT II SS**

Quantity / Cantidad: **48 Pcs/42**

Weight / Peso: **35300 LB
16012 KG**

Customer / Cliente: **VAN LEEUWEN PIPE & TUBE (CANADA) IN**

Product Type / Tipo de Producto: **CARBON STEEL FOR LOW TEMPERATURE SERVICE**

Steel Grade / Grado de acero: **1/8"359 CAT II SS**

Quantity / Cantidad: **48 Pcs/42**

Weight / Peso: **35300 LB
16012 KG**

TENSILE TEST / ENSAYO DE TENSION

Heat N° Coleta N°	Sample N° Muestra N°	Zone Zona	Lot N° Lote N°	Pipe N° Tubo N°	Specimen condition Condición de la probeta		Specimen dimensions Dimensiones de la probeta		Test temp Temp. ensayo	Y.S. Estr. 0.50 %	U.T.S. Req.	Elongation / Alargamiento		Obl. %
					LS	SS	Type Tipo	Orientation Orientación				Area Sección	Temp. Temperatura	
84679	1741552	E2	48858	3	B	AM	SS	24.94 x 6.98	RT	436	511	50.8	33.0	36.6
84679	1741684	E1	48858	29	B	AM	SS	25.10 x 7.15	RT	435	510	50.8	33.0	34.1
84680	1740770	E1	48831	5	B	AM	SS	25.07 x 7.57	RT	465	534	50.8	33.0	34.9
84680	1740796	E2	48831	45	B	AM	SS	24.89 x 7.38	RT	426	507	50.8	33.0	37.9
84680	1740781	E1	48831	65	B	AM	SS	25.04 x 6.97	RT	441	512	50.8	33.0	34.5
84680	1740795	E2	48831	85	B	AM	SS	24.95 x 6.87	RT	481	503	50.8	33.0	36.4
84680	1741674	E2	48858	10	B	AM	SS	25.01 x 6.95	RT	448	524	50.8	33.0	35.6
84680	1741578	E1	48858	30	B	AM	SS	25.02 x 6.82	RT	447	523	50.8	33.0	34.7
84680	1741581	E2	48857	5	B	AM	SS	25.10 x 6.89	RT	468	498	50.8	33.0	33.3
84680	1741642	E1	48857	28	B	AM	SS	25.11 x 7.12	RT	484	517	50.8	33.0	37.0
84680	1741642	E1	48857	28	B	AM	SS	24.92 x 7.43	RT	422	501	50.8	33.0	34.8

CG-3
GNPS sch 40
ASTM A333 Gr. 6
ASME SA333 Gr. 6
CSA Z245.1 Gr. 359
HE # 84680
Rec'd May 18, 2012
EJH

AM: As manufactured / Según proceso de fabricación
E1 / E2: Ends of Sampling / Extremos de Muestra
L: Longitudinal / Longitudinal
Lo: Initial length / Longitudinal initial

LS: Lessen of sample / Ubicación de la muestra
Max: Maximum / Máximo
Min: Minimum / Mínimo
Obl: Obtained / Obtenido
Ori: Orientation / Orientación

Req: Required / Requerido
RT: Room temperature / Temperatura ambiente
SS: Strip specimen / Muestra rectangular

U.T.S: Ultimate tensile strength / Resistencia
Y.S: Yield strength / Fluencia

This certificate is issued by a computerized system and it is valid with electronic signature. On the original certificate the recipient must return a copy of it, to the most effect its conformity to the original one being upon based the responsibility for any unapproved or not allowed use. Any alteration under publication will be subjected to the law.

APPROVED BY
FORU3171



INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1B: 1991)

Customer / Cliente: VAN LEEUWEN PIPE & TUBE (CANADA) IN

Manufacturing Process / Proceso de Manufactura: SEAMLESS HOT ROLLED

Standard or Specification / Normas o Especificaciones: ASTM/A53RE A53A338*CSA 2245-1-07 CATH SSPSP0374(+NAACE MR0175U109+PRO LP-006

Dimensions / Dimensiones: 6.5618 X 0.280 INCH / 168.30 X 7.11 MM

Schedule / Cédula: 040

Length / Longitud: 11800 mm

Quantity / Cantidad: 48 Pcs/pez

Weight / Peso: 53300 LB / 16012 KG

Number / Número: 635625

Date / Dia: December 14, 2011

Customer's Reference / Ref. del Cliente: 45887408

Manufacturer's Name / Nombre del Fabricante: 50885M \$

Surface / Superficie: INT BARE / EXT VARNISHED

Ends / Extremos: REVELLED AT 30 DEG. ASTM

Nominal Weight / Peso Nominal: 18.97 LB/FT

Weight / Peso: 26.26 KG/M

Subsidiary S.A.I.C.
Dr. José A. Rivera 255
8266-C-2-A) Company
Buenos Aires, Argentina
(54) 2498 433 100 tel

THROUGH WALL HARDNESS / DUREZA EN EL ESPESOR

Heat N° / Cebada N°	Sample N° / Muestra N°	Zone / Zona	Pipe N° / Tube N°	Individuals / Individuales		Average / Promedio		Hardness type HV10 / Tipo de dureza				ID	AVG.	Ver.	
				Min	Max	Min	Max	1	2	3	4				
84679	1741652	E2	49858	1	162.0	156.0	153.0	168.0	177.3	156.0	162.0	159.5	165.0	160.0	163.3
84680	1741694	E1	49858	1	163.0	159.0	164.0	165.0	162.8	159.0	167.0	164.0	165.0	161.0	163.3
84680	1740770	E1	49831	1	169.0	167.0	162.0	166.0	166.0	165.0	167.0	166.0	166.0	162.0	165.3
84680	1740773	E2	49831	1	152.0	153.0	154.0	163.0	156.0	161.0	162.0	161.0	160.0	160.0	163.3
84680	1740785	E2	49831	1	161.0	158.0	161.0	161.0	160.3	159.0	160.0	158.0	158.0	160.0	163.3
84680	1740791	E1	49831	1	158.0	160.0	162.0	163.0	163.0	159.0	160.0	158.0	158.0	160.0	163.3
84680	1740795	E2	49831	1	159.0	165.0	161.0	162.0	162.8	166.0	169.0	171.0	167.0	160.0	163.3
84680	1741571	E2	49855	1	163.0	159.0	164.0	165.0	162.8	166.0	167.0	164.0	163.0	163.0	163.3
84680	1741578	E1	49855	1	161.0	159.0	160.0	167.0	167.0	165.0	166.0	164.0	165.0	162.0	163.3
84680	1741581	E2	49857	1	148.0	143.0	150.0	151.0	148.3	145.0	147.0	149.5	151.0	148.0	160.5
84680	1741642	E1	49857	1	148.0	143.0	150.0	151.0	148.3	145.0	147.0	149.5	151.0	148.0	160.5

AVG: Average / Promedio

B: Body / Cuerpo

E1 / E2: Ends of Sampling / Extremos de Muestra

ID: Internal diameter / Diámetro interno

Le: Location of sample / Ubicación de la muestra

Max: Maximum / Máximo

Min: Minimum / Mínimo

mm: Outside wall / Centeo

OD: Outside diameter / Diámetro externo

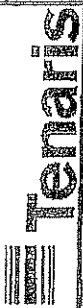
Quest: Quotient / Cociente

Var: Variation / Variación

This certificate is issued by a computerized system and it is valid with electronic signature. On the original certificate the trace-mark green colored "Tenaris" is stamped. In case the owner of the original certificate would release a copy of it, he must attest its conformity to the original one taking upon himself the responsibility for any use that is not allowed one. Any alteration made in this certificate will be subjected to the law.

Este certificado es emitido mediante sistema Computarizado y es válido con firma electrónica. El certificado original presenta impresa al logo Tenaris en verde. En caso de que el poseedor del certificado entregara una copia, deberá garantizar la conformidad con el original haciéndose responsable por cualquier uso que no sea el permitido. Cualquier alteración en este certificado será sancionada de acuerdo a la ley.

FOR03171



INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1B: 1991)

Number / Número: **635625**
 Pags / Páginas: **4 / 8**

S d'arçà S.A.I.C
 D-48-96 A. Sirmed 250
 E-02644-A4 Company
 R-4-125 A.Tes. Especificada
 T-0 3448 433 100 181

Customer / Cliente: VAN LEEUWEN PIPE & TUBE (CANADA) IN
 Customer's Order / Orden Cliente - Item: 45001406-00021
 Date / Dia: December 14, 2011
 Customer's Reference / Ref. del Cliente: 45901408

Manufacturer's Process / Proceso de Manufactura: SEAMLESS HOT ROLLED
 Product Type / Tipo de Producto: CARBON STEEL FOR LOW TEMPERATURE SERVICE
 Standard or Specification / Normas o Especificaciones: ASTM/A516 A/SA333+CSA Z245.1-07 CATH SSPSP003741+NAACE BIR0750103+IPRO LP-006

Dimensions / Dimensiones: 6 5/8 X 0.286 INCH / 168.30 X 7.11 MM
 Schedule / Cédula: 940
 Length / Longitud: N/A
 Quantity / Cantidad: 48 Pcs/pz
 Nominal Weight / Peso Nominal: 18.97 LB/FT / 28.26 KG/M

Surface / Superficie: INT BARE EXT VARNISHED
 Ends / Extremos: BEVELLED AT 30 DEG. ASTM

Manufacturer's Works Order / Orden de Fabricación: 5088876

IMPACT TEST / ENSAYO DE IMPACTO

Heat No. Cofada N°	Sample No. Muestra N°	Lot No. Lote N°	Pipe No. Tubo N°	S	Ls	Sc	T.T. °C	Unit/Dimens. mm	Orientation/Orientación: T			Ind. Min. Req.	Req. Min. Avg.	Shear area / Area de cizall. %
									Results / Resultados	Avg.	Req. Min. Avg.			
84679	1741684	49856	28	B	AM	-45	10.0 x 5.0	137.0	141.0	184.0	100	100	100	100
84680	1740770	49831	5	B	AM	-45	10.0 x 5.0	166.0	164.0	196.0	100	100	100	100
84680	1741578	49856	30	B	AM	-45	10.0 x 5.0	124.0	141.0	133.0	100	100	100	100
84680	1741531	49857	5	B	AM	-45	10.0 x 5.0	164.0	146.0	144.0	100	100	100	100

AM: As manufactured / Según proceso de fabricación
 Avg: Average / Promedio
 B: Body / Cuerpo
 Ind. Min. Req: Individual Minimum Required / Requerido Mínimo Individual
 L: Location of sample / Ubicación de la muestra
 Req. Min. Avg: Required minimum average / Promedio mínimo requerido
 Sc: Specimen condition / Condición de la probeta
 T.T: Test temperature / Temperatura de ensayo

Heat No. Cofada N°	Sample No. Muestra N°	Lot No. Lote N°	Pipe No. Tubo N°	S	Ls	Sc	T.T. °C	Unit/Dimens. mm	Orientation/Orientación: L			Ind. Min. Req.	Req. Min. Avg.
									Results / Resultados	Avg.	Req. Min. Avg.		
84679	1741684	49856	28	B	AM	-52	10.0 x 5.0	173.0	164.0	170.0	100	100	
84680	1740770	49831	5	B	AM	-52	10.0 x 5.0	155.0	165.0	158.0	100	100	
84680	1741578	49856	30	B	AM	-52	10.0 x 5.0	170.0	167.0	171.0	100	100	
84680	1741531	49857	5	B	AM	-52	10.0 x 5.0	161.0	156.0	147.0	100	100	

AM: As manufactured / Según proceso de fabricación
 Avg: Average / Promedio
 Ind. Min. Req: Individual Minimum Required / Requerido Mínimo Individual
 L: Location of sample / Ubicación de la muestra
 Req. Min. Avg: Required minimum average / Promedio mínimo requerido
 Sc: Specimen condition / Condición de la probeta
 T.T: Test temperature / Temperatura de ensayo

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INSPECTION CERTIFICATE



(BS EN 10204 3.1: 2004 - ISO 10474 3.1B: 1991)

Page / Página:
5 / 8

Number / Número:
6355625

Date / Día: December 14, 2011

Customer / Cliente: VAN LEEUWEN PIPE & TUBE (CANADA) IN

Customer's Order Item / Orden Cliente - Item:
45801406-00021

Customer's Reference / Ref. del Cliente:
45801408

Manufacturing Process / Proceso de Manufactura:
SEAMLESS HOT ROLLED

Product Type / Tipo de Producto:
CARBON STEEL FOR LOW TEMPERATURE SERVICE

Steel Grade / Grado de acero:
1/8359 CAT II SS

Surface / Superficie:
INT BARE (EXT VARNISHED)

Ends / Extremos:
BEVELLED AT 30 DEG. ASTM

Quantity / Cantidad: 48 Pcs/lbz
1847.88 FT

Nominal Weight / Peso Nominal:
18.37 LB/FT
28.28 KG/M

Dimensions / Dimensiones:
Ø 51.8 X 0.230 INCH
129.30 X 7.11 MM

Schedule / Condición:
040

Length / Longitud:
11590 mm

Standard / Norma:
ASTM/A533-03/CSA Z245.1-07 CATH SSPS-P003741+NAACE MR0170-103+IPRO LP-0108

Manufacturer's Works Order N° / Orden de Fabricación:
508867/8

Temp. Temperatura / Temperatura:
milímetro requerido

L: Longitudinal / Longitudinal

E: Body / Cuerpo

IMPACT TEST / ENSAYO DE IMPACTO

Standard / Norma:	Heat N° / Colada N°	Lot N° / Muestra N°	Sample N° / Muestra N°	Result / Resultado
	34680	49831	1740733	Good / Bueno
	34680	49831	1740791	Good / Bueno
	34680	49831	1740795	Good / Bueno
	34680	49836	1741571	Good / Bueno

Standard / Norma:	Heat N° / Colada N°	Lot N° / Muestra N°	Sample N° / Muestra N°	Result / Resultado
	34680	49854	1741574	Good / Bueno
	34680	49857	1741581	Good / Bueno
	34680	49857	1741642	Good / Bueno

E: Body / Cuerpo

FLATTENING TEST / ENSAYO DE APLASTAMIENTO

L: Longitudinal / Longitudinal

E: Body / Cuerpo

HYDROSTATIC TEST / PRUEBA HIDRAULICA

L: Longitudinal / Longitudinal

E: Body / Cuerpo

Pressure / Presión

Value / Valor
3,000

Time / Tiempo

Result / Resultado
Satisfactory / Satisfactorio

Unit / Unidad

Value / Valor
5

Result / Resultado
Satisfactory / Satisfactorio

Subsidiary / Subsidiario

Temp. Temperatura / Temperatura:
milímetro requerido

L: Longitudinal / Longitudinal

E: Body / Cuerpo

Pressure / Presión

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Time / Tiempo

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Satisfactory / Satisfactorio

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Subsidiary / Subsidiario

Temp. Temperatura / Temperatura:
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E: Body / Cuerpo

Pressure / Presión

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Subsidiary / Subsidiario

L: Location of sample / Ubicación de la muestra

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L: Location of sample / Ubicación de la muestra



Tenaris

INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1B: 1991)

Customer / Cliente: VAN LEEUWEN PIPE & TUBE (CANADA) IN

Number / Número: 635625

Page / Página: 6 / 8

Date / Día: December 14, 2011

Sociedad S.A.T.C.
D-0798 A Street 250
Buenos Aires, Argentina
(54) 3463 433 60 Tel

Manufacturing Process / Proceso de Manufactura:
SEAMLESS HOT ROLLED

Customer's Order Item / Orden Cliente - Item:
45007406-00021

Customer's Reference / Ref. del Cliente:
45007408

Manufacturer's Order N° / Orden Cliente Ref. Verifica:
50880748

Product Type / Tipo de Producto:
CARBON STEEL FOR LOW TEMPERATURE SERVICE

Size / Grado / Grado de acero:
169359 CAT II SS

Surface / Superficie:
INT BARE EXT VARNISHED

Standard or Specification / Normas o Especificaciones:
ASTM A333-4/CSA Z245.1-07 CAT II SSPSP00374/1+NACE MR01750903+IPRO LP-006

Ends / Extremos:
BEVELLED AT 30 DEG. ASTM

Dimensions / Dimensiones:
6.678 X 0.280 INCH
168.30 X 7.11 MM

Schedule / Código:
040

Quantity / Cantidad: 48 Pcs/pz

Nominal Weight / Peso Nominal:
18.97 LB/FT
25.26 KG/M

HEAT TREATMENT / TRATAMIENTO TERMICO

Heat treatment / Tratamiento térmico: Pipe / Tubo
Quench media of heat treatment process / Medio de enfriamiento del tratamiento térmico: WATER
Temperature Scale / Escala de Temperatura: Celsius

Type / Tipo	Temperature / Temperatura	Tolerance / Tolerancia	Duration / Duración (Min.)
QUENCHED	900	-10	26
TEMPERED	685	-8	32

SPECIAL REQUIREMENTS / REQUERIMIENTOS ESPECIALES

Condition / Condición
Pipe residual magnetism / Magnetismo remanente de tubo
End protectors / Protector de extremo

Description / Descripción
30 GAUSS
NON LIFTABLE CLOSED PLASTIC PROTECTOR FOR FLAT / BEVELED PIPE, SUPPLIER METALCENTRO.

SUPPLEMENTARY INFORMATION / INFORMACION SUPLEMENTARIA

Supplementary Information / Información Suplementaria

*MANUFACTURED BY TENARIS SIDERCA

ACIERAGE PROCESS

*THE LF PRACTICE INCLUDES ARGON RINSE AND A FINAL INJECTION OF CALCIUM SILICIDE WIRE FOR MICROINCLUSION SHAPE CONTROL.

FABRICADO POR TENARIS SIDERCA

PROCESO DE ACERACION

*LA PRACTICA DE AFINO EN EL HORNO - CUCHARA INCLUYE AGITACION POR ARGON Y LINA INYECCION FINAL DE LÍVARILLA DE SILICIOURO DE CALCIO PARA OBTENER UNA FORMA GLOBULAR DE EVENTUALES MICROINCLUSIONES.

*THIS CERTIFICATE IS ISSUED BY TENARIS SIDERCA AND IS VALID ONLY FOR THE ORIGINAL PRODUCT. ANY ALTERATION OR REPRODUCTION OF THIS CERTIFICATE WITHOUT THE WRITTEN PERMISSION OF TENARIS SIDERCA IS STRICTLY PROHIBITED. *ESTE CERTIFICADO ES EMITIDO POR TENARIS SIDERCA Y ES VALIDO SOLO PARA EL PRODUCTO ORIGINAL. CUALQUIER ALTERACION O REPRODUCCION DE ESTE CERTIFICADO SIN EL CONSENTIMIENTO POR ESCRITO DE TENARIS SIDERCA ESTÁ ESTRICTAMENTE PROHIBIDA.



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INSPECTION CERTIFICATE

Customer / Cliente: VAN LEEUWEN PIPE & TUBE (CANADA) IN

(BS EN 10204 3.1: 2004 - ISO 10474 3.1B: 1991)

Number / Número: 635625

Page / Página: 7/8

Date / Día: December 14, 2011

Manufacturing Process / Proceso de Manufactura: SEAMLESS HOT ROLLED

Customer's Order Item / Orden Cliente - Item: 45007408-00021

Customer's Reference / Ref. del Cliente: 45007408

Manufacturer's Works Order N° / Orden de Trabajo del Fabricante: 5886715

Standard or Specification / Norma o Especificación: ASTM/ASME A5A333+CSA Z245.1-07 CATH SSP-SP00374/1+WACE MR0175/0103+IPRO LP-006

Product Type / Tipo de Producto: CARBON STEEL FOR LOW TEMPERATURE SERVICE

Surface / Superficie: INT BARE TEXT VARNISHED

Dimensions / Dimensiones: 6 5/8 X 0.280 INCH
166.30 X 7.11 MM

Schedule / Cédula: 040

Steel Grade / Grado de acero: 160359 CAT II SS

Length / Longitud: 11809 MM

Quantity / Cantidad: 48 Pcs/lpz

Ends / Extremos: BEVELLED AT 30 DEG. ASTM

Nominal Weight / Peso Nominal: 18.97 LB/FT

Weight / Peso: 563.22 NITS

Net Weight / Peso Neto: 28.26 KGM

SUPPLEMENTARY INFORMATION / INFORMACION SUPLEMENTARIA

Supplementary Information / Información Suplementaria

- *MATERIAL FREE FROM MERCURY CONTAMINATION.
- *ROLLING PROCESS*
- *MANUFACTURING PROCESS : SEAMLESS HOT ROLLED.
- *CONTROLS*
- *VISUAL AND DIMENSIONAL INSPECTION : SATISFACTORY.
- *WATERIAL CONDITIONS*
- *NOT REPAIRED BY WELDING.
- *STANDARDS*
- *EDITION OF REGULATION: ASTM A 333-11
- *EDITION OF REGULATION: ASME SA 333/2010
- *EDITION OF REGULATION: NACE MR-01-03 EDITION 2010
- *EDITION OF REGULATION: NACE MR 01-75 - ISO 15156-2 : 2000
- *EDITION OF REGULATION : CSA Z246 : 2007

- *MATERIAL LIBRE DE CONTAMINACIÓN DE MERCURIO.
- *PROCESO DE LAMINACIÓN*
- *FABRICACIÓN DE TUBO: LAMINADO EN CALIENTE Y SIN COSTURA.
- *CONTROLES*
- *CONTROL VISUAL Y DIMENSIONAL: SATISFACTARIO.
- *CONDICIONES DEL MATERIAL*
- *NO REPARADO POR SOLDADURA.
- *NORMAS*
- *EDICIÓN DE LA NORMA: ASTM A 333-11
- *EDICIÓN DE LA NORMA: ASME SA 333/2010
- *EDICIÓN DE LA NORMA: NACE MR-01-03 EDITION 2010
- *EDICIÓN DE LA NORMA: NACE MR 01-75 - ISO 15156-2 : 2000
- *EDICIÓN DE LA NORMA: CSAZ246: 2007

Additional Information / Información Adicional

NON DESTRUCTIVE TEST: SATISFACTORY.
INSPECTION METHODS: E.M.I. LONG. (EXT.) NOTCH 5 % (INT.) NOTCH 10 % + E.M.I. TRANSV. (EXT./INT.)
NOTCH 10 % + M.P.I. LONG./TRANSV. (EXT./INT.) ENDS + W.M.P.I. ON BEVELS.

Additional Information / Información Adicional
WALL THICKNESS MONITORING: U.T. LONGITUDINAL PATH.
ONE YELLOW BAND ON EACH END.

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Este certificado es emitido únicamente a través de un sistema automatizado y es válido con firma electrónica. El certificado original posee un sello de color verde. En caso de que el poseedor del certificado emita una copia, deberá garantizar la conformidad con el original haciendo responsable por cualquier uso ilegal e indebido. Cualquier alteración y/o falsificación estará sujeta a la ley.

FOR03171



LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: National Process Equipment Inc. **Laboratory Test No.:** C12-810.7
 5049 - 74th Avenue S.E. **Date:** May 30, 2012
 Calgary, Alberta
 T2C 3H2

Attention: Rick St. Louis


PQR Number: NPE-4-1
Material: SA 333 Gr. 6 to SA 350 Gr. LF2 (Heat No.: 84680 to 12/30011)
Size: 168.3 mm (6.625 in.) O.D. x 6.32 mm (0.249 in.) w.t.
Thermal Condition: As welded

CHARPY V-NOTCH IMPACT TEST

Machine: Satec, SI-1C SN:1363 **Specimen Size:** 10 x 5 mm (0.394 x 0.197 in.)
Capacity: 325 J (240 ft-lbf) **Orientation:** Transverse
Verified Range: 1.7 - 141.3 J (1.3 - 104.2 ft-lbf) **Test Temp.:** -48°C (-55°F)

Specimen Number	Notch Location	Impact Values	
		Joules	(ft-lbf)
J2.1	Weld Metal	18.4	(13.6)
J2.2	within 1/16 in.	78.9	(58.2)
J2.3	of root	23.3	(17.2)
J3.1	Gr. 6 HAZ	55.9	(41.2)
J3.2	Gr. 6 HAZ	>141	(>104)
J3.3	Gr. 6 HAZ	38.5	(28.4)
K3.1	Gr. LF2 HAZ	22.0	(16.2)
K3.2	Gr. LF2 HAZ	37.1	(27.4)
K3.3	Gr. LF2 HAZ	39.6	(29.2)

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section VIII, Div. 1, UG-84 – 2010 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. **Samples associated with this report will be discarded in 45 days.**

Laboratory Test Conducted By: 
 Claire Robinson, T.T. / Steve Rieberger, C.E.T.



QW-483 PROCEDURE QUALIFICATION RECORD (PQR)

National Process Equipment Inc.

Procedure Qualification Record No. NPE-4-2 Date May 28, 2012

Welding Procedure Specification No. NPE-4

Welding Process(es) GMAW / FCAW Type(s) Semi-automatic

JOINTS (QW-402)

Type Butt joint, single vee groove, see next page

BASE METALS (QW-403)

Material Spec. SA 333 to SA 350 Type or Grade Gr. 6 to Gr. LF2

P-No. P1 Grp. 1 To P-No. P1 Grp. 2 Thickness 12.7 mm (0.500 in.)

Diameter 219.1 mm (8.625 in.) O.D. Other 8 in. NPS Schedule 80

Heat Number 75361 to 555063 Carbon Equivalent 0.238 to 0.409

Deposited Weld Metal (Per pass) Did not exceed 12.7 mm (0.500 in.)

C.E. formula per CSA Z662-11: $C + F(Mn/6 + Si/24 + Cu/15 + Ni/20 + Cr/5 + Mo/5 + V/5 + Cb/5 + 5B)$

FILLER METALS (QW-404)

Specification No. (SFA) GMAW SFA 5.18 FCAW SFA 5.20

AWS No. (Class) ER70S-2 E71T-12MJ

Filler Metal F-No. F6 F6

Filler Metal A-No. *A1 A1

Filler Metal Product Form Solid wire Flux cored wire

Supplementary Fillers Without Without

Size of Electrode See attached sketch

Deposited Weld Metal Thickness 3.18 mm (0.125 in.) 9.52 mm (0.375 in.)

Trade Name Bonarc ER70S-2 Kobelco DW-A55ESR

Other *See attached chemical analysis report C12-810.8

POSITION (QW-405)

Position of Groove GMAW: Plate at 30° off flat FCAW: 1G (Rolled)

Weld Progression GMAW: Vertical down FCAW: N/A

PREHEAT (QW-406)

Preheat Temperature 10°C (50°F) Interpass Temp. (Max.) 232°C (450°F)

POSTWELD HEAT TREATMENT (QW-407)

Temperature Range None Time Range N/A

GAS (QW-408)

Specification No. (SFA) SFA 5.32 AWS No. SG-AC-25

Shielding GMAW: 75% Argon, 25% CO₂, 15 liters per minute (30 cfph)

FCAW: 75% Argon, 25% CO₂, 17.5 liters per minute (35 cfph)

Backing None Trailing Without

ELECTRICAL CHARACTERISTICS (QW-409)

Current Direct Polarity Reverse, electrode positive

Amps See next page Volts See next page

Maximum Heat Input GMAW: 1.22 kJ/mm (31,000 J/in.) FCAW: 2.34 kJ/mm (59,423 J/in.)

Mode of Metal Transfer GMAW: Short circuiting, waveform controlled (Miller RMD)

Mode of Metal Transfer FCAW: Spray

Other Formula for GMAW (short circuiting, waveform controlled):

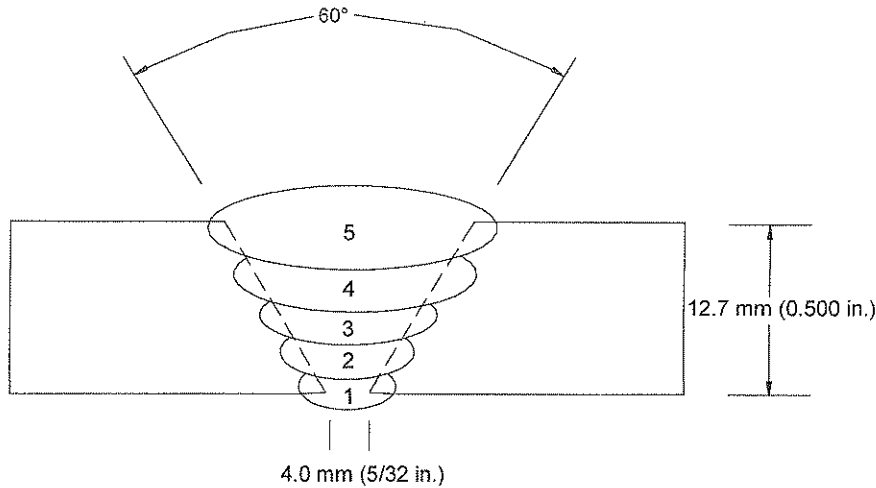
Heat Input kJ/mm (J/in.) = Power (J/s) x Arc time (s) / Weld Bead Length mm (in.)

Formula for FCAW:

Heat Input kJ/mm (J/in.) = Amps x Volts x 60 / Travel speed mm/min. (ipm)

TECHNIQUE (QW-410)

String or Weave	<u> Weave </u>	Travel Speed	<u> See below </u>
Orifice or Gas Cup Size	<u> GMAW: 9.52 mm (0.375 in.) </u>	FCAW:	<u> 15.9 mm (0.625 in.) </u>
Initial & Interpass Cleaning	<u> Brushing, chipping & grinding to remove slag </u>		
Method of Back Gouging	<u> Not used </u>	Oscillation	<u> N/A </u>
Contact Tube to Work Distance	<u> GMAW: 9.52 mm (0.375 in.) </u>		
	<u> FCAW: 12.7 to 19.1 mm (0.500 to 0.750 in.) </u>		
Multiple or Single Pass Per Side	<u> Multiple </u>	Multiple or Single Electrodes	<u> Single </u>
Electrode Spacing	<u> N/A </u>	Peening	<u> None </u>
Use of Thermal Processes	<u> N/A </u>		



Pass	Process	Filler Metal	Diameter mm (in.)	Current & Polarity	Amperage Range	Voltage Range	Travel Speed mm/min. (i.p.m.)
1	*GMAW	ER70S-2	0.9 (0.035)	DCRP	125 - 135	18.5 - 19.0	117 (4.6)
2	**FCAW	E71T-12MJ	1.1 (0.045)	DCRP	225 - 235	25	295 (11.6)
3	**FCAW	E71T-12MJ	1.1 (0.045)	DCRP	245 - 250	30	257 (10.1)
4	**FCAW	E71T-12MJ	1.1 (0.045)	DCRP	250 - 265	30	236 (9.3)
5	**FCAW	E71T-12MJ	1.1 (0.045)	DCRP	250 - 265	30	198 (7.8)

* Short circuiting - Waveform controlled (Miller RMD)

** Wire Feed Speed for FCAW: 320 - 330 ipm

***GMAW (Miller RMD) Heat Input Parameters**

Pass	Power kJ/sec.	Arc Time Sec.	Weld Bead Length mm (in.)	Heat Input kJ/mm (Joule/in.)	Wire Feed Speed i.p.m.
1	2.3 - 2.5	310	610 (24)	1.22 (31,000)	235

TENSILE TEST (QW-150)

Specimen No.	Width mm (in.)	Thickness mm (in.)	Area Sq. mm (Sq. in.)	Ultimate Load N (lbs.)	Ultimate Stress MPa (psi)	Character & Fracture Location
T1	19.1 (0.752)	10.7 (0.421)	204 (0.317)	101 532 (22,800)	497 (72,100)	Partial cup & cone Weld Metal
T2	19.1 (0.752)	10.8 (0.425)	206 (0.320)	102 955 (23,100)	499 (72,400)	Partial cup & cone Weld Metal

GUIDED BEND TEST (QW-160)

Type & Figure No.	Result	Type & Figure No.	Result
QW-462.2, TSB - S1	Pass	QW-462.2, TSB - S3	Pass
QW-462.2, TSB - S2	Pass	QW-462.2, TSB - S4	Pass

CHARPY IMPACT TOUGHNESS

Type of Test Charpy V-Notch Orientation Transverse
 Test Temperature -46°C (-50°F) Specimen Size 10 X 10 mm (0.394 X 0.394 in.)

Specimen No.	Notch Location	Impact Values J (ft. lbs)
L2.1	Weld Metal	106 (78.0)
L2.2	within 1/16 in.	44.5 (32.8)
L2.3	of root	42.0 (31.0)
L3.1	Gr. 6 - HAZ	>141 (>104)
L3.2	Gr. 6 - HAZ	>141 (>104)
L3.3	Gr. 6 - HAZ	>141 (>104)
M3.1	Gr. LF2 - HAZ	>141 (>104)
M3.2	Gr. LF2 - HAZ	120 (88.6)
M3.3	Gr. LF2 - HAZ	>141 (>104)

OTHER TESTS

Vickers Hardness - see attached laboratory test report # C12-810.8
Weld Root Chemical Analysis - see attached laboratory test report # C12-810.8

Welders Name Donald Kennedy Certificate File No. W-7153
 Tests Conducted By Ludwig Associates Ltd.
 Laboratory Test No. C12-810.8

We certify the statements in this record are correct and that the test welds were prepared, welded and tested in accordance with the requirements of Section IX of the ASME Code.

Manufacturer NATIONAL PROCESS EQUIPMENT INC.

Date June 11/12 Certified by 



LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: National Process Equipment Inc.
 5049 - 74th Avenue S.E.
 Calgary, Alberta
 T2C 3H2

Laboratory Test No.: C12-810.8
Date: June 1, 2012

Attention: Rick St. Louis

PQR Number: NPE-4-2

Material: SA 333 Gr. 6 to SA 350 Gr. LF2 (Heat No.: 75361 to 555063)

Size: 219.1 mm (8.625 in.) O.D. x 12.7 mm (0.500 in.) w.t.

Thermal Condition: As welded

TENSILE TEST QW-150

SAMPLE NUMBER	T1 QW-462.1(b)	T2 QW-462.1(b)
WIDTH mm (in)	19.1 (0.752)	19.1 (0.752)
THICKNESS mm (in)	10.7 (0.421)	10.8 (0.425)
AREA sq mm (sq in)	204 (0.317)	206 (0.320)
ULT. LOAD N (lbs)	101 532 (22,800)	102 955 (23,100)
UTS MPa (psi)	497 (72,100)	499 (72,400)
FRACTURE TYPE	Partial Cup & Cone	Partial Cup & Cone
FRACTURE LOCATION	Weld Metal	Weld Metal

GUIDED-BEND TEST QW-160

SAMPLE WIDTH:	9.52 mm (0.375 in.)	SAMPLE THICKNESS:	12.7 mm (0.500 in.)
PLUNGER SIZE:	38.1 mm (1.50 in.)	YOKE SIZE:	60.3 mm (2.375 in.)
QW-462.2	Side Bend	Side Bend	Side Bend
SAMPLE NUMBER(S)	S1	S2	S3
RESULTS	Pass	Pass	Pass

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section IX, 2010 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. Samples associated with this report will be discarded in 45 days.

Laboratory Test Conducted By: _____


 Eric Dacyk, C.E.T. / Steve Rieberger, C.E.T.





LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: National Process Equipment Inc. **Laboratory Test No.:** C12-810.8
 5049 - 74th Avenue S.E. **Date:** May 29, 2012
 Calgary, Alberta
 T2C 3H2

Attention: Rick St. Louis

PQR Number: NPE-4-2
Material: SA 333 Gr. 6 to SA 350 Gr. LF2 (Heat No.: 75361 to 555063)
Size: 219.1 mm (8.625 in.) O.D. x 12.7 mm (0.500 in.) w.t.
Thermal Condition: As welded

CHARPY V-NOTCH IMPACT TEST

Machine: Satec, SI-1C SN:1363 **Specimen Size:** 10 x 10 mm (0.394 x 0.394 in.)
Capacity: 325 J (240 ft-lbf) **Orientation:** Transverse
Verified Range: 1.7 - 141.3 J (1.3 - 104.2 ft-lbf) **Test Temp.:** -46°C (-50°F)

Specimen Number	Notch Location	Impact Values	
		Joules	(ft-lbf)
L2.1	Weld Metal	106	(78.0)
L2.2	within 1/16 in.	44.5	(32.8)
L2.3	of root	42.0	(31.0)
L3.1	Gr. 6 HAZ	>141	(>104)
L3.2	Gr. 6 HAZ	>141	(>104)
L3.3	Gr. 6 HAZ	>141	(>104)
M3.1	Gr. LF2 HAZ	>141	(>104)
M3.2	Gr. LF2 HAZ	120	(88.6)
M3.3	Gr. LF2 HAZ	>141	(>104)

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section VIII, Div. 1, UG-84 – 2010 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. **Samples associated with this report will be discarded in 45 days.**

Laboratory Test Conducted By: _____


 Steve Rieberger, C.E.T.





LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: National Process Equipment Inc.
5049 - 74th Avenue S.E.
Calgary, Alberta
T2C 3H2

Laboratory Test No.: C12-810.8
Date: May 29, 2012

Attention: Rick St. Louis

PQR Number: NPE-4-2

Material: SA 333 Gr. 6 to SA 350 Gr. LF2 (Heat No.: 75361 to 555063)

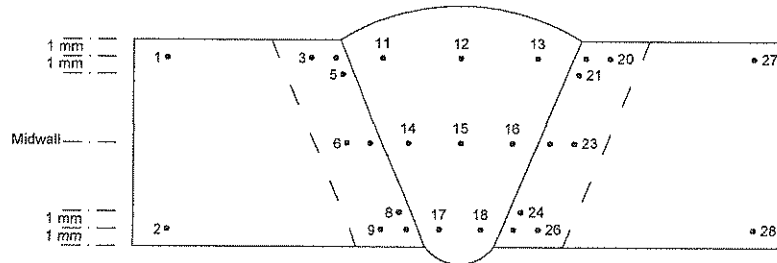
Size: 219.1 mm (8.625 in.) O.D. x 12.7 mm (0.500 in.) w.t.

Thermal Condition: As welded

HARDNESS TEST

Type of Test: Vickers 10 kg (HV10)

Instrument: Mitutoyo AVK-C1



SA 350 Gr. LF2		Weld Metal		SA 333 Gr. 6					
Parent Metal	HAZ			HAZ	Parent Metal				
1	151	3	167	11	173	19	185	27	168
2	153	4	192	12	165	20	161	28	150
		5	192	13	161	21	190		
		6	161	14	157	22	163		
		7	171	15	146	23	153		
		8	165	16	154	24	167		
		9	160	17	156	25	171		
		10	167	18	158	26	165		

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASTM E384-10^{e2} and ANSI/NACE MR0175/ISO 15156-2:2009(E). The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. **Samples associated with this report will be discarded in 45 days.**

Laboratory Test Conducted By: _____


Michelle Marien, T.T. / Steve Rieberger, C.E.T.





LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: National Process Equipment Inc.
5049 - 74th Avenue S.E.
Calgary, Alberta
T2C 3H2

Laboratory Test No.: C12-810.8
Date: June 8, 2012

Attention: Rick St. Louis

PQR Number: NPE-4-2
Material: SA 333 Gr. 6 to SA 350 Gr. LF2 (Heat No.: 75361 to 555063)
Size: 219.1 mm (8.625 in.) O.D. x 12.7 mm (0.500 in.) w.t.
Thermal Condition: As Welded
Test Location: Weld Root (ER70S-2)

CHEMICAL ANALYSIS

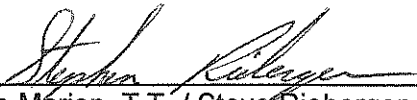
(% by weight)

Instrument Type: Shimadzu PDA-7000 Optical Emission Spectrometer

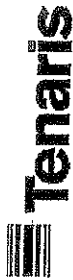
Carbon	0.05
Manganese	0.88
Sulphur	0.007
Phosphorus	0.015
Silicon	0.38
Chromium	0.02
Nickel	0.02
Molybdenum	<0.01
Copper	0.26
Vanadium	<0.01

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASTM E415-08. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. **Samples associated with this report will be discarded in 45 days.**

Laboratory Test Conducted By: _____


Michelle Marien, T.T. / Steve Rieberger, C.E.T.





INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1B: 1991)

SIDERCA S.A.I.C.
 Dr. Jorge A. Sini 250
 (8250) Avda. Comodoro
 Buenos Aires, Argentina
 (54) 3488 433100 tel.
 (54) 3488 433405 fax

Ciente / Customer VAN LEEUWEN PIPE & TUBE (CANADA) IN		Expediente / Manufacturing Order 508594.05		Número / Number 573927		Fecha / Date 05/01/2011		Pag./Page 4 / 7	
Producto / Product CARBON STEEL FOR LOW TEMPERATURE SERVICE		Orden de Compra / Purchase Order 45001373		Item 21807		Referencia del Cliente / Customer Reference			
Norma / Standard ASTM/AISME A5333+CSA Z245.1-07 CATH SSPSP00374/P-NACE MR0175/103-IPRO LP-006		Grado / Grade 1B23035S CATH SS		Extremos / Ends BEVELLED AT 30 DEG. ASTME		Cantidades / Quantities 24 Pz 184.72 m 9915 KG 24 Pcs 607.61 Ft 21869 LD			
Dimensiones / Dimensions 219.10 x 12.70 mm		Peso Nominal / Nominal Weight 84.64 KG/MT		Longitud / Length S.R. (SP)		Superficie Externa / External Surface INT BARE / EXT VARNISHED			
3 5/8 x 0.500 inches		Schedule - 80		S.R. (SP)					

Valores Requeridos / Required Values	Individuales			Promedios			Tipo de dureza	
	Max	Min	Var	Max	Min	Var	Average	Hardness type
							248	VICKERS HV10

ENSAYO DE DUREZA / HARDNESS TEST

Cuadrante	Colada/ Heat	Ensayo/ Test	Tubo/ Pipe	Extremo Ext/ External Diam.	Centro/ Mid-wall	Diametro Int/ Internal Diam.	Obtenidos/ Obtained							
							Valor Individual/ Individual Value							
1							1	2	3	4	Max	Min	P/A	Var
							159	162	162	157	162.0	157.0	160.0	
							161	159	160	163	163.0	159.0	160.8	9.8
							149	151	152	152	152.0	149.0	151.0	

Cuadrante	Colada/ Heat	Ensayo/ Test	Tubo/ Pipe	Extremo Ext/ External Diam.	Centro/ Mid-wall	Diametro Int/ Internal Diam.	Obtenidos/ Obtained							
							Valor Individual/ Individual Value							
1							1	2	3	4	Max	Min	P/A	Var

Cuadrante	Colada/ Heat	Ensayo/ Test	Tubo/ Pipe	Extremo Ext/ External Diam.	Centro/ Mid-wall	Diametro Int/ Internal Diam.	Obtenidos/ Obtained							
							Valor Individual/ Individual Value							
1							1	2	3	4	Max	Min	P/A	Var
							163	167	165	169	169.0	163.0	166.0	
							159	150	161	161	161.0	159.0	160.0	14.7
							150	153	150	152	153.0	150.0	151.3	

Cuadrante	Colada/ Heat	Ensayo/ Test	Tubo/ Pipe	Extremo Ext/ External Diam.	Centro/ Mid-wall	Diametro Int/ Internal Diam.	Obtenidos/ Obtained							
							Valor Individual/ Individual Value							
1							1	2	3	4	Max	Min	P/A	Var

Ind = Individual Val. = Valor/ Value Min = Minimum/ Minimum Max = Máximo/ Maximum P/A = Promedio/ Average Var. = Variación/ Variation
 E/B = Stencil starting - Comienzo marcación / Cuerpo - Body O/B = Opposite extreme to E-Extremo opuesto al E/ Cuerpo - Body
 E/U = Stencil starting - Comienzo marcación / Recalque - Upset O/U = Opposite extreme to E-Extremo opuesto al E/ Recalque - Upset
 E/VU = Vanishing upset - Desvanecimiento de recalque / Cuerpo - Body O/VU = Vanishing upset - Desvanecimiento de recalque / Recalque - Upset



INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1B: 1991)

SIDERCA S.A.I.C.
 Dr. Jorge A. Simini 250
 (22004VHA) Campana
 Buenos Aires, Argentina
 (54) 3489 433100 tel.
 (54) 3489 433405 fax

Cliente / Customer VAN LEEUWEN PIPE & TUBE (CANADA) IN Producto / Product CARBON STEEL FOR LOW TEMPERATURE SERVICE	Expediente / Manufacturing Order 573927 Orden de Compra / Purchase Order 45004373	Número / Number 573927 Item 21607	Fecha / Date 05/01/2011 Referencia del Cliente / Customer Reference	Pág. / Page 6 / 7
Norma / Standard ASTM/ASME A5A333+CSA Z245.1-07 CATH SSPSP037410+NACE MR0175103-IPRO LP-008		Grado / Grade 1B7290369 CATH SS		
Dimensiones / Dimensions 219.10 x 12.70 mm 8 5/8 x 0.500 inches	Schedule 80	Peso Nominal / Nominal Weight 94.64 KG/MET 43.43 LB/FT	Longitud / Length S.R. (SP)	Superficie / Surface INT BARE / EXT VARNISHED
Extremo / Ends BEVELLED AT 30 DEG. ASTM Cantidades / Quantities 24 Pz 154.72 m 9915 KG 21659 LB 24 Pcs 507.69 Ft				
Observaciones / Remarks -LA DUREZA CUMPLE CON LA NACE MR-01-75/ISO-15156-2 *NORMAS* -EDICIÓN DE LA NORMA: ASTM A 333 - 2005 -EDICIÓN DE LA NORMA: ASME SA 333/ 2007 -EDICIÓN DE LA NORMA: NACE MR 01-75 - ISO 15156-2 : 2003 -EDICIÓN DE LA NORMA: NACE MR-01-03 EDICION 2007 EDICIÓN DE LA NORMA : CSAZ245: 2007 -HARDNESS ACCORDING TO NACE MR-01-75/ ISO-15156-2. *STANDARDS* -EDITION OF REGULATION: ASTM A 333 - 2005 -EDITION OF REGULATION: ASME SA 333/ 2007 -EDITION OF REGULATION: NACE MR 01-75 - ISO 15156-2 : 2003 -EDITION OF REGULATION: NACE MR-01-03 EDITION 2007 -EDITION OF REGULATION : CSA Z245 : 2007				
Observaciones / Remarks NON DESTRUCTIVE TEST: SATISFACTORY. INSPECTION METHODS: U.T. LONG./TRANSV. (EXT./INT.); NOTCH 12.5% → M.P.I. LONG./TRANSV. (EXT./INT.); ON ENDS → W.M.P.I. ON BEVELS. UT 100% LAMINATIONS CONTROL: SATISFACTORY. ONE YELLOW BAND ON EACH END (RAL 1023). SEE ATTACHED VICKERS HARDNESS TEST REPORT. Tratamiento térmico (Tubo) Heat treatment (Pipe): Tipo / Type: QUENCHED AND TEMPERED Temperatura / Temp: 890°C 680°C Método de enfriamiento del tratamiento térmico (Tubos) / Quench media of heat treatment process (Pipes): Magnético remanente/residual magnetism (max.): 30 GAUSS Duración / Duration: 42 min., 70 min. Protectores / End Protectors: NON LIFTABLE CLOSED PLASTIC PROTECTOR FOR FLAT / BEVELED PIPE. SUPPLIER METAL CENTRO.				




INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1B: 1991)

SIDERCA S.A.I.C.
 C/ Jorge A. Simini 250
 (B2804VHA) Campana
 Buenos Aires, Argentina
 (54) 3489 433100 tel.
 (54) 3489 433405 fax

Cliente / Customer VAN LEEUWEN PIPE & TUBE (CANADA) IN		Expediente / Manufacturing Order 516594.05		Número / Number 573927		Fecha / Date 05/01/2011		Pág. / Page 7 / 7	
Producto / Product CARBON STEEL FOR LOW TEMPERATURE SERVICE		Orden de Compra / Purchase Order 45001373		Referencia del Cliente / Customer Reference 21807					
Norma / Standard ASTM/A516 ANSA333+CSA Z245.1-07 CATH SSPSP003740+NACE MR01750103+IPRO LP-006		Grado / Grade 116290369 CATH SS		Extremo / Ends BEVELLED AT 30 DEG. ASTM					
Dimensiones / Dimensions 249.10 x 12.70 mm 8 5/8 x 0.500 inches		Schedule 60		Superficie / Surface INT BARE TEXT VARNISHED					
Longitud / Length S.R. (SPT)		Peso Nominal / Nominal Weight 64.64 KG/MT 43.43 LB/FT		Cantidades / Quantities 24 Pz 154.72 MT 24 Pcs 507.61 Ff 21659 LD					

Por la presente certificamos que el material aquí descrito ha sido fabricado de acuerdo con las normas y especificaciones solicitadas en vuestro orden y satisfacen los correspondientes requerimientos.		We hereby certify that material herein described has been manufactured in accordance with the standards and specifications required in your order and satisfies the corresponding requirements.	
Este certificado se emite mediante un sistema computarizado y es válido con firma electrónica. El certificado original presenta el logo Tenaris (verde claro) impreso en la parte inferior de la hoja. En caso que el poseedor del certificado entregue una copia del mismo, deberá garantizar la conformidad con el original. Inéditables respaldables por cualquier uso ilegal o indebido.		This certificate is issued by a computerized system and it is valid with electronic signature. On the original certificate the trade-mark Tenaris light-green coloured at the bottom of the page is stamped. In case the owner of the certificate would release a copy of it, he must attest its conformity to the original one taking upon himself the responsibility for any unlawful or not allowed use.	
Cualquier alteración y / o falsificación estará sujeta a la ley. Si necesita asegurar la autenticidad de este certificado, contactarse con Siderca SAIC, e-mail: ayer@siderca.com		Any alteration and / or falsification will be subject to the law. If you need to assure the authenticity of this certificate, please do not hesitate to contact Siderca SAIC through this e-address: ayer@siderca.com	


 QUALITY CERTIFICATION DEPT.
 DTO CERTIFICACION DE CALIDAD
EDUARDO A. AYERBE

04/11/2011

QW-483 PROCEDURE QUALIFICATION RECORD (PQR)

National Process Equipment Inc.

Procedure Qualification Record No. NPE-4-3 Date May 29, 2012
Welding Procedure Specification No. NPE-4
Welding Process(es) SMAW / FCAW Type(s) Manual / Semi-auto.

JOINTS (QW-402)

Type Butt joint, single vee groove, welded from both sides, see next page

BASE METALS (QW-403)

Material Spec. SA 516 to SA 516 Type or Grade Gr. 60 to Gr. 70
P-No. P1 Grp. 1 To P-No. P1 Grp. 2 Thickness 38.1 mm (1.50 in.)
Diameter N/A Other Plate
Heat Number 362476 - 12952 Carbon Equivalent 0.407
Deposited Weld Metal (Per pass) Did not exceed 12.7 mm (0.500 in.)
C.E. formula per CSA Z662-11: $C + F(\text{Mn}/6 + \text{Si}/24 + \text{Cu}/15 + \text{Ni}/20 + \text{Cr}/5 + \text{Mo}/5 + \text{V}/5 + \text{Cb}/5 + 5B)$

FILLER METALS (QW-404)

	SMAW	FCAW
Specification No. (SFA)	<u>SFA 5.1</u>	<u>SFA 5.20</u>
AWS No. (Class)	<u>E7018-1</u>	<u>E71T-12MJ</u>
Filler Metal F-No.	<u>F4</u>	<u>F6</u>
Filler Metal A-No.	<u>A1</u>	<u>A1</u>
Filler Metal Product Form	<u>N/A</u>	<u>Flux cored wire</u>
Supplementary Fillers	<u>N/A</u>	<u>Without</u>
Size of Electrode	<u>See attached sketch</u>	
Deposited Weld Metal Thickness	<u>19.1 mm (0.750 in.)</u>	<u>19.1 mm (0.750 in.)</u>
Trade Name	<u>Air Liquide, Blueshield LA 18 Plus</u>	<u>Kobelco, DW-A55ESR</u>

POSITION (QW-405)

Position of Groove SMAW: 3G FCAW: 1G
Weld Progression SMAW: Vertical Up FCAW: N/A

PREHEAT (QW-406)

Preheat Temperature 66°C (150°F) Interpass Temp. (Max.) 232°C (450°F)

POSTWELD HEAT TREATMENT (QW-407)

Temperature Range None Time Range N/A

GAS (QW-408)

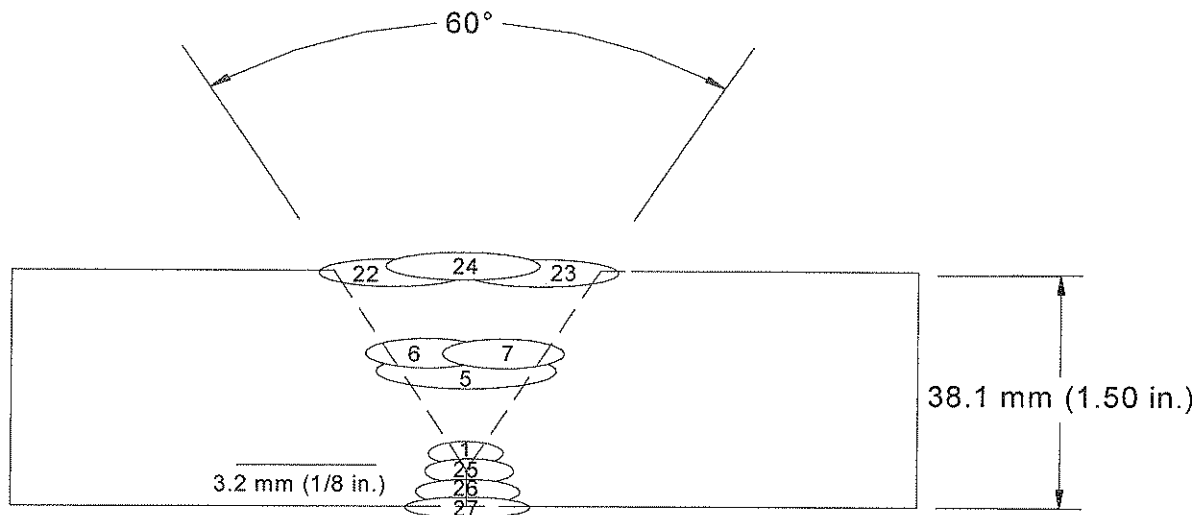
Specification No. (SFA) SFA 5.32 AWS No. SG-AC-25
Shielding FCAW: 75% Argon, 25% CO₂, 17.5 liters per minute (35 cfph)
Backing None Trailing Without

ELECTRICAL CHARACTERISTICS (QW-409)

Current Direct Polarity Reverse, electrode positive
Amps See next page Volts See next page
Maximum Heat Input SMAW: 3.36 kJ/mm (85,263 J/in.) FCAW: 2.16 kJ/mm (54,878 J/in.)
Mode of Metal Transfer FCAW: Spray
Other Heat Input kJ/mm (J/in.) = Amps x Volts x 60 / Travel speed mm/min. (ipm)

TECHNIQUE (QW-410)

String or Weave	<u> Weave </u>	Travel Speed	<u> See below </u>
Orifice or Gas Cup Size	<u> FCAW: 15.9 mm (0.625 in.) </u>		
Initial & Interpass Cleaning	<u> Brushing, chipping & grinding to remove slag </u>		
Method of Back Gouging	<u> Back ground to sound metal prior to depositing pass # 25 </u>		
Contact Tube to Work Distance	<u> FCAW: 12.7 to 19.1 mm (0.500 to 0.750 in.) </u>		
Multiple or Single Pass Per Side	<u> Multiple </u>	Multiple or Single Electrodes	<u> Single </u>
Electrode Spacing	<u> N/A </u>	Peening	<u> None </u>
Use of Thermal Processes	<u> N/A </u>	Oscillation	<u> N/A </u>



Pass	Process	Filler Metal	Diameter mm (in.)	Current & Polarity	Amperage Range	Voltage Range	Travel Speed mm/min. (i.p.m.)
1 - 3	SMAW	E7018-1	2.4 (3/32)	DCRP	100 - 105	21 - 23	71 - 89 (2.8 - 3.5)
4	SMAW	E7018-1	2.4 (3/32)	DCRP	110 - 115	23 - 25	71 (2.8)
5	SMAW	E7018-1	2.4 (3/32)	DCRP	110 - 115	23 - 25	48 (1.9)
6 - 18	*FCAW	E71T-12MJ	1.1 (0.045)	DCRP	215 - 245	30	221 - 366 (8.7 - 14.4)
19	*FCAW	E71T-12MJ	1.1 (0.045)	DCRP	245 - 255	30	208 (8.2)
20 - 24	*FCAW	E71T-12MJ	1.1 (0.045)	DCRP	225 - 245	30	229 - 246 (9.0 - 9.7)
25 - 27	SMAW	E7018-1	2.4 (3/32)	DCRP	110 - 115	23 - 25	69 - 130 (2.7 - 5.1)

* Wire Feed Speed for FCAW: 330 ipm

TENSILE TEST (QW-150)

Specimen No.	Width mm (in.)	Thickness mm (in.)	Area Sq. mm (Sq. in.)	Ultimate Load N (lbs.)	Ultimate Stress MPa (psi)	Character & Fracture Location
T1	19.1 (0.752)	37.7 (1.48)	720 (1.12)	379 720 (85,400)	527 (76,500)	Partial cup & cone Parent metal (Gr. 60)
T2	19.1 (0.752)	37.6 (1.48)	718 (1.11)	378 946 (85,200)	528 (76,500)	Partial cup & cone Parent metal (Gr. 70)

GUIDED BEND TEST (QW-160)

Type & Figure No.	Result	Type & Figure No.	Result
QW-462.2, TSB - S1	Pass	QW-462.2, TSB - S3	Pass
QW-462.2, TSB - S2	Pass	QW-462.2, TSB - S4	Pass

CHARPY IMPACT TOUGHNESS

Type of Test Charpy V-Notch Orientation Transverse
 Test Temperature -46°C (-50°F) Specimen Size 10 X 10 mm (0.394 X 0.394 in.)

Specimen No.	Notch Location	Impact Values J (ft. lbs)
A2.1	Weld Metal	108 (79.8)
A2.2	within 1/16 in.	90.6 (66.8)
A2.3	of surface - SMAW	81.3 (60.0)
B2.1	Weld Metal	>141 (>104)
B2.2	within 1/16 in.	>141 (>104)
B2.3	of surface - FCAW	133 (98.2)
A3.1	Gr. 60 - HAZ	>141 (>104)
A3.2	Gr. 60 - HAZ	>141 (>104)
A3.3	Gr. 60 - HAZ	141 (104)
B3.1	Gr. 70 - HAZ	23.3 (17.2)
B3.2	Gr. 70 - HAZ	31.2 (23.0)
B3.3	Gr. 70 - HAZ	51.5 (38.0)

OTHER TESTS

Vickers Hardness - see attached laboratory test report # C12-810.13

Welders Name Donald Kennedy Certificate File No. W-7153
 Tests Conducted By Ludwig Associates Ltd.
 Laboratory Test No. C12-810.13

We certify the statements in this record are correct and that the test welds were prepared, welded and tested in accordance with the requirements of Section IX of the ASME Code.

Manufacturer NATIONAL PROCESS EQUIPMENT INC.

Date June 11/12 Certified by [Signature]



LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: National Process Equipment Inc. **Laboratory Test No.:** C12-810.13
 5049 - 74th Avenue S.E. **Date:** June 1, 2012
 Calgary, Alberta
 T2C 3H2

Attention: Rick St. Louis

PQR Number: NPE-4-3
Material: SA 516 Gr. 60 to SA 516 Gr. 70 (Heat No.: 362476 – 12952)
Thickness: 38.1 mm (1.50 in.)
Thermal Condition: As welded

TENSILE TEST QW-150

SAMPLE NUMBER	T1 QW-462.1(a)	T2 QW-462.1(a)
WIDTH mm (in)	19.1 (0.752)	19.1 (0.752)
THICKNESS mm (in)	37.7 (1.48)	37.6 (1.48)
AREA sq mm (sq in)	720 (1.12)	718 (1.11)
ULT. LOAD N (lbs)	379 720 (85,400)	378 946 (85,200)
UTS MPa (psi)	527 (76,500)	528 (76,500)
FRACTURE TYPE	Partial Cup & Cone	Partial Cup & Cone
FRACTURE LOCATION	Parent Metal (SA 516 Gr. 60)	Parent Metal (SA 516 Gr. 70)

GUIDED-BEND TEST QW-160

SAMPLE WIDTH:	9.52 mm (0.375 in.)	SAMPLE THICKNESS:	38.1 mm (1.50 in.)
PLUNGER SIZE:	38.1 mm (1.50 in.)	YOKE SIZE:	60.3 mm (2.375 in.)
QW-462.2	Side Bend	Side Bend	Side Bend
SAMPLE NUMBER(S)	S1	S2	S3
RESULTS	Pass	Pass	Pass

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section IX, 2010 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. Samples associated with this report will be discarded in 45 days.

Laboratory Test Conducted By: _____


 Colin Burnette, T.T. / Steve Rieberger, C.E.T.





LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: National Process Equipment Inc. **Laboratory Test No.:** C12-810.13
 5049 - 74th Avenue S.E. **Date:** May 31, 2012
 Calgary, Alberta
 T2C 3H2

Attention: Rick St. Louis

PQR Number: NPE-4-3
Material: SA 516 Gr. 60 to SA 516 Gr. 70 (Heat No.: 362476 – 12952)
Thickness: 38.1 mm (1.50 in.)
Thermal Condition: As welded

CHARPY V-NOTCH IMPACT TEST

Machine: Satec, SI-1C SN:1363 **Specimen Size:** 10 x 10 mm (0.394 x 0.394 in.)
Capacity: 325 J (240 ft-lbf) **Orientation:** Transverse
Verified Range: 1.7 - 141.3 J (1.3 - 104.2 ft-lbf) **Test Temp.:** -46°C (-50°F)

Specimen Number	Notch Location	Impact Values	
		Joules	(ft-lbf)
A2.1	Weld Metal	108	(79.8)
A2.2	within 1/16 in.	90.6	(66.8)
A2.3	of surface - SMAW	81.3	(60.0)
B2.1	Weld Metal	>141	(>104)
B2.2	within 1/16 in.	>141	(>104)
B2.3	of surface - FCAW	133	(98.2)
A3.1	Gr. 60 HAZ	>141	(>104)
A3.2	Gr. 60 HAZ	>141	(>104)
A3.3	Gr. 60 HAZ	141	(104)
B3.1	Gr. 70 HAZ	23.3	(17.2)
B3.2	Gr. 70 HAZ	31.2	(23.0)
B3.3	Gr. 70 HAZ	51.5	(38.0)

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section VIII, Div. 1, UG-84 – 2010 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. **Samples associated with this report will be discarded in 45 days.**

Laboratory Test Conducted By: _____

Eric Dacyk, C.E.T. / Steve Rieberger, C.E.T.





LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: National Process Equipment Inc.
5049 - 74th Avenue S.E.
Calgary, Alberta
T2C 3H2

Laboratory Test No.: C12-810.13
Date: June 1, 2012

Attention: Rick St. Louis

PQR Number: NPE-4-3

Material: SA 516 Gr. 60 to SA 516 Gr. 70 (Heat No.: 362476 – 12952)

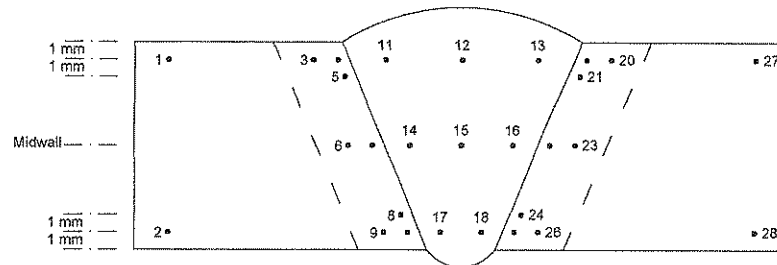
Thickness: 38.1 mm (1.50 in.)

Thermal Condition: As welded

HARDNESS TEST

Type of Test: Vickers 10 kg (HV10)

Instrument: Mitutoyo AVK-C1



SA 516 Gr. 60		Weld Metal		SA 516 Gr. 70					
Parent Metal	HAZ			HAZ	Parent Metal				
1	165	3	207	11	190	19	247	27	149
2	160	4	241	12	202	20	196	28	156
		5	215	13	188	21	246		
		6	182	14	200	22	202		
		7	199	15	198	23	194		
		8	219	16	199	24	208		
		9	183	17	201	25	232		
		10	232	18	209	26	183		

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASTM E384-10^{e2} and ANSI/NACE MR0175/ISO 15156-2:2009(E). The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. **Samples associated with this report will be discarded in 45 days.**

Laboratory Test Conducted By: _____

Michelle Marien, T.T. / Steve Rieberger, C.E.T.



QM-System - certification as per ISO 9001

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)



A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004
 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991
 MATERIAL TEST REPORT (MTR)

A10 Advice of dispatch No/ Date of dispatch
 398448-11.08.11

A03 Manufacturer's order/ Certificate No.
 366727-001

Sheet 1/1
 S01 Product
 HOT ROLLED PLATES

A05 Established inspecting body A06 Purchaser Final receiver
 DH SA516-70 EDMONTON STEEL, EDMON A07.1 No. ED10571-J1010-ER REV01
 EDMONTON STEEL, EDMON A07.2 No.

B02 Steel design. SA516-70
 B03 Any suppl. requirements ASME-III-A:10
 DIL-HUE-3:R30-2010-11-22

SA20-S5



B04 B99 Description of the product

B34 Item No.	B06 Number of pieces	B09 Thickness	B10 Width	B11 Length	B12 Theoretical mass	B04 Product delivery condition	B07.2 Heat No.	B07.1 Rolled plate No./ Test No.	A06 Purchaser article number
01	1	1,5000 X	97,00000 X	480,00000 X	8984 M		362476	12946-01	CPL-78
01	1	1,5000 X	97,00000 X	480,00000 X	8984 N		362476	12947-01	SA516 Gr 70
01	1	1,5000 X	97,00000 X	480,00000 X	8984 N		362476	12948-01	
01	1	1,5000 X	97,00000 X	480,00000 X	8984 N		362476	12950-01	
01	1	1,5000 X	97,00000 X	480,00000 X	8984 N		362476	12952-01	← 362476-12952
**	6	1,5000 X	97,00000 X	480,00000 X	8984 N		362476	12959-01	
02	1	1,5000 X	121,00000 X	480,00000 X	53904		362125	82079-01	
02	1	1,5000 X	121,00000 X	480,00000 X	11207 N		362125	82093-01	
02	1	1,5000 X	121,00000 X	480,00000 X	11207 N		362125	82094-01	
02	1	1,5000 X	121,00000 X	480,00000 X	11207 N		362476	12895-01	
**	5	1,5000 X	121,00000 X	480,00000 X	11207 N		362476	12902-01	
***	11				56035				
***	11				109939				

B04 Product delivery condition

ITEM NO.: 01-03
 N: HT: 1670 GR.F +36 -27 GR.F
 SOAKING TIME TO ATTAIN THE TARGET TEMPERATURE OVER THE WHOLE SECTION: 1-1,75 MIN/MM. (25-45 MIN/INCH)
 COOLING IN STILL AIR

A04 201202203. We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

DILLINGER HÜTTE
 Manufacturer's mark:

AG der Dillinger Hüttenwerke
 Postfach 1580, D-66748 Dillingen/Saar
 Inspection department

B. B. B. ADB
 Inspector's stamp

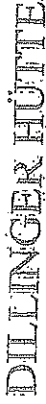
J. BAUDAUF
 Test House Manager

Date: 11.08.11

BM

QM-System -ertification as per ISO 9001

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificates)



A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004
 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991.A1:1995 + AS PER ISO 10474:1991
 MATERIAL TEST REPORT (MTR)

A05 Established inspecting body: A06 Purchaser: EDMONTON STEEL, EDMON A07.1 No. ED10571-J1010-ER REV01
 DH Final receiver: EDMONTON STEEL, EDMON A07.2 No. SA20-S5

B02 Steel design: SA516-70
B03 Any suppl. requirements: ASME-II-A:10
 DIL-HUE-3:R30-2010-11-22

A10: Advice of dispatch No./ Date of dispatch: 396448-11.08.11

A08 Manufacturer's order Certificate No.: 366727-001
B01 Product: HOT ROLLED PLATES

Sheet: 2/

B06 Marking of the product

ITEM NO.: 01-03
 STEEL DESIGNATION SA516 70 MILTY SA516 60 MILTY
 HEAT NO. / TRADEMARK / ROLLED PLATE NO. -TEST NO. / INSPECTOR'S STAMP

B07-B99 Further information about the product

ITEM NO.: 01-03
 THICKNESS REDUCTION RATIO >= 3,0 IS FULFILLED (CF. A/SA20 PAR. 5.3)

C10-C29 Tensile test

B14 Item No.	B07.1 Heat No.	B05 Rol./plate/ Test No.	Reference (heat) treatment	C01 C02		C03 GR.F.	C10 KSI	C11 RP02	C12 Rm	C13 % LB-ZIN
				QV	RT					
01	362476	12946		K1	QV	RT	51,5		76,1	36
01	362476	12947		K1	QV	RT	50,5		75,8	35
01	362476	12948		K1	QV	RT	49,9		75,1	36
01	362476	12950		K1	QV	RT	49,7		76,1	38
01	362476	12952		K1	QV	RT	50,5		75,5	36
01	362476	12959		K1	QV	RT	50,9		74,7	37
02	362125	82079		K1	QV	RT	50,3		75,1	36
02	362125	82093		K1	QV	RT	53,2		76,1	38
02	362125	82094		K1	QV	RT	51,0		76,0	37
02	362476	12895		K1	QV	RT	51,2		76,0	37
02	362476	12902		K1	QV	RT	50,6		76,7	37

A04

Z01/Z02/Z03 We hereby certify that the above mentioned materials have been delivered in accordance with the terms of order.



B. Baldauf



AG der Dillinger Hüttenwerke
 Postfach 1580, D-66748 Dillingen/Saar
 Inspektion department

B. BALDAUF
 Test-House Manager

Inspector's stamp

Date: 11.08.11

BW 1

QM-System - Certification as per ISO 9001

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)



A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004
 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991
 MATERIAL TEST REPORT (MTR)

A05 Established inspecting body. A06 Purchaser
 Final receiver
 EDMONTON STEEL, EDMONTON A07.1 No. ED10571-J1010-ER REV01
 EDMONTON STEEL, EDMONTON A07.2 No. SA20-S5

A10 Advice of dispatch No. / Date of dispatch
 396448-11.08.11
 A08 / Manufacturers order / Certificate No.
 366727-001
 B01 Product
 HOT ROLLED PLATES

A04
 37

B02 Steel design. SA516-70
 B03 Any suppl. ASME-III-A:10 requirements. DIL-HUE-3:R30-2010-11-22

C30-C39 Hardness test

B14 Item No.	B07.2 Heat No.	B07.1 Roll plate Test No.	B05 Reference (heat) treatment	C01	C02/C01	C03 Temp. GR.F	C30 Method of test	C35 C31 individual values.	C40 Energy	C45 C42 individual values AVE-TLBF	C43 Mean value
01	362476	12946		K1	O	RT	HBW 10/3000	HB 149	149	AV 103	151
01	362476	12947		K1	O	RT	HBW 10/3000	HB 148	149	AV 105	148
01	362476	12948		K1	O	RT	HBW 10/3000	HB 148	145	AV 103	146
01	362476	12950		K1	O	RT	HBW 10/3000	HB 148	149	AV 18	149
01	362476	12952		K1	O	RT	HBW 10/3000	HB 146	146	AV 40	146
01	362476	12959		K1	O	RT	HBW 10/3000	HB 145	145	AV 88	145
02	362125	82079		K1	O	RT	HBW 10/3000	HB 146	148	AV 50	147
02	362125	82093		K1	O	RT	HBW 10/3000	HB 149	150	AV 73	148
02	362125	82094		K1	O	RT	HBW 10/3000	HB 149	149	AV 89	149
02	362476	12895		K1	O	RT	HBW 10/3000	HB 148	151	AV 107	149
02	362476	12902		K1	O	RT	HBW 10/3000	HB 148	148	AV 69	149

C40-C49 Impact test

B14 Item No.	B07.2 Heat No.	B07.1 Roll plate Test No.	B05 Reference (heat) treatment	C01	C02/C01	C03 Temp. GR.F	C40 Width of test piece	C44 Testing method	C46 Energy	C45 C42 individual values AVE-TLBF	C43 Mean value
01	362476	12946		K1	LV	-51	CHP-V	CHP-V	103	71	73
01	362476	12947		K1	LV	-51	CHP-V	CHP-V	105	97	96
01	362476	12948		K1	LV	-51	CHP-V	CHP-V	103	102	98
01	362476	12950		K1	LV	-51	CHP-V	CHP-V	18	90	62
01	362476	12952		K1	LV	-51	CHP-V	CHP-V	40	77	53
02	362125	82079		K1	LV	-51	CHP-V	CHP-V	88	91	91
02	362125	82093		K1	LV	-51	CHP-V	CHP-V	50	73	69
02	362125	82094		K1	LV	-51	CHP-V	CHP-V	89	107	102
02	362125	82094		K1	LV	-51	CHP-V	CHP-V	69	80	81

A04 Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

AG der Dillinger Hüttenwerke
 Postfach: 1880, D-66748 Dillingen/Saar
 Inspection department

B. BAUDAUF
 Test House Manager

Inspector's stamp Date 11.08.11 BM 1

Manufacturer's mark

QM-System. Certification as per ISO 9001



DILLINGER HÜTTE

Erläuterungen, siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02. INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004
 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995. + AS PER ISO 10474:1991
 MATERIAL TEST REPORT (MTR)

A05 Established/Inspecting body: A06 Prüfgerätr EDMONTON STEEL, EDMONT A07.1 No. ED10571-J1010-ER REV01
 DH Final receiver EDMONTON STEEL, EDMONT A07.2 No. SA20-S5

B02. Steel/design. SA516-70
 B03 Any suppl. ASME-II-A-10
 requirements: DIL-HUE-3:R30-2010-11-22

A10 Advice of dispatch No./ Date of dispatch
 396448-11.08.11

A03 Manufacturer's order/ Certificate No.
 366727-001

-Sheet: 4/

B01 Product
 HOT ROLLED PLATES

C40-C49 Impact test

B04 Item No.	B07.2 Heat No.	B07.1 Roll plate/ Test No.	B05 Reference (heat) treatment	C01	C02/ C01	C03 Temp. GR.F	C41 Width of test piece	C40 Type of test piece	C44 Testing method	C46 Energy	C45 Individual values AV=FT.LBF	C43 Mean value
02	362476	12895		K1	LV	-51		CHP-V			99	91
02	362476	12902		K1	LV	-51		CHP-V			74	80

C70-C99 Chemical composition % - Heat analysis

B07.2 Heat	C	SI	MN	P	S	N	MO	NI	CR	NE	SN	TI
362125	Y	0,185	0,375	1,17	0,009	0,0072	0,010	0,038	0,029	0,000	0,001	0,001
362476	Y	0,191	0,379	1,17	0,009	0,0072	0,007	0,032	0,033	0,000	0,002	0,002

C94 Heat analysis Carbon equivalent / Alloying restrictions

B07.2 Heat	FO-02=	FO-51=	FO-55=	FO-78=	FO-91=
362125	0,39	0,40	0,000	0,10	0,04
362476	0,40	0,40	0,000	0,10	0,04

C95 Ladle treatment
 ITEM NO.: 01-03
 HEAT OF THE INDICATED ITEM: VACUUM DEGASSED / SULPHIDE SHAPE CONTROL

C95 Further information about ladle treatment
 ITEM NO.: 01-03
 CALCIUM TREATED

A04 2017/202/203 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.



AG der Dillinger Hüttenwerke
 Postfach 1580, D-66748 Dillingen/Saar
 Inspection department

B. B. B.
 AHB
 8. BAUDÄUf.
 Test House Manager.

Inspector's stamp Date: 11.08.11 BM 1

QM-System: Certification as per ISO 9001



DILLINGER HÜTTE

Erfüllungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004
 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991
 MATERIAL TEST REPORT (MTR)

A10 Advice of dispatch No./ Date of dispatch
 396448-11.08.11

A08 Purchaser
 EDMONTON STEEL, EDMON A07.1 No. ED10571-J1010-ER REV01

A09 Manufacturer's order/ Certificate No.
 366727-001

A06 Established/inspecting body
 Final receiver
 EDMONTON STEEL, EDMON A07.2 No. SA20-S5

DH: SA20-S5

Sheet 5/...

C70-C99 Chemical composition % - Product analysis

Heat	Test No.	C	SI	MN	P	S	N	CU	MO	NI	CR	V	NB	SN	TI
B07.2	B07.1	C01													
362125	82093	K1	0,181	1,17	0,009	0,0007	0,0066	0,019	0,011	0,039	0,028	0,001	0,000	0,001	0,001
362476	12907	K1	0,191	1,15	0,008	0,0011	0,0076	0,024	0,006	0,031	0,033	0,000	0,000	0,001	0,002
362476	12948	K1	0,178	1,17	0,008	0,0009	0,0068	0,020	0,008	0,026	0,032	0,001	0,000	0,001	0,001
B07.2	B07.1	C01													
362125	82093	K1	0,0001	CA	AL-T										
362476	12907	K1	0,0001	0,0022	0,033										
362476	12948	K1	0,0002	0,0019	0,032										

C94 Product analysis Carbon equivalent / Alloying restrictions

Heat	Test No.	FO-02	FO-02	FO-02	FO-55
B07.2	B07.1	C01			
362125	82093	K1	FO-02=	0,39	FO-51=
362476	12907	K1	FO-02=	0,39	FO-51=
362476	12948	K1	FO-02=	0,38	FO-51=

C94 Carbon equivalent formula / Alloying restrictions

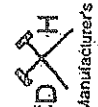
FO-02 = C + (MN/6) + (CR+MO+V) / 5 + (NI+CU) / 15
 FO-51 = V + NB
 FO-55 = CU+MO+NI+CR
 FO-78 = CR+MO
 FO-91 = MN/C

A04 2012/02/203 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

AG der Dillinger Hüttenwerke
 Postfach 1580, D-66748 Dillingen/Saar
 Inspection department

Inspector's stamp
 Date 11.08.11

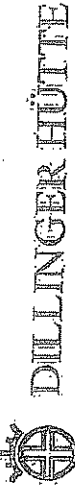
Test House Manager
 B. BALDUF



BM 1

QMI-System. Certification as per ISO 9001

Erläuterungen siehe Rückseite/Explications voir au verso (See reverse for explanations (www.dillinger.de/certificate))



DILLINGER HÜTTE

A02	INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004	A10 Advice of dispatch No./ Date of dispatch	396448-11.08.11	Sheet
A03	INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991	A06 Purchaser	EDMONTON STEEL, EDMONTON A07.1 No. ED10571-J1010-ER REV01	Manufacturer's order/Certificate No.
A05	MATERIAL TEST REPORT (MTR)	Final receiver	EDMONTON STEEL, EDMONTON A07.2 No. SA20-S5	B01 Product
B02	DH	SA516-70	ASME-II-A:10	HOT ROLLED PLATES
B03	Any suppl. requirements	DILL-HUE-3:R30-2010-11-22		

D01 Marking and identification, surface appearance, shape and dimensional properties

ITEM NO.: 01-03
 RESULT OF MARKING, SURFACE, SHAPE AND DIMENSIONS: NO REMARKS
 SURFACE AS PER ASME-SA20
 THICKNESS AS PER ASME-SA20
 LENGTH AND WIDTH AS PER ASME-SA20
 FLATNESS AS PER 1/2-ASME-SA20



A04	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.	Inspector's stamp	Date 11.08.11	BMI
		A07	AG der Dillinger Hüttenwerke Postfach 1580, D-66748 Dillingen/Saar Inspection department	
	B. Balduf	A08		
	B. BALDAUF			
	Test House/Manager			

QM-System: Certification as per ISO 9001



DILLINGER HÜTTE

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004

INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991

MATERIAL TEST REPORT (MTR)

A05 Established inspecting body

A06 Purchaser

EDMONTON STEEL, EDMON A07.1 No. ED10571-F1010-ER REV01

EDMONTON STEEL, EDMON A07.2 No.

B02/ Steel design. SA516-60

B03 Any suppl. ASME-II-A:10

requirements DILL-HUE-3-R30-2010-11-22

SA20-S5

A10 Advice of dispatch No./

Date of dispatch

396248-11.08.11

A08 Manufacturer's order/

A09 Certificate No.

366727-001

B01 Product

HOT ROLLED PLATES



15433

B01-B99 Description of the product

B14 Item No.	B06 Number of pieces	B89 Thickness	B10 Width INCH	B11 Length	B12 Theoretical mass KG	B04 Product delivery condition	B07.2 Heat No.	B07.1 Rolled plate No./ Test No.	A08 Purchaser article number
01	1	1,5000 X	97,00000 X	480,00000 X	8984	N	362476	12946-01	APL-78
01	1	1,5000 X	97,00000 X	480,00000 X	8984	N	362476	12947-01	SA516 Gr 60
01	1	1,5000 X	97,00000 X	480,00000 X	8984	N	362476	12948-01	362476-12952
01	1	1,5000 X	97,00000 X	480,00000 X	8984	N	362476	12950-01	
01	1	1,5000 X	97,00000 X	480,00000 X	8984	N	362476	12952-01	
**	6	1,5000 X	97,00000 X	480,00000 X	8984	N	362476	12959-01	
02	1	1,5000 X	121,00000 X	480,00000 X	53904	N	362125	82079-01	
02	1	1,5000 X	121,00000 X	480,00000 X	11207	N	362125	82093-01	
02	1	1,5000 X	121,00000 X	480,00000 X	11207	N	362125	82094-01	
02	1	1,5000 X	121,00000 X	480,00000 X	11207	N	362476	12895-01	
**	5	1,5000 X	121,00000 X	480,00000 X	11207	N	362476	12902-01	
**	11				56035				
					109939				

B04 Product delivery condition

ITEM NO.: 01-03

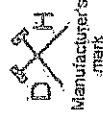
N: HT: 1-670 GR.F +36 -27 GR.F

SOAKING TIME TO ATTAIN THE TARGET TEMPERATURE OVER THE WHOLE SECTION: 1-1,75 MIN/MM (25-45 MIN/INCH)

COOLING IN STILL AIR

A04

Z01/Z02/Z03 We hereby certify, that the above-mentioned materials have been delivered in accordance with the terms of order.



Manufacturer's mark

B. Baldaluf



AG der Dillinger Hüttenwerke
Postfach 1500, D-66748 Dillingen/Saar
inspection department

B. BALDALUF
Test-House Manager

Inspector's stamp

Date: 11.08.11

EM: 1

QM-System - Certification as per ISO 9001



DILLINGER HÜTTE

Erklärungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004
 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991
 MATERIAL TEST REPORT (MTR)

A05 Established/inspecting body
 DH A08 Purchaser EDMONTON STEEL, EDMON. A07.1 No. ED10571-J1010-ER REV01
 Final receiver EDMONTON STEEL, EDMON. A07.2 No. SA20-S5

A10 Advice of dispatch No./Date of dispatch
 396448-11.08.11

A08/ Manufacturer's order/ A03/ Certificate No.
 366727-001

Sheet
 2/...

B02/ Steel design. SA516-60
 B03 Any suppl. requirements ASME-II-A:10
 DIL-HUE-3-R30-2010-11-22

B06 Marking of the product

ITEM NO.: 01-03
 STEEL DESIGNATION SA516 70 MTLV SA516 60 MTLV
 HEAT NO. / TRADEMARK / ROLLED PLATE NO.-TEST NO. / INSPECTOR'S STAMP

B07-B99 Further information about the product

ITEM NO.: 01-03
 THICKNESS REDUCTION RATIO >= 3,0 IS FULFILLED (CF. A/SA20 PAR. 5.3)

C10-C29 Tensile test

B14 Item No.	B07.2 Heat No.	B05 Ref./plate/ Test No.	Reference (heat) treatment	C01 C02/ C03 C01		C10 C11	C12	C13	A %
				Temp. GR.F	Temp. GR.F				
01	362476	12946		K1 QV	RT	51,5	RM	76,1	LD=2IN
01	362476	12947		K1 QV	RT	50,5		75,8	36
01	362476	12948		K1 QV	RT	49,9		75,1	35
01	362476	12950		K1 QV	RT	49,7		76,1	36
01	362476	12952		K1 QV	RT	50,5		75,5	38
01	362476	12959		K1 QV	RT	50,9		74,7	36
02	362125	82079		K1 QV	RT	50,3		75,1	37
02	362125	82093		K1 QV	RT	53,2		76,1	36
02	362125	82094		K1 QV	RT	51,0		76,0	38
02	362476	12895		K1 QV	RT	51,2		76,0	37
02	362476	12902		K1 QV	RT	50,6		76,7	37

A04 Z01/Z02/Z03 We hereby certify, that the above-mentioned materials have been delivered in accordance with the terms of order.

AG der Dillinger Hüttenwerke
 Postfach 1580, D-66748 Dillingen/Saar
 Inspection department

Inspector's stamp
 Date 11.08.11

Test House Manager
 S. BAUDAUF

BM. 1

QM-System. Certification as per ISO 9001



DILLINGER HÜTTE

Erklärungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004
 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991
 MATERIAL TEST REPORT (WTR)
 A05 Established inspecting body A06 Purchaser EDMONTON STEEL, EDMON. A07.1 No. ED10571-J1010-ER REV01
 DH Final receiver EDMONTON STEEL, EDMON A07.2 No. SA20-S5
 B02 Steel design SA516-60
 B03 Any suppl. requirements ASME-II-A:10
 DILL-HUE-3:R30-2010-11-22

A10 Advice of dispatch No.7
 Date of dispatch
 396448-11.08.11
 A08/Manufacturer's order
 A03 Certificate No.
 366727-001
 B01 Product
 HOT ROLLED PLATES

Sheet
 3/

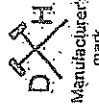
C30-C39 Hardness test

B14 Item No.	B07.2 Heat No.	B07.1 Roll plate Test No.	B05 Reference (heat) treatment	C01	C02/C01	C03 Temp. GRF	C30 Method of test	C35 C31 Individual values	C32 Mean value
01	362476	12946		K1	O	RT	HBW 10/3000	HB 149	151
01	362476	12947		K1	O	RT	HBW 10/3000	HB 148	148
01	362476	12948		K1	O	RT	HBW 10/3000	HB 148	146
01	362476	12950		K1	O	RT	HBW 10/3000	HB 148	149
01	362476	12952		K1	O	RT	HBW 10/3000	HB 146	146
01	362476	12959		K1	O	RT	HBW 10/3000	HB 145	145
02	362125	82079		K1	O	RT	HBW 10/3000	HB 146	147
02	362125	82093		K1	O	RT	HBW 10/3000	HB 149	148
02	362125	82094		K1	O	RT	HBW 10/3000	HB 149	149
02	362476	12895		K1	O	RT	HBW 10/3000	HB 148	149
02	362476	12902		K1	O	RT	HBW 10/3000	HB 148	149

C40-C49 Impact test

B14 Item No.	B07.2 Heat No.	B07.1 Roll plate Test No.	B05 Reference (heat) treatment	C01	C02/C01	C03 Temp. GRF	C40 Width of test piece	C40 Type of test piece	C44 Testing method	C46 Energy	C45 C42 Individual values AV=FT.LBF	C43 Mean value
01	362476	12946		K1	LV	-51	51	CHP-V	CHP-V	AV 103	71	73
01	362476	12947		K1	LV	-51	51	CHP-V	CHP-V	AV 105	97	96
01	362476	12948		K1	LV	-51	51	CHP-V	CHP-V	AV 103	102	98
01	362476	12950		K1	LV	-51	51	CHP-V	CHP-V	AV 118	90	62
01	362476	12959		K1	LV	-51	51	CHP-V	CHP-V	AV 40	74	53
02	362125	82079		K1	LV	-51	51	CHP-V	CHP-V	AV 88	91	91
02	362125	82093		K1	LV	-51	51	CHP-V	CHP-V	AV 50	73	69
02	362125	82094		K1	LV	-51	51	CHP-V	CHP-V	AV 89	107	102
				K1	LV	-51	51	CHP-V	CHP-V	AV 69	80	81

Z01Z02Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.



B. Baldauf



AG der Dillinger Hüttenwerke
 Postfach 1580, D-66748 Dillingen/Saar
 inspection department

G. BALDAUF
 Test House Manager

Inspector's stamp
 Date 11.08.11

BM 1

A01

QIM-System: Certification as per ISO 9001



DILLINGER HÜTTE

Erläuterungen: siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004
 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+AM:1995 + AS PER ISO 10474:1991
 MATERIAL: TEST REPORT: (WTR)

A10 Advice of dispatch to / Date of dispatch
 396448-11.08.11

A08 Manufacturer's order / A03 Certificate No.
 366727-001

A06 Purchaser / A07.1 No. / A07.2 No.
 EDMONTON STEEL, EDMONTON / ED10571-J1040-ER-REV01

DH / A06 Purchaser / Final receiver
 EDMONTON STEEL, EDMONTON

B02 Steel design: SA516-60

B03 Any suppl. requirements: ASME-II-A:10 / DIL-HUE-3:R30-2010-11-22

B01 Product: HOT ROLLED PLATES

Site: 4/...

SA20-S5

C40-C49 Impact test

B14 Item No.	B07.2 Heat No.	B07.1 Rol. plate / Test No.	B05 Reference (heat) treatment	C01	C02/ C01	C03 Temp. GRF	C41 Width of test-piece	C40 Type of test piece	C44 Tasting method	C45 Energy	C42 Individual values AV=FT.LBF	C43 Meat value
02	362476	12895		K1	LV	-51		CHP-V		AV	99	89
02	362476	12902		K1	LV	-51		CHP-V		AV	91	75

C70-C99 Chemical composition % - Heat analysis

B07.2 Heat	C70	C	SI	MN	P	S	N	CU	MO	NI	CR	NB	SN	TI
362125	Y	0,185	0,375	1,17	0,009	0,0072	0,018	0,010	0,038	0,029	0,000	0,000	0,001	0,001
362476	Y	0,191	0,379	1,17	0,009	0,0072	0,026	0,007	0,032	0,033	0,000	0,000	0,002	0,002

C94 Heat analysis Carbon equivalent / Alloying restrictions

B07.2 Heat	FO-02	FO-51	FO-55	FO-78	FO-91
362125	0,39	0,40	0,000	0,10	0,04
362476	0,40	0,40	0,000	0,10	0,04

C95 Ladle treatment

ITEM NO.: 01-03
 HEAT OF THE INDICATED ITEM: VACUUM DEGASSED / SULPHIDE SHAPE CONTROL

C95 Further information about ladle treatment

ITEM NO.: 01-03
 CALCIUM TREATED

A04 201202/203 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

Inspector's stamp: **B. BALDAGF** / Test House Manager

Inspector's stamp: **ADB**

Date: 11.08.11

AG der Dillinger Hüttenwerke
 Postfach 1580, D-66748 Dillingen/Saar.
 Inspection department:

Signature: *B. Baldagf*

QM-System. Verification as per ISO 9001

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)



DILLINGER HÜTTE

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004
 INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991
 MATERIAL TEST REPORT. (MTR)

A05 Established/inspecting body A06 Purchaser A07.1 No. ED10571-J1010-ER REV01
 DH Final receiver EDMONTON STEEL, EDMON A07.2 No. SA20-S5

B02/ Steel design. SA516-60
 B03 Any suppl. requirements ASME-II-A:10
 DIL-HUE-3:R30-2010-11-22

A10 Advice of dispatch No./ Date of dispatch
 396448-11.08.11

A08/ Manufacturer's order/ A03 Certificate No.
 366727-001

B01 Product
 HOT ROLLED PLATES

Steel

5/

C70-C99 Chemical composition % - Product analysis

B07.2 Heat	B07.1 Test No.	C01													
		C	SI	MN	P	S	N	CU	MO	NI	CR	V	MS	SN	Ti
362125	82093	K1 0,181	0,380	1,17	0,009	0,0007	0,0066	0,019	0,011	0,039	0,028	0,001	0,000	0,001	0,001
362476	12907	K1 0,191	0,375	1,15	0,008	0,0034	0,0076	0,024	0,006	0,031	0,033	0,000	0,000	0,001	0,002
362476	12948	K1 0,178	0,375	1,17	0,008	0,0009	0,0068	0,020	0,008	0,026	0,032	0,001	0,000	0,001	0,001

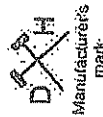
C94 Product analysis Carbon equivalent / Alloying restrictions

B07.2 Heat	B07.1 Test No.	C01		
		CA	AL-T	AL-T
362125	82093	K1 FO-02= 0,39	FO-51= 0,001	FO-55= 0,10
362476	12907	K1 FO-02= 0,39	FO-51= 0,000	FO-55= 0,09
362476	12948	K1 FO-02= 0,38	FO-51= 0,001	FO-55= 0,09

C94 Carbon equivalent formula / Alloying restrictions

FO-02 = C + (MN/6) + (CR+MO+V) / 5 + (NI+CU) / 15
 FO-51 = V + NB
 FO-55 = CU+MO+NI+CR
 FO-78 = CR+MO
 FO-91 = MN/C

A04



Manufacturers' mark

Z017202Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

B. BALDAUF

B. BALDAUF
 Test House Manager



AG der Dillinger Hüttenwerke
 Postfach 1590, D-66748 Dillingen/Saar
 inspection department

Inspector's stamp

Date 11.08.11

BM 1

QM-System. Certification as per ISO 9001

Erläuterungen: siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

DILLINGER HÜTTE



A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004	A10 Advice of dispatch No./ Date of dispatch	Sheet
INSPECTION CERTIFICATE 3.1.B AS PER EN 10204:1991+A1:1995 + AS PER ISO 10474:1991	396448-11.08.11	A08/Manufacturer's order A03:Certificate No.
MATERIAL TEST REPORT (MTR)		366727-001
A05 Established inspecting body	A06 Purchaser	B01 Product
DH	EDMONTON STEEL, EDMON A07.1 No. ED10571-J1010-ER REV01	HOT ROLLED PLATES
B02 Steel design.	Final receiver	
SA516-60	EDMONTON STEEL, EDMON A07.2 No.	
B03 Any suppl. requirements	SA20-S5	
ASME-II-A:10		
DIL-HUE-3:R30-2010-11-22		

D01 Marking and identification, surface appearance, shape and dimensional properties

ITEM NO.: 01-03.
 RESULT OF MARKING, SURFACE, SHAPE AND DIMENSIONS: NO REMARKS
 SURFACE AS PER ASME-SA20
 THICKNESS AS PER ASME-SA20
 LENGTH AND WIDTH AS PER ASME-SA20
 FLATNESS AS PER 1/2-ASME-SA20



A04.		AG der Dillinger Hüttenwerke Postfach 1580, D-66748 Dillingen/Saar Inspection department
	B. BAUDAUF Test House Manager	Date 11.08.11
	Inspector's stamp 	EM 1

IZO10203 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

QW-483 PROCEDURE QUALIFICATION RECORD (PQR)

National Process Equipment Inc.
Procedure Qualification Record No. NPE-1-1 Date March 15, 2010
PQR Revision(s): November 3, 2011 - Editorial change, company name incorrectly
reported as National Process Equipment.
June 4, 2012 - Addition of QW-410.64 to address the use of thermal
processes.
Welding Procedure Specification No. NPE-1 (Rev. 2)
Welding Process(es) SMAW Type(s) Manual

JOINTS (QW-402)

Type Butt joint, single vee groove, see next page

BASE METALS (QW-403)

Material Spec. SA 516 to SA 516 Type or Grade Gr. 60N to Gr. 70N
P-No. P1 Grp. 1 To P-No. P1 Grp. 2 Thickness 6.32 mm (0.249 in.)
Heat No. 28549 - 84705 Carbon Equivalent 0.344
Deposited Weld Metal (Per pass) Did not exceed 12.7 mm (0.500 in.)
C.E. formula per CSA Z662-07: $C + F(\text{Mn}/6 + \text{Si}/24 + \text{Cu}/15 + \text{Ni}/20 + \text{Cr}/5 + \text{Mo}/5 + \text{V}/5 + \text{Cb}/5 + 5B)$

FILLER METALS (QW-404)

Specification No. (SFA) SFA 5.1 SFA 5.1
AWS No. (Class) E6010 E7018-1
Filler Metal F-No. F3 F4
Filler Metal A-No. A1 A1
Size of Electrode See attached sketch
Deposited Weld Metal Thickness 2.39 mm (0.094 in.) 3.94 mm (0.155 in.)

POSITION (QW-405)

Position of Groove 3G
Weld Progression Vertical Up

PREHEAT (QW-406)

Preheat Temperature 10°C (50°F) Interpass Temp. (Max.) 232°C (450°F)

POSTWELD HEAT TREATMENT (QW-407)

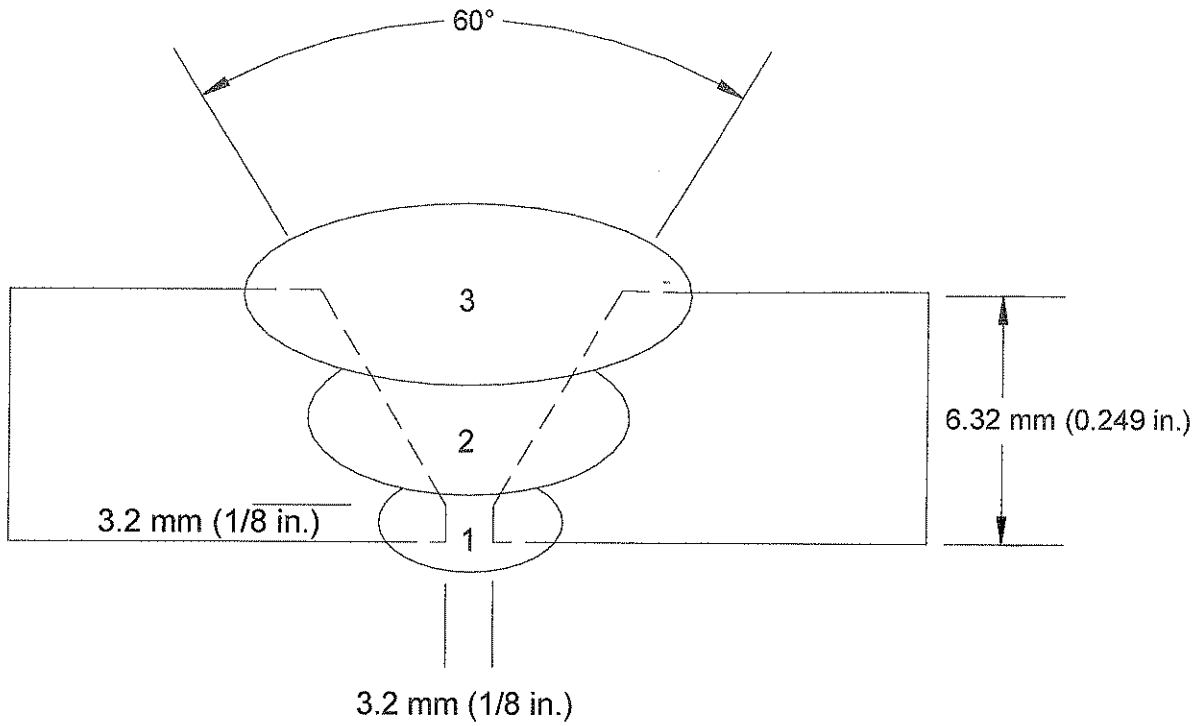
Temperature None Time N/A

ELECTRICAL CHARACTERISTICS (QW-409)

Current Direct Polarity Reverse, electrode positive
Amps See next page Volts See next page
Maximum Heat Input F3: 1.80 kJ/mm (45,724 J/in.) F4: 2.54 kJ/mm (64,421 J/in.)

TECHNIQUE (QW-410)

String or Weave F3: String F4: Both Travel Speed See next page
Initial & Interpass Cleaning Brushing, chipping & grinding to remove slag
Method of Back Gouging Not used
Multiple or Single Pass Per Side Multipass from groove side
Multiple or Single Electrodes Single
Use of Thermal Processes N/A



Pass	Process	Filler Metal	Diameter mm (in.)	Current & Polarity	Amperage Range	Voltage Range	Travel Speed mm/min (ipm.)
1	SMAW	E6010	3.2 (1/8)	DCRP	80 - 90	25 - 27	74 (2.9)
2	SMAW	E7018-1	2.4 (3/32)	DCRP	80 - 90	23 - 25	97 (3.8)
3	SMAW	E7018-1	2.4 (3/32)	DCRP	80 - 90	23 - 25	48 (1.9)

TENSILE TEST (QW-150)

Specimen No.	Width mm (in.)	Thickness mm (in.)	Area Sq. mm (Sq. in.)	Ultimate Load N (lbs.)	Ultimate Stress Mpa (Psi)	Character & Fracture Location
T1	19.1 (0.752)	5.26 (0.207)	101 (0.156)	53 400 (12,000)	532 (77,100)	Partial cup & cone Parent metal (Gr. 60N)
T2	19.1 (0.752)	5.21 (0.205)	99.5 (0.154)	51 900 (11,700)	522 (75,600)	Partial cup & cone Parent metal (Gr. 60N)

GUIDED BEND TEST (QW-160)

Type & Figure No.	Result	Type & Figure No.	Result
QW-462.3a, TFB - F1	Pass	QW-462.3a, TRB - R1	Pass
QW-462.3a, TFB - F2	Pass	QW-462.3a, TRB - R2	Pass

CHARPY IMPACT TOUGHNESS

Type of Test Charpy V-Notch Orientation Transverse
 Test Temperature -48°C (-55°F) Specimen Size 10 x 5 mm (0.394 x 0.197 in.)

Specimen No.	Notch Location	Impact Values J (ft. lbs)
V2.1	Weld Metal	42.8 (31.6)
V2.2	within 1/16 in.	18.2 (13.4)
V2.3	of root	11.0 (8.1)
V3.1	Gr. 60N - HAZ	57.2 (42.2)
V3.2	Gr. 60N - HAZ	46.4 (34.2)
V3.3	Gr. 60N - HAZ	83.0 (61.2)
W3.1	Gr. 70N - HAZ	39.0 (28.8)
W3.2	Gr. 70N - HAZ	62.9 (46.4)
W3.3	Gr. 70N - HAZ	57.2 (42.2)

OTHER TESTS

Vickers Hardness - see attached laboratory test report # C10-524.1R1
Rockwell Hardness - see attached laboratory test report # C10-524.1R1

Welder Gary Motley Certificate No. W-7204
 Tests Conducted By Ludwig Associates Ltd.
 Laboratory Test No. C10-524.1R1

We hereby recertify that the statements in this record have been revised in accordance with paragraph QW-200.2 and that the test welds were prepared, welded and tested in accordance with the requirements of Section IX of the ASME Code.

Manufacturer NATIONAL PROCESS EQUIPMENT INC.

Date June 11/12 Certified by 



LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: National Process Equipment Inc.
 5, 3401 - 19th Street N.E.
 Calgary, Alberta
 T2E 6S8

Laboratory Test No.: C10-524.1R1
Date: March 16, 2010
Revision Date: November 3, 2011

Attention: Ed Tedorsthorst

PQR Number: NPE-1-1
Material: SA 516 Gr. 60N to SA 516 Gr. 70N (Heat No.: 28549 - 84705)
Thickness: 6.32 mm (0.249 in.)
Thermal Condition: As Welded

TENSILE TEST QW-150

SAMPLE NUMBER	T1 QW-462.1(a)	T2 QW-462.1(a)
WIDTH mm (in)	19.1 (0.752)	19.1 (0.752)
THICKNESS mm (in)	5.26 (0.207)	5.21 (0.205)
AREA sq mm (sq in)	101 (0.156)	99.5 (0.154)
ULTIMATE LOAD N (lbs)	53 400 (12,000)	51 900 (11,700)
UTS Mpa (psi)	532 (77,100)	522 (75,600)
FRACTURE TYPE	Partial Cup & Cone	Partial Cup & Cone
FRACTURE LOCATION	Parent Metal (SA 516 Gr. 60N)	Parent Metal (SA 516 Gr. 60N)

GUIDED-BEND QW-160

SAMPLE WIDTH:	38.1 mm (1.50 in.)	SAMPLE THICKNESS:	6.32 mm (0.249 in.)
PLUNGER SIZE:	25.1 mm (0.990 in.)	YOKE SIZE:	41.1 mm (1.62 in.)
QW-462.3(a)	Root Bend	Root Bend	Face Bend
SAMPLE NUMBER(S)	R1	R2	F1
RESULTS	Pass	Pass	Pass

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section IX, 2007 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. Samples associated with this report will be discarded in 45 days.

Laboratory Test Conducted By: _____

Ernie Gabriel / Simon Kirkland, C.E.T.



LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: National Process Equipment Inc.
5, 3401 - 19th Street N.E.
Calgary, Alberta
T2E 6S8

Laboratory Test No.: C10-524.1R1
Date: March 16, 2010
Revision Date: November 3, 2011

Attention: Ed Tedorsthorst

PQR Number: NPE-1-1
Material: SA 516 Gr. 60N to SA 516 Gr. 70N (Heat No.: 28549 - 84705)
Thickness: 6.32 mm (0.249 in.)
Thermal Condition: As Welded

CHARPY V-NOTCH IMPACT TEST

Machine: Satec, SI-1C SN:1363 **Specimen Size:** 10 x 5 mm (0.394 x 0.197 in.)
Capacity: 325 J (240 ft-lbf) **Orientation:** Transverse
Verified Range: 1.7 - 140.1 J (1.3 - 103.3 ft-lbf) **Test Temp.:** -48°C (-55°F)

Specimen Number	Notch Location	Impact Values Joules (ft-lbf)	
V2.1	Weld Metal	42.8	(31.6)
V2.2	within 1/16 in.	18.2	(13.4)
V2.3	of root	11.0	(8.1)
V3.1	Gr. 60N - HAZ	57.2	(42.2)
V3.2	Gr. 60N - HAZ	46.4	(34.2)
V3.3	Gr. 60N - HAZ	83.0	(61.2)
W3.1	Gr. 70N - HAZ	39.0	(28.8)
W3.2	Gr. 70N - HAZ	62.9	(46.4)
W3.3	Gr. 70N - HAZ	57.2	(42.2)

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASME Section VIII, Div. 1, UG-84, 2007 edition and latest addenda. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. Samples associated with this report will be discarded in 45 days.

Laboratory Test Conducted By:  Claire Robinson, T.T. /  Simon Kirkland, C.E.T.





LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: National Process Equipment Inc.
5, 3401 - 19th Street N.E.
Calgary, Alberta
T2E 6S8

Laboratory Test No.: C10-524.1R1
Date: March 16, 2010
Revision Date: November 3, 2011

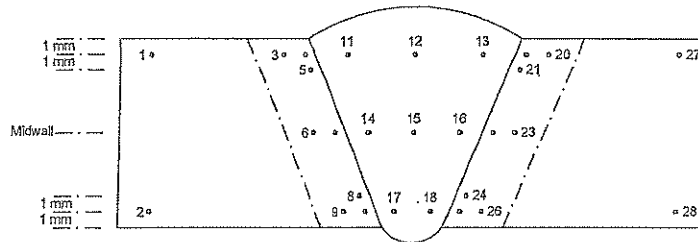
Attention: Ed Tedorsthorst

PQR Number: NPE-1-1
Material: SA 516 Gr. 60N to SA 516 Gr. 70N (Heat No.: 28549 - 84705)
Thickness: 6.32 mm (0.249 in.)
Thermal Condition: As Welded

HARDNESS TEST

Type of Test: Vickers 500 g (HV₅₀₀)


Instrument: Mitutoyo Macroickers 5112



SA 516 Gr. 60N				Weld Metal		SA 516 Gr. 70N			
Parent Metal		HAZ				HAZ		Parent Metal	
1	160	3	168	11	181	19	192	27	165
2	159	4	178	12	183	20	167	28	159
		5	183	13	187	21	178		
		6	171	14	168	22	168		
		7	178	15	172	23	163		
		8	158	16	163	24	167		
		9	160	17	153	25	166		
		10	151	18	178	26	161		

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASTM E384-09. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report. Samples associated with this report will be discarded in 45 days.

Laboratory Test Conducted By: _____

 Ernie Gabriel / Simon Kirkland, C.E.T.





LUDWIG ASSOCIATES LTD.

Materials and Welding Consulting

LABORATORY TEST REPORT

CUSTOMER: National Process Equipment Inc.
5, 3401 - 19th Street N.E.
Calgary, Alberta
T2E 6S8

Laboratory Test No.: C10-524.1R1
Date: March 16, 2010
Revision Date: November 3, 2011

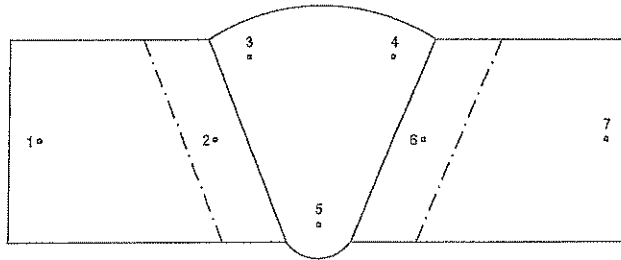
Attention: Ed Tedorsthorst

PQR Number: NPE-1-1
Material: SA 516 Gr. 60N to SA 516 Gr. 70N (Heat No.: 28549 - 84705)
Thickness: 6.32 mm (0.249 in.)
Thermal Condition: As Welded

HARDNESS TEST

Type of Test: Rockwell Scale B (HRBW*)

Instrument: NewAge Digital Versitron



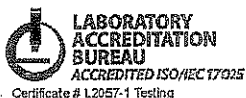
SA 516 Gr. 60N		HAZ		Weld Metal		SA 516 Gr. 70N		Parent Metal	
1	79	2	84	3	73	6	85	7	80
				4	81				
				5	83				

* Note: HRBW indicates testing was conducted with a tungsten carbide indenter.

We certify the test results in this report and that the specimen(s) were prepared and tested in accordance with the requirements of ASTM E18 – 08b. The information regarding material identification (i.e. size, thickness, heat number, etc.) has been provided by the customer whose name appears on this report.

Laboratory Test Conducted By: _____

Ernie Gabriel / Simon Kirkland, C.E.T.





DILLINGER HÜTTE

Edüftungen siehe Rückseite/Explications voir au verso/See reverse for explanations

A02 ABNÄHMEPRÜFUNG/INSPECTION CERTIFICATE
 A03 CERTIFICATE DE RECEPTION
 A04 INSPECTION CERTIFICATE
 A05 Established inspecting body
 A06 Purchaser
 A07 Final receiver
 A08 Advice of dispatch No./Date of dispatch
 A09 Manufacturer's order/A03 Certificate No.
 A10 Sheet

DIN EN 10204 - EN 10204 - DIN 50049
 EN 10204 - EN 10204
 BS EN 10204 - ISO 10474 MATERIAL TEST REPORT
 A071 No. PS4105
 A072 No. E10159-J1-0101G
 USINOR CANADA, WESTMO
 EDMONTON STEEL, EDMON

B09 Item No.	B08 Heat No.	B07 Rol. plate/ Test No.	B05 Reference condition	C01		C02/ C03 Temp. RE	C11 G11	KSL	C12 RW	C13 AZ	C14	C15
				C01	C01							
C10-C29 TENSILE TEST												
01	28549	84703		K4	Q	GR.F RT	RP02 51,6		72,2	27,0		
01	28549	84704		K4	Q	RT	50,8		71,5	27,5		
01	28549	84705		K4	Q	RT	51,5		70,9	27,5		
01	28549	84706		K4	Q	RT	51,8		71,6	27,5		
01	28549	84707		K4	Q	RT	51,0		70,8	27,5		
01	28549	84709		K4	Q	RT	51,3		71,2	27,0		
01	28551	86360		K4	Q	RT	49,9		70,2	26,0		
01	28551	86361		K4	Q	RT	50,9		71,5	28,0		
01	28551	86362		K4	Q	RT	51,9		72,2	27,0		
01	28551	86363		K4	Q	RT	53,9		72,9	27,0		
01	28551	86363		K4	Q	RT	53,9		73,2	27,0		

B09 Item No.	B08 Heat No.	B07 Rol. plate/ Test No.	B05 Reference condition	C01		C02/ C03 Temp. GR.F	C01 Width	C40 Type of specimen	C44	C45/C42 Individual values	C43 Average value
				C01	C01						
C40-C49 IMPACT TEST											
01	28549	84699		K4	LV	-51	1/2	CHP-V	AV 52	67	72
01	28549	84700		K4	LV	-51	1/2	CHP-V	AV 48	49	70
01	28549	84701		K4	LV	-51	1/2	CHP-V	AV 49	50	73
01	28549	84702		K4	LV	-51	1/2	CHP-V	AV 91	53	77
01	28549	84703		K4	LV	-51	1/2	CHP-V	AV 73	42	83
01	28549	84704		K4	LV	-51	1/2	CHP-V	AV 71	80	72
01	28549	84705		K4	LV	-51	1/2	CHP-V	AV 52	74	81
01	28549	84706		K4	LV	-51	1/2	CHP-V	AV 72	75	74
01	28549	84707		K4	LV	-51	1/2	CHP-V	AV 83	74	74
01	28549	84709		K4	LV	-51	1/2	CHP-V	AV 88	76	74

2017/202 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.
 CIM-System: Certification as per ISO 9001 since 14 March 1990
 AG der Dillinger Hüttenwerke
 Postfach 1580, D-66743 Dillingen/Saar
 Inspection department



Trennpunkt
 Der Werksachverständige
 B. MUELLER
 Inspector's stamp
 Date 08.04.02
 KW 1



DILLINGER HÜTTE

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations

A02 ABNAHMEPRÜFZEUGNIS 3.1.B DIN EN 10204 - EN 10204 - DIN 50049 A03 Advice of dispatch No./ A03 Manufacturer's order/ Sheet
 CERTIFICAT DE RECEPTION 3.1.B NF EN 10204 Date of dispatch 63568-05.04.02 248944-001 4/...
 INSPECTION CERTIFICATE 3.1.B BS EN 10204 - ISO 10474 MATERIAL TEST REPORT A07.1 No: PS4105 A07.2 No: E10159-J1010LG
 A05 Established inspecting body/ A06 Purchaser USINOR CANADA, WESTMO A07.1 No: PS4105 A07.2 No: E10159-J1010LG
 Final receiver EDMONTON STEEL, EDMON

DH B02/ Steel grade SA516-70 B03 Specifications ASME-2A: 01 flans SA20-55

C40-C49 IMPACT TEST

Item No.	B03 Heat No.	B07 Rol. plate/ Test No.	B05 Reference condition	C01 C02/ C03 C01 Temp. GR.F	C41 Width	C40 Type of specimen	C45/C42 Individual values AV=FT.LBF	C43 Average value
01	28549	84710	K4 LV	-51	1/2	CHP-V	AV 47 94	74
01	28551	86360	K4 LV	-51	1/2	CHP-V	AV 55 77	73
01	28551	86361	K4 LV	-51	1/2	CHP-V	AV 76 69	69
01	28551	86362	K4 LV	-51	1/2	CHP-V	AV 69 69	66
01	28551	86363	K4 LV	-51	1/2	CHP-V	AV 69 68	69

C70-C99 CHEMICAL COMPOSITION Z - HEAT ANALYSIS

Item No.	B03 Heat No.	C SI	MN	P	S	N	AL	CU	MO	NI	CR	VB	WT
28549	Y	0,153	0,312	0,009	0,0006	0,004	0,040	0,027	0,012	0,047	0,036	0,001	0,003
28551	Y	0,0002	0,003	0,05	0,12	7,3	0,049	0,027	0,028	0,043	0,030	0,000	0,002
		0,0001	0,001	0,011	0,0014	7,5							

C95 LADLE TREATMENT
 ITEM NO.: 01
 HEAT OF THE INDICATED ITEM: VACUUM DEGASSED / SULPHIDE SHAPE CONTROL

C70-C99 CHEMICAL COMPOSITION Z - PRODUCT ANALYSIS

Item No.	B07 Rol. plate/ Test No.	C SI	MN	P	S	N	AL	CU	MO	NI	CR	VB	WT
28549	Y	0,147	0,317	0,009	0,0002	0,000	0,042	0,027	0,011	0,045	0,037	0,001	0,001
28551	Y	0,002	0,003	0,000	0,010	7,6	0,065	0,032	0,026	0,044	0,034	0,000	0,000
		0,000	0,002	0,002	0,002	7,8							

A04 Z01/Z02 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

DM-System: Certification as per ISO 9001 since 14 March 1990
 AG der Dillinger-Hüttenwerke
 Postfach 1580, D-66748 Dillingen/Saar
 Inspection department

Trademark

B. MUELLER
 Der Werkssachverständige Inspector's stamp Date 08.04.02 KW 1



DILLINGER HÜTTE

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations

A02 ABNAHMEPRUEFZEUGNIS 3.1.B DIN EN 10204 - EN 10204 - DIN 50049 A03 Advice of dispatch No./ Date of dispatch 63568-05-04-02 A03 Certificate No. 248944-001 Sheet 3/...

A05 Established inspecting body/A06 Purchaser Final receiver USINOR CANADA, WESTMO A07.1 No. PS4105 A07.2 No. EL0159-J1010LG

B02/ Steel grade SA516-60 B03 Specifications ASME-2A:01 SA20-S5

C10-C29 TENSILE TEST B05 Reference condition

Table with columns: Item No., Heat No., Rol. plate/ Test No., C01, C02, C03, C04, C05, C06, C07, C08, C09, C10, C11, C12, C13, C14, C15. Includes data for items 01-08.

C40-C49 IMPACT TEST B05 Reference condition

Table with columns: Item No., Heat No., Rol. plate/ Test No., C40, C41, C42, C43, C44, C45. Includes data for items 01-08.

201202 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order. CIM-System: Certification as per ISO 9001 since 14 March 1990

AG der Dillinger Hüttenwerke Postfach 1580, D-66748 Dillingen/Saar inspection department

Inspector's stamp: B. MOELLER, Der Werkssachverständige, Date 08.04.02, Inspector's stamp, Date 08.04.02, KW 2



DILLINGER HÜTTE

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations

A02 ABNAHMEPRUEFZUGNIS 3.1.B DIN EN 10204 - EN 10204 - DIN 50049 A03 Advice of dispatch No./ Date of dispatch 63568-05.04.02 A03 Certificate No. 248944-001 Sheet 4/...

CERTIFICAT DE RECEPTION 3.1.B NF EN 10204

INSPECTION CERTIFICATE 3.1.B BS EN 10204 - ISO 10474 MATERIAL TEST REPORT

A05 Established inspecting body/A06 Purchaser USINOR CANADA, WESTMO A07.1 No. PS4105 A07.2 No. E10159-F1010LC

Final receiver EDMONTON STEEL, EDMON

B02/ Steel grade SA516-60.

B03 Specifications- ASME-2A:01 SA20-S5

C40-C49 IMPACT TEST

B09 Item No.	B08 Heat No.	B07 Rol. plate/ Test No.	Reference condition	C01 K4	C02 LV	C03 GR.F	C41 Width	C40 Type of specimen	C43 Individual values	C43 Average value
01	28549	84710				-51	1/2	CHP-V	AV 47	74
01	28551	86360				-51	1/2	CHP-V	AV 55	72
01	28551	86361				-51	1/2	CHP-V	AV 76	68
01	28551	86362				-51	1/2	CHP-V	AV 69	71
01	28551	86363				-51	1/2	CHP-V	AV 69	65

C70-C99 CHEMICAL COMPOSITION Z - HEAT ANALYSIS

B08 Heat No.	C70 Y	C	SI	MN	P	S	N	AL	CU	MO	NI	CR	Y	MB	TI
28549	Y	B	0,159	0,312	0,009	0,0006	0,004	0,040	0,027	0,012	0,047	0,036	0,001	0,001	0,003
28551	Y	B	0,153	0,317	0,011	0,0014	0,004	0,049	0,027	0,028	0,043	0,030	0,000	0,000	0,002

C95 LADLE TREATMENT

ITEM NO.: 01

HEAT OF THE INDICATED ITEM: VACUUM DEGASSED / SULPHIDE SHAPE CONTROL

C70-C99 CHEMICAL COMPOSITION Z - PRODUCT ANALYSIS

B08 Heat No.	C70 Y	C01 Rol. plate/ Test No.	C	SI	MN	P	S	N	AL	CU	MO	NI	CR	Y
28549	Y	84703 - EPL	MB	0,147	0,317	1,12	0,009	0,004	0,042	0,027	0,011	0,045	0,037	0,001
28551	Y	86363	K	0,002	0,003	0,0002	0,000	0,35	0,065	0,032	0,026	0,044	0,034	0,000

A04 Z01/202 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

QMS-System: Certification as per ISO 9001 since 14 March 1990

AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Sea
Inspection department

S. Müller

B. MUELLER
Der Werksachverständige Inspector's stamp Date 08.04.02

TradeMark

KW 2

WELDING PROCEDURE SPECIFICATION NO.: NPE-8

WELDING PROCEDURE QUALIFICATION RECORD NO.(S): NPE-8-1, NPE-8-2

QUALIFIED FOR

Base Metal (Typical): P8 to P8 (SA 182, SA 240, SA 312 Types 304, 304L, 316, 316L, etc.)

Process(es): GMAW / SMAW Weld Types: GROOVE & FILLET

Position: ALL POSITIONS Diameter: ALL DIAMETERS

Filler Metal: GMAW: ER308(L), ER308(L)Si, ER316(L), ER316(L)Si, etc.*
SMAW: E308(L)-15/16/17, E316(L)-15/16/17, etc.*

Note: *Match filler metal chemical composition and tensile strength to base metal being welded

BASE METAL CONDITIONS & GROOVE THICKNESS RANGE QUALIFIED:

BASE METAL THICKNESS RANGE – ASME SECTION IX

STANDARD APPLICATIONS AS WELDED 1.6 to 38.1 mm (0.062 to 1.50 in.) inclusive

COMBINED DEPOSITED WELD METAL THICKNESS

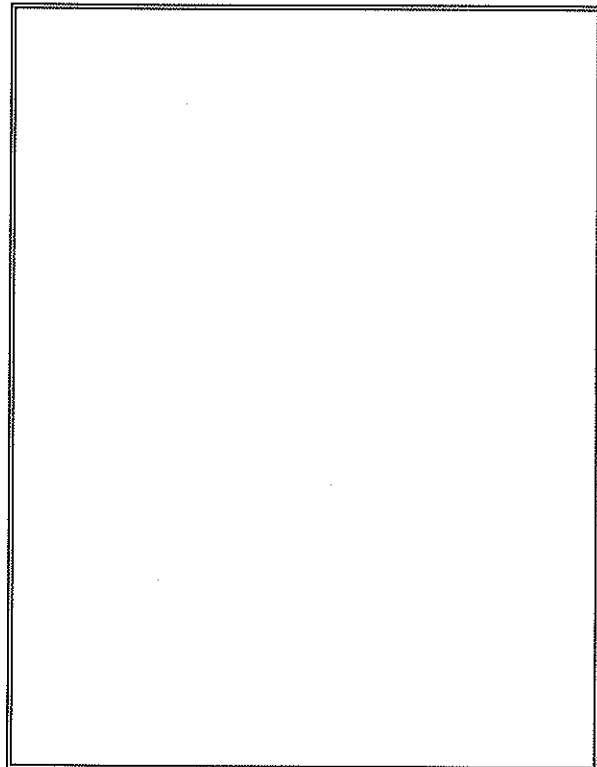
ASME B31.1	<u>35.8 mm (1.41 in.) maximum</u>
ASME B31.3	<u>35.8 mm (1.41 in.) maximum</u>
ASME SECT. VIII, DIV.1	<u>35.8 mm (1.41 in.) maximum</u>

ASQA
SAFETY CODES ACT - PROVINCE OF ALBERTA
WELDING PROCEDURE

Reg. No. WP 3101.2
Spec. No. NPE-8
Weld Process GMAW/SMAW
Matl. Gr. P No. 8 to P No. 8
Elec. Gr. F No. 6+5 A No. 8
Th. Qual. For 38.1 mm P.W.H.T. NO

Yr. 13 Mo. 6 Day 19 signed [Signature]
R. ROSEBERG, P.ENG.
WELDING SPECIALIST

PROVINCIAL REGISTRATION



QW-482 WELDING PROCEDURE SPECIFICATION (WPS)

National Process Equipment Inc.

Welding Procedure Specification No. NPE-8 Date June 5, 2013
Supporting PQR No.(s) NPE-8-1, NPE-8-2
Welding Process(es) GMAW / SMAW Type(s) Semi-auto / Manual

JOINTS (QW-402)

Joint Design All ASME groove & fillet, reference construction drawing for joint details.
Where joint details are not specified, see figures 1 to 15 attached
Root Opening As per attached typical groove designs, see figures 1 to 15 attached
Backing With or without Retainers Not required

BASE METALS (QW-403)

P-Number P8 To P-Number P8
Thickness Range: Groove See cover page for thickness qualified by governing code
Fillet All base metal thicknesses
Base Metal See cover page
Pipe Diameter Ranges: Groove All diameters
Fillet All diameters
Deposited Weld Metal (Per Pass) GMAW: 2.79 mm (0.110 in.) maximum
SMAW: 9.52 mm (0.375 in.) maximum

FILLER METALS (QW-404)

	GMAW	SMAW
Specification No. (SFA)	<u>SFA 5.9</u>	<u>SFA 5.4</u>
AWS No. (Class)	<u>ER308(L), ER308(L)Si, ER316(L), ER316(L)Si, etc.*</u>	<u>E308(L)-15/16/17 E316(L)-15/16/17, etc.*</u>
F-No.	<u>F6</u>	<u>F5</u>
A-No.	<u>A8</u>	<u>A8</u>
Size	<u>See Table #1</u>	<u>See Table #1</u>
Filler Metal Product Form	<u>Solid wire</u>	<u>N/A</u>
Supplemental Filler Metal	<u>Without</u>	<u>N/A</u>
Deposited Weld Metal Thickness Range:		
Groove	<u>2.79 mm (0.110 in.) max.</u>	<u>33.0 mm (1.30 in.) max.</u>
Fillet	<u>All fillet sizes</u>	<u>All fillet sizes</u>
Other	<u>*Match filler metal chemical composition and tensile strength to base metal being welded</u>	

POSITION (QW-405)

Position of Groove & Fillet GMAW: All positions SMAW: All positions
Weld Progression GMAW: Vertical up or down SMAW: Vertical up

PREHEAT (QW-406)

Preheat Temperature (Minimum) 10°C (50°F)
Interpass Temperature (Maximum) 177°C (350°F)
Preheat Maintenance 10°C (50°F) prior to welding. Preheat maintenance is not required if
welding is interrupted or after the completion of welding unless required
by the code of construction.

POST WELD HEAT TREATMENT (QW-407)

Temperature None Time N/A

GAS (QW-408)

Specification No. (SFA) SFA 5.32 AWS No. (Class) SG-HeAC-7.5/2.5
 Shielding GMAW: 90% He, 7.5% Ar, 2.5% CO₂, 5 - 25 liters per minute (10 - 50 cfph)
 Backing With or Without, if used 100% Argon, 5 - 15 liters per minute (10 - 30 cfph)
 Trailing Not Required

ELECTRICAL CHARACTERISTICS (QW-409)

Current Direct Polarity Reverse, electrode positive
 Amps See Table #1 Volts See Table #1
 Electrode Wire Feed Speed Amperage Controlled, See Table 1 Welding Parameters
 Mode of Metal Transfer GMAW: Short circuiting, Waveform controlled (Miller RMD)
 Maximum Heat Input N/A

TECHNIQUE (QW-410)

String or Weave Either Travel Speed See Table #1
 Orifice or Gas Cup Size GMAW: 9.52 to 19.1 mm (0.375 to 0.750 in.) inclusive
 Initial & Interpass Cleaning Brushing, chipping or grinding as required with equipment that will not contaminate
 Method of Back Gouging Air carbon arc, back-grind as required with equipment that will not contaminate
 Oscillation N/A
 Contact Tube to Work Distance GMAW: 6.35 to 19.1 mm (0.250 to 0.750 in.) inclusive
 Multiple or Single Pass Per Side Either
 Multiple or Single Electrodes Single
 Electrode Spacing N/A
 Use of Thermal Processes N/A Peening Not permitted

TABLE 1 - WELDING PARAMETERS

Standard Applications

Process	Filler Metal*	Diameter mm (in.)	Current & Polarity	Amperage Range	Voltage Range	Travel Speed mm/min (i.p.m.)
GMAW	ER308(L),ER308(L)Si	0.8 (0.030)	DCRP	70 - 130	14 - 22	43 - 250 (1.7 - 10)
GMAW	or	0.9 (0.035)	DCRP	80 - 200	14 - 22	56 - 600 (2.2 - 25)
GMAW	ER316(L),ER316(L)Si, etc.	1.1 (0.045)	DCRP	115 - 250	14 - 23	79 - 900 (3.1 - 35)
SMAW	E308(L)-15/16/17	2.4 (3/32)	DCRP	50 - 110	16 - 30	25 - 300 (1.0 - 12)
SMAW	or	3.2 (1/8)	DCRP	70 - 150	17 - 31	38 - 350 (1.5 - 14)
SMAW	E316(L)-15/16/17,	4.0 (5/32)	DCRP	100 - 200	18 - 32	50 - 400 (2.0 - 16)
SMAW	etc.*	5.0 (3/16)	DCRP	150 - 265	20 - 34	64 - 500 (2.5 - 20)

* Match filler metal chemical composition and tensile strength to base metal being welded.

Note: Size of electrode, filler metal, number of passes, voltage, amperage, and travel speed will vary with position, joint thickness, joint type etc.

TYPICAL JOINT DESIGNS

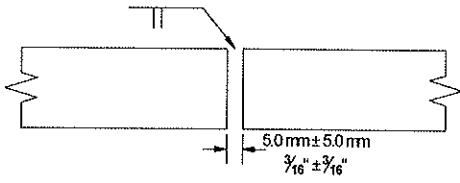


Fig. 1 Single Square Butt

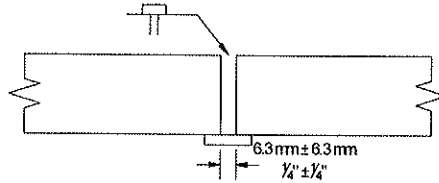


Fig. 2 Single Square Butt with Backing Strip

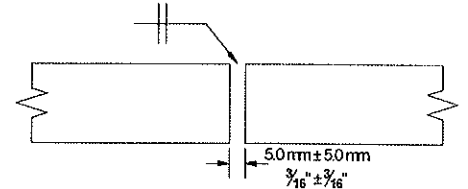


Fig. 3 Double Square Butt

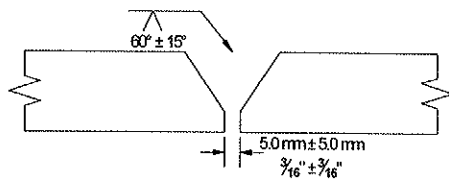


Fig. 4 Single Vee Butt

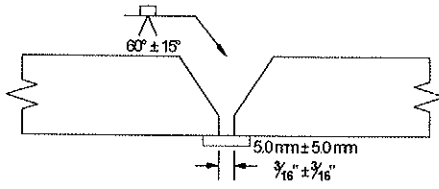


Fig. 5 Single Vee Butt with Backing Strip

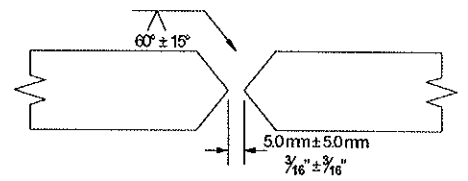


Fig. 6 Double Vee Butt

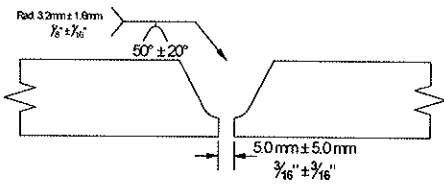


Fig. 7 Single U Butt

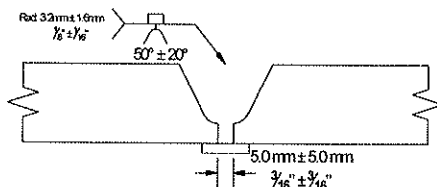


Fig. 8 Single U Butt with Backing Strip

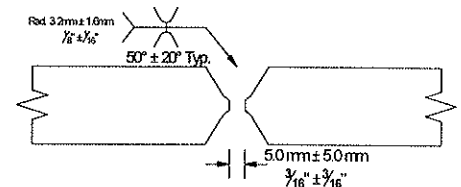


Fig. 9 Double U Butt

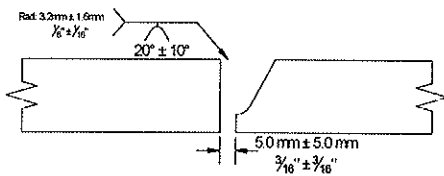


Fig. 10 Single J Butt

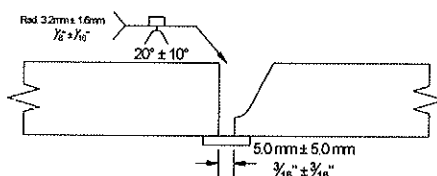


Fig. 11 Single J Butt with Backing Strip

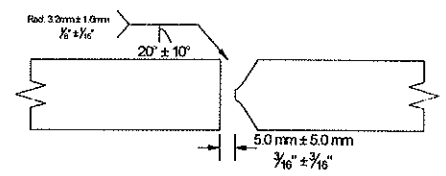


Fig. 12 Double J Butt

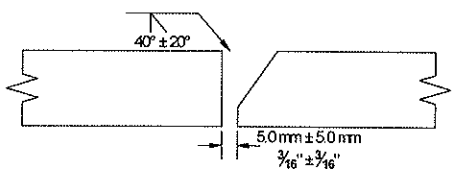


Fig. 13 Single Bevel Butt

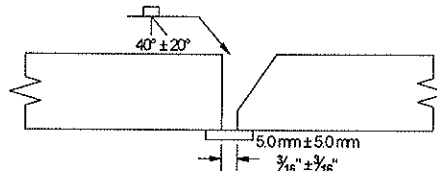


Fig. 14 Single Bevel Butt with Backing Strip

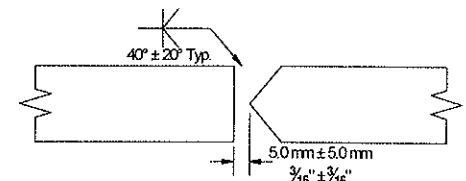


Fig. 15 Double Bevel Butt

Additional joint designs and internal misalignment on circumferential welds shall be within the dimensional limits stated on the approved construction drawing and / or the engineering design.

QW-483 PROCEDURE QUALIFICATION RECORD (PQR)

National Process Equipment Inc.

Procedure Qualification Record No. NPE-8-1 Date May 29, 2013
Welding Procedure Specification No. NPE-8
Welding Process(es) GMAW / SMAW Type(s) Semi-auto / Manual

JOINTS (QW-402)

Type Butt joint, single vee groove, see next page

BASE METALS (QW-403)

Material Spec. SA 240 Type or Grade Type 304L
P-No. P8 To P-No. P8 Thickness 9.52 mm (0.375 in.)
Diameter N/A - Plate Heat Number E712121 57759
Deposited Weld Metal (Per pass) Did not exceed 12.7 mm (0.500 in.)

FILLER METALS (QW-404)

	GMAW	SMAW
Specification No. (SFA)	<u>SFA 5.9</u>	<u>SFA 5.4</u>
AWS No. (Class)	<u>ER308LSi</u>	<u>E308L-17</u>
F-No.	<u>F6</u>	<u>F5</u>
A-No.	<u>A8</u>	<u>A8</u>
Filler Metal Product Form	<u>Solid wire</u>	<u>N/A</u>
Supplemental Filler Metal	<u>Without</u>	<u>N/A</u>
Size of Electrode	<u>See attached sketch</u>	
Deposited Weld Metal Thickness	<u>2.54 mm (0.100 in.)</u>	<u>6.98 mm (0.275 in.)</u>
Trade Name	<u>Special Metals INCOWELD ER308LSi</u>	<u>Avesta 308L AC/DC & Avesta 308L/MVR 3D</u>

POSITION (QW-405)

Position of Groove GMAW: Plate at 30° off flat SMAW: 1G
Weld Progression GMAW: Vertical down SMAW: N/A

PREHEAT (QW-406)

Preheat Temperature 10°C (50°F) Interpass Temp. (Max.) 177°C (350°F)

POSTWELD HEAT TREATMENT (QW-407)

Temperature None Time N/A

GAS (QW-408)

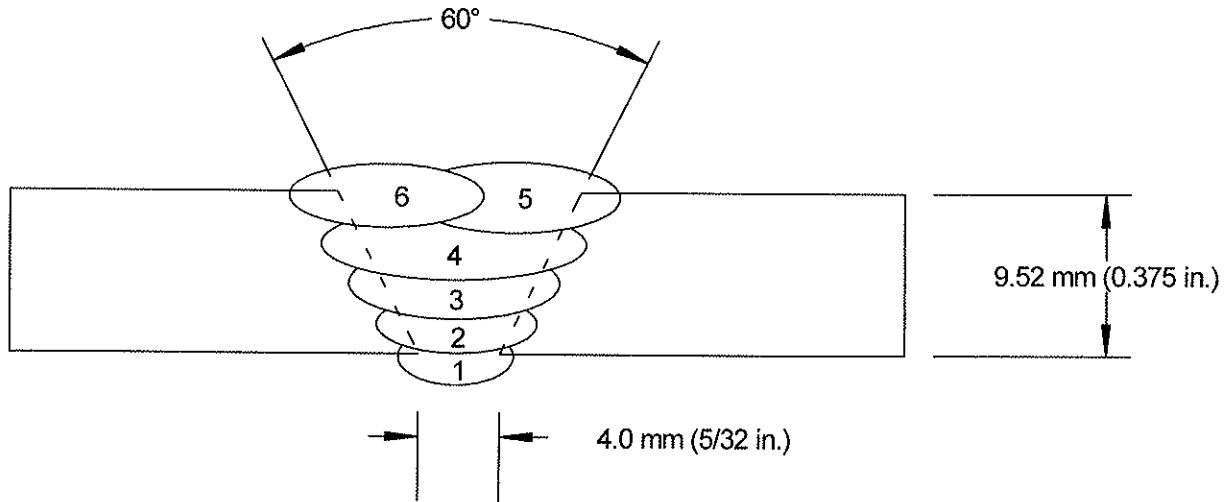
Specification No. (SFA) SFA 5.32 AWS No. (Class) SG-HeAC-7.5/2.5
Shielding GMAW: 90% He, 7.5% Ar, 2.5% CO₂, 10 liters per minute (20 cfph)
Backing Without
Trailing Without

ELECTRICAL CHARACTERISTICS (QW-409)

Current Direct Polarity Reverse, electrode positive
Amps See next page Volts See next page
Maximum Heat Input N/A
Wire Feed Speed GMAW: 4 318 mm/min. (170 ipm)
Mode of Metal Transfer GMAW: Short-circuiting waveform controlled (Miller RMD)

TECHNIQUE (QW-410)

String or Weave	<u> Weave </u>	Travel Speed	<u> See below </u>
Orifice or Gas Cup Size	<u> GMAW: 9.52 mm (0.375 in.) </u>		
Initial & Interpass Cleaning	<u> Brushing, chipping & grinding to remove slag </u>		
Method of Back Gouging	<u> Not used </u>	Oscillation	<u> N/A </u>
Tube to Work Distance	<u> GMAW: 9.52 to 12.7 mm (0.375 to 0.500 in.) </u>		
Multiple or Single Pass Per Side	<u> Multipass </u>		
Multiple or Single Electrodes	<u> Single </u>	Electrode Spacing	<u> N/A </u>
Use of Thermal Processes	<u> N/A </u>	Peening	<u> None </u>



Pass	Process	Filler Metal	Diameter mm (in.)	Current & Polarity	Amperage Range	Voltage Range	Travel Speed mm/min (i.p.m.)
1	GMAW	ER308LSi	0.9 (0.035)	DCRP	60 - 70	20 - 22	81 (3.2)
2	SMAW	E308L-17	3.2 (1/8)	DCRP	90 - 100	27 - 29	180 (7.1)
3	SMAW	E308L-17	4.0 (5/32)	DCRP	150 - 160	27 - 29	206 (8.1)
4	SMAW	E308L-17	4.0 (5/32)	DCRP	150 - 160	26 - 28	165 (6.5)
5	SMAW	E308L-17	4.0 (5/32)	DCRP	150 - 160	28 - 30	241 (9.5)
6	SMAW	E308L-17	4.0 (5/32)	DCRP	150 - 160	27 - 29	198 (7.8)

Heat Input Parameters - RMD

Pass	Power kJ/sec.	Arc Time Sec.	Weld Bead Length In.	Heat Input kJ/mm (Joule/in.)	Wire Feed Speed i.p.m.
1	1.3	223	12	0.95 (24,158)	170

TENSILE TEST (QW-150)

Specimen No.	Width mm (in.)	Thickness mm (in.)	Area Sq. mm (Sq. in.)	Ultimate Load N (lbs.)	Ultimate Stress Mpa (Psi)	Character & Fracture Location
T1	19.1 (0.752)	7.88 (0.310)	150 (0.233)	88 584 (19,900)	589 (85,400)	Partial Cup & Cone Weld Metal
T2	19.1 (0.752)	7.90 (0.311)	151 (0.234)	88 952 (20,000)	590 (85,500)	Partial Cup & Cone Weld Metal

GUIDED BEND TEST (QW-160)

Type & Figure No.	Result	Type & Figure No.	Result
QW-462.2, TSB - S1	Pass	QW-462.2, TSB - S3	Pass
QW-462.2, TSB - S2	Pass	QW-462.2, TSB - S4	Pass

OTHER TESTS

 Vickers Hardness - see attached laboratory test report # C13-745.1

 Ferrite Test on Weld Cap & Root - see attached laboratory test report # C13-745.1

Welders Name Darren Jolly Certificate File No. W-19754
 Tests Conducted By SGS Ludwig Associates Ltd.
 Laboratory Test No. C13-745.1

We certify the statements in this record are correct and that the test welds were prepared, welded and tested in accordance with the requirements of Section IX of the ASME Code.

Manufacturer NATIONAL PROCESS EQUIPMENT INC.

Date June 7 2013 Certified by [Signature]



LUDWIG

LABORATORY TEST REPORT

CUSTOMER: National Process Equipment Inc.
5049 - 74th Avenue S.E.
Calgary, AB
T2C 3H2

Laboratory Test No.: C13-745.1
Date: June 4, 2013

Attention: Rick St. Louis

PQR Number: NPE-8-1
Material: SA 240 Type 304L (Heat No.: E712121 57759)
Thickness: 9.52 mm (0.375 in.)
Thermal Condition: As Welded

Governing Specification: ASME Section IX, 2010 edition and latest addenda.

TENSILE TEST QW-150


SAMPLE NUMBER	T1 QW-462.1(a)	T2 QW-462.1(a)
WIDTH mm (in)	19.1 (0.752)	19.1 (0.752)
THICKNESS mm (in)	7.88 (0.310)	7.90 (0.311)
AREA sq mm (sq in)	150 (0.233)	151 (0.234)
ULT. LOAD N (lbf)	88 584 (19,900)	88 952 (20,000)
UTS MPa (psi)	589 (85,400)	590 (85,500)
FRACTURE TYPE	Partial Cup & Cone	Partial Cup & Cone
FRACTURE LOCATION	Weld Metal	Weld Metal

Note: Imperial values calculated by direct conversion.

GUIDED-BEND TEST QW-160

SAMPLE TYPE - QW-462.2	Side Bend	Side Bend	Side Bend	Side Bend
SAMPLE NUMBER(S)	S1	S2	S3	S4
RESULTS	Pass	Pass	Pass	Pass

Laboratory Test Conducted In Calgary By: Oksana Shevchenko, ASET Associate / Xin (Vincent) Su, T.T.

Laboratory Test Certified By:  L-A-B Accredited Certificate Number L2057-1 Testing
Steve Rieberger, C.E.T.

This report (or certificate) is issued by the Company under its General Conditions for Inspection and Testing Services (copy available upon request). The issuance of this report (or certificate) does not exonerate buyers or sellers from exercising all their rights and discharging all their liabilities under the Contract of Sale. Stipulations to the contrary are not binding on the Company. The Company's responsibility under this report (or certificate) is limited to proven negligence and will in no case be more than ten times the amount of the fees or commission. Except by special arrangement, samples, if drawn, will not be retained by the Company for more than 30 days. The information stated in this report (or certificate) is derived from the results of inspection or testing procedures carried out in accordance with the instructions of our Client, and/or our assessment of such results on the basis of any technical standards, trade custom or practice, or other circumstances which should in our professional opinion be taken into account.

LUDWIG ASSOCIATES LTD. IS NOW PART OF SGS, THE WORLD'S LEADING INSPECTION, VERIFICATION, TESTING AND CERTIFICATION COMPANY.



LUDWIG

LABORATORY TEST REPORT

CUSTOMER: National Process Equipment Inc.
5049 - 74th Avenue S.E.
Calgary, AB
T2C 3H2

Laboratory Test No.: C13-745.1
Date: June 3, 2013

Attention: Rick St. Louis

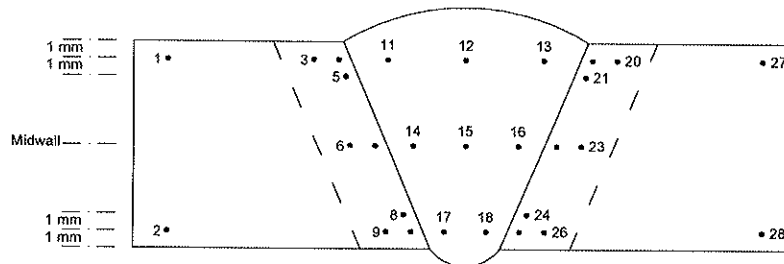
PQR Number: NPE-8-1
Material: SA 240 Type 304L (Heat No.: E712121 57759)
Thickness: 9.52 mm (0.375 in.)
Thermal Condition: As Welded

Governing Specification: ASTM E384-11^{e1}, ANSI/NACE MR0175/ISO 15156-3:2009(E).

HARDNESS TEST

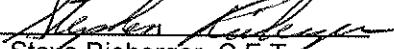
Type of Test: Vickers 10 kg (HV10)

Instrument: Mitutoyo AVK-C1



Parent Metal		HAZ		Weld Metal		HAZ		Parent Metal	
1	172	3	183	11	182	19	171	27	166
2	176	4	178	12	168	20	172	28	173
		5	181	13	174	21	176		
		6	188	14	187	22	179		
		7	192	15	191	23	184		
		8	193	16	195	24	192		
		9	195	17	198	25	193		
		10	196	18	204	26	194		

Laboratory Test Conducted In Calgary By: Yuxiang (Bill) Yao

Laboratory Test Certified By:  L-A-B Accredited Certificate Number L2057-1 Testing
Steve Rieberger, C.E.T.

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LUDWIG

LABORATORY TEST REPORT

CUSTOMER: National Process Equipment Inc.
5049 - 74th Avenue S.E.
Calgary, AB
T2C 3H2

Laboratory Test No.: C13-745.1
Date: June 3, 2013

Attention: Rick St. Louis

PQR Number: NPE-8-1
Material: SA 240 Type 304L (Heat No.: E712121 57759)
Thickness: 9.52 mm (0.375 in.)
Thermal Condition: As Welded

FERRITE CONTENT DETERMINATION

TEST UNIT: Fischer Feritscope FMP30 **TEST PROCEDURE:** FERITSCO.000 Rev. 0
RANGES CALIBRATED: 0.54 % Fe, 3.03 % Fe, 10.4 % Fe

Location	*Ferrite Avg. (%)
Weld Cap	7.6
Weld Cap	6.2
Weld Cap	7.5
Weld Root	5.5
Weld Root	5.3
Weld Root	5.6

**Note: Average based on five readings.*

Laboratory Test Conducted In Calgary By: Oksana Shevchenko, ASET Associate.

Laboratory Test Certified By: _____

Steve Rieberger
Steve Rieberger, C.E.T.

This report (or certificate) is issued by the Company under its General Conditions for Inspection and Testing Services (copy available upon request). The issuance of this report (or certificate) does not exonerate buyers or sellers from exercising all their rights and discharging all their liabilities under the Contract of Sale. Stipulations to the contrary are not binding on the Company. The Company's responsibility under this report (or certificate) is limited to proven negligence and will in no case be more than ten times the amount of the fees or commission. Except by special arrangement, samples, if drawn, will not be retained by the Company for more than 30 days. The information stated in this report (or certificate) is derived from the results of inspection or testing procedures carried out in accordance with the instructions of our Client, and/or our assessment of such results on the basis of any technical standards, trade custom or practice, or other circumstances which should in our professional opinion be taken into account.

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308 LST
wire

KMD/Smaw
Procedure



Certified Material Test Report

Controlled Products Group

A Special Metals Company
590 Seaman Street
Stoney Creek, Ontario
L8E 4H1

Date: 19 December, 2012

Purchase Order No:

Mark Order No:

Description of Material: INCO-WELD ER308LSI ✓

Type: ER308LSI ✓

Dimensions: 0.035" x 30 LB.W.B ✓

Quality Systems

This material conforms to Specification:

AWS A5.9-93 / ASME SFA 5.9

EN10204 Type 3.1

Chemical

Analysis

(Wt.%)

Heat: 42473

Lot: 182211

Carbon:	0.0160
Manganese:	1.9100
Silicon:	0.6900
Sulphur:	0.0090
Phosphorus:	0.0190
Nickel:	10.0600
Chromium:	19.6000
Molybdenum:	0.0500
Copper:	0.0700
Columbium*:	0.0100
Titanium:	0.0100
Nitrogen:	0.0550
Cobalt:	0.0300
Aluminum:	0.0004
Boron:	0.0009
Vanadium:	0.0900

Ferrite:	7.9	FN Delong
	8.0	FN WRC
	10.4	% Shaeffler

* Includes Tantalum

This is to certify that all required samplings, inspections and tests have been performed in accordance with the specification requirements. The test report represents the actual attributes of the material furnished and the values shown are correct and true. The material described by this certificate is in full compliance with all order and inspection requirements. We hereby certify that the above data are in accordance with the specification requirements.

By:

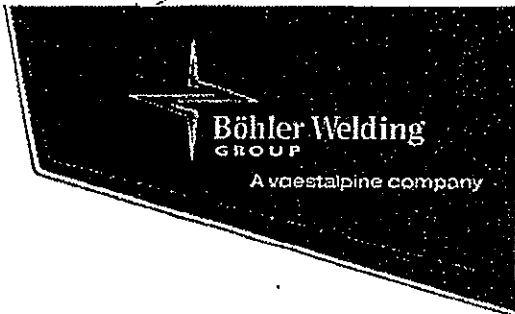

Paul Farion - Authorized Quality Assurance Representative

INCO-WELD, INCONEL, MONEL, NI-ROD, NILO, INCO-CORED, UDIMET, DURANICKEL, 686CPT, INCOLOY, NIMONIC, INCOFLUX, NDUR-ALL WIGGEN, and 725NDUR are trademarks of the Special Metals group of companies.

Kw 535102

INSPECTION CERTIFICATE

Certificate No.: 17289
Standard: 3.1 / EN 10204



Customer:
Böhler Welding Group USA Inc.
10401 Greenbough Drive
Stafford, TX 77477 USA

PHONE/FAX : +1 281-499-1212

Your Order:	4250008293	Issued Date:	5-Feb-13
Our Order :	212235		
Pack:	103687		
Product	STAINLESS STEEL WELDING MATERIAL	Article No.:	EL8109A325000
Trade Designation	ELECTRODES AVESTA 308L AC/DC		
Standard Designation	AWS A5.4: 2006 E308L-17 ASME SFA 5.4 : 2010 E308L-17 ✓		
Size	3,25 X 350 MM 1/8" X 14"	Lot No.	13014 ✓
Quantity	553.5 kg / 1219.2 lbs		
Special Requirements	NA		

Chemical composition-All weld metal (wt%)												
Lot No.	C	SI	Mn	P	S	Cr	NI	Mo	Cu	N	FN	Remarks
13014 ✓	0.031 ✓	0.84 ✓	0.95 ✓	0.019 ✓	0.011 ✓	20.40 ✓	10.01 ✓	0.02 ✓	0.04 ✓	0.07	9	Ferite According to WRC-82

Tensile test (minimum values according to AWS)							
	T Test temp. °C	R _{0.2} Yield Point Mpa	R _{p0.2} Yield Strength Mpa	R _m Tensile Strength Mpa	A ₅ Elongation %	Z Reduction %	Remarks
Typical Values	+25	-	425	580	44	-	As Welded

Impact test						
	T Test temp. °C	KV Absorbed energy min. values J	Average min. values J	Lateral Expansion mm	Shear Fracture %	Remarks
Typical Values	-	-	-	-	-	-

Remarks The product AVESTA 308L AC/DC, meets the requirement of the filler metal specification AWS A5.4: 2006 (ASME SFA 5.4 : 2010), Classification E308L-17 when tested in accordance with that specification.

Place Jakarta

[Handwritten Signature]



The requirements stipulated are satisfied.

PT BOHLER WELDING GROUP ASIA PACIFIC
Jl. Industri Selatan 2 Blok JJ No. 7-10
Kawasan Industri Jababeka Cikarang,
Pasirsari, Cikarang Selatan
Bekasi 17530
INDONESIA

Quality Department
PT BOHLER WELDING GROUP ASIA PACIFIC
OKIRI VIRILIS



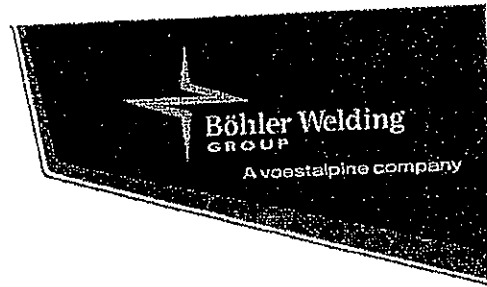
FULFILLING HIGH DEMANDS

Rev No.: 0

Par 535102

INSPECTION CERTIFICATE

Certificate No.: 16301
Standard: 3.1 / EN 10204



Customer:
Bohler Welding Group USA, Inc.
4950 Camp Road
Hamburg, NY 14075

PHONE/FAX :+1 281-499-1212

Your Order:	PQ4250008005	Issued Date:	27-Feb-13
Our Order:	212105		
Pack:	103376		
Product	STAINLESS STEEL WELDING MATERIAL	Article No.:	EL8109A400000 ✓
Trade Designation	ELECTRODES AVESTA 308L/MVR 3D		
Standard Designation	AWS A5.4: 2006 E308L-17 ASME SFA 5.4: 2010 E308L-17 ✓		
Size	4,00 X 350 MM	5/32" X 14"	Lot No. 12366 ✓
Quantity	744.9 kg / 1640.7 lbs		
Special Requirements	N.A		

Chemical composition-All weld metal (wt%)													Remarks
Lot No.	C	SI	Mn	P	S	Cr	NI	Mo	Cu	N	FN		
12366 ✓	0.028 ✓	0.81 ✓	0.79 ✓	0.021 ✓	0.011 ✓	18.88 ✓	10.73 ✓	0.001 ✓	0.01 ✓	0.06	5	Ferrite According to WRC-92	

Tensile test (minimum values according to AWS)							Remarks
Test temp. °C	R _{0.2} Yield Point Mpa	R _{p0.2} Yield Strength Mpa	R _m Tensile Strength Mpa	A ₄ Elongation %	Z Reduction %		
Typical Values	+25	-	425	580	44	-	As Welded

Impact test						Remarks
Test temp. °C	KV Absorbed energy min. values J	Average min. values J	Lateral Expansion mm	Shear Fracture %		
Typical Values	-	-	-	-	-	-

Remarks: The product AVESTA 308L/MVR 3D, meets the requirement of the filler metal specification AWS A5.4: 2006 (ASME SFA 5.4: 2010), Classification E308L-17 when tested in accordance with the specification.

Place: Jakarta

The requirements stipulated are satisfied.

Quality Department
PT BOHLER WELDING GROUP ASIA PACIFIC
OKTRI VIRJIS

PT BOHLER WELDING GROUP ASIA PACIFIC
Jl. Industri Selatan 2 Blok JJ No. 7-10
Kawasan Industri Jababeka Cikarang,
Pastreari, Cikarang Selatan
Bekasi 17530
INDONESIA



FULFILLING HIGH DEMANDS

Rev No.: 1

QW-483 PROCEDURE QUALIFICATION RECORD (PQR)

National Process Equipment Inc.

Procedure Qualification Record No. NPE-8-2 Date May 29, 2013
Welding Procedure Specification No. NPE-8
Welding Process(es) GMAW / SMAW Type(s) Semi-auto / Manual

JOINTS (QW-402)

Type Butt joint, single vee groove, see next page

BASE METALS (QW-403)

Material Spec. SA 240 Type or Grade Type 304L
P-No. P8 To P-No. P8 Thickness 19.1 mm (0.750 in.)
Diameter N/A - Plate Heat Number 90560
Deposited Weld Metal (Per pass) Did not exceed 12.7 mm (0.500 in.)

FILLER METALS (QW-404)

	GMAW	SMAW
Specification No. (SFA)	<u>SFA 5.9</u>	<u>SFA 5.4</u>
AWS No. (Class)	<u>ER308LSi</u>	<u>E308L-17</u>
F-No.	<u>F6</u>	<u>F5</u>
A-No.	<u>A8</u>	<u>A8</u>
Filler Metal Product Form	<u>Solid wire</u>	<u>N/A</u>
Supplemental Filler Metal	<u>Without</u>	<u>N/A</u>
Size of Electrode	<u>See attached sketch</u>	
Deposited Weld Metal Thickness	<u>2.54 mm (0.100 in.)</u>	<u>16.5 mm (0.650 in.)</u>
Trade Name	<u>Special Metals INCOWELD ER308LSi</u>	<u>Avesta 308L AC/DC & Avesta 308L/MVR 3D</u>

POSITION (QW-405)

Position of Groove GMAW: Plate at 30° off flat SMAW: 1G
Weld Progression GMAW: Vertical down SMAW: N/A

PREHEAT (QW-406)

Preheat Temperature 10°C (50°F) Interpass Temp. (Max.) 177°C (350°F)

POSTWELD HEAT TREATMENT (QW-407)

Temperature None Time N/A

GAS (QW-408)

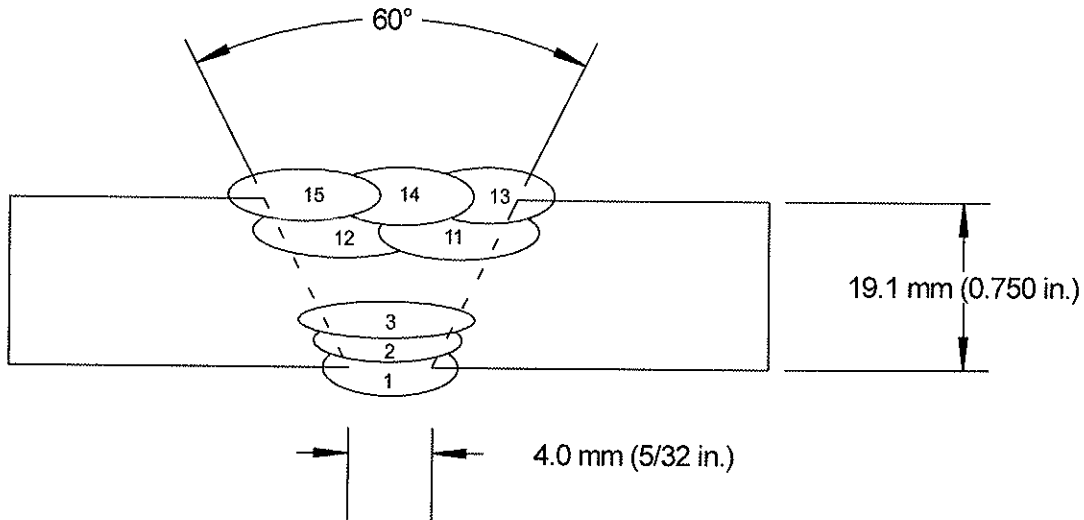
Specification No. (SFA) SFA 5.32 AWS No. (Class) SG-HeAC-7.5/2.5
Shielding GMAW: 90% He, 7.5% Ar, 2.5% CO₂, 10 liters per minute (20 cfph)
Backing Without
Trailing Without

ELECTRICAL CHARACTERISTICS (QW-409)

Current Direct Polarity Reverse, electrode positive
Amps See next page Volts See next page
Maximum Heat Input N/A
Wire Feed Speed GMAW: 4 318 mm/min. (170 ipm)
Mode of Metal Transfer GMAW: Short-circuiting waveform controlled (Miller RMD)

TECHNIQUE (QW-410)

String or Weave	<u> Weave </u>	Travel Speed	<u> See below </u>
Orifice or Gas Cup Size	<u> GMAW: 9.52 mm (0.375 in.) </u>		
Initial & Interpass Cleaning	<u> Brushing, chipping & grinding to remove slag </u>		
Method of Back Gouging	<u> Not used </u>	Oscillation	<u> N/A </u>
Tube to Work Distance	<u> GMAW: 9.52 to 12.7 mm (0.375 to 0.500 in.) </u>		
Multiple or Single Pass Per Side	<u> Multipass </u>		
Multiple or Single Electrodes	<u> Single </u>	Electrode Spacing	<u> N/A </u>
Use of Thermal Processes	<u> N/A </u>	Peening	<u> None </u>



Pass	Process	Filler Metal	Diameter mm (in.)	Current & Polarity	Amperage Range	Voltage Range	Travel Speed mm/min (i.p.m.)
1	GMAW	ER308LSi	0.9 (0.035)	DCRP	65 - 70	19 - 21	117 (4.6)
2	SMAW	E308L-17	3.2 (1/8)	DCRP	95 - 105	27 - 29	185 (7.3)
3	SMAW	E308L-17	4.0 (5/32)	DCRP	155 - 165	28 - 30	198 (7.8)
4	SMAW	E308L-17	4.0 (5/32)	DCRP	150 - 160	27 - 29	241 (9.5)
5	SMAW	E308L-17	4.0 (5/32)	DCRP	150 - 160	26 - 28	211 (8.3)
6	SMAW	E308L-17	4.0 (5/32)	DCRP	150 - 160	26 - 28	190 (7.5)
7	SMAW	E308L-17	4.0 (5/32)	DCRP	150 - 160	26 - 28	175 (6.9)
8	SMAW	E308L-17	4.0 (5/32)	DCRP	150 - 160	26 - 28	216 (8.5)
9	SMAW	E308L-17	4.0 (5/32)	DCRP	150 - 160	27 - 29	183 (7.2)
10	SMAW	E308L-17	4.0 (5/32)	DCRP	150 - 160	27 - 29	178 (7.0)
11	SMAW	E308L-17	4.0 (5/32)	DCRP	150 - 160	26 - 28	183 (7.2)
12	SMAW	E308L-17	4.0 (5/32)	DCRP	150 - 160	26 - 28	183 (7.2)
13	SMAW	E308L-17	4.0 (5/32)	DCRP	150 - 160	26 - 28	185 (7.3)
14	SMAW	E308L-17	4.0 (5/32)	DCRP	150 - 160	27 - 29	198 (7.8)
15	SMAW	E308L-17	4.0 (5/32)	DCRP	150 - 160	27 - 29	213 (8.4)

Heat Input Parameters - RMD

Pass	Power kJ/sec.	Arc Time Sec.	Weld Bead Length In.	Heat Input kJ/mm (Joule/in.)	Wire Feed Speed i.p.m.
1	1.3	156	12	0.67 (16,900)	170

TENSILE TEST (QW-150)

Specimen No.	Width mm (in.)	Thickness mm (in.)	Area Sq. mm (Sq. in.)	Ultimate Load N (lbs.)	Ultimate Stress Mpa (Psi)	Character & Fracture Location
T1	19.1 (0.752)	16.2 (0.638)	309 (0.480)	185 474 (41,700)	599 (86,900)	Partial Cup & Cone Weld Metal
T2	19.2 (0.756)	16.4 (0.646)	315 (0.488)	187 843 (42,200)	597 (86,500)	Partial Cup & Cone Weld Metal

GUIDED BEND TEST (QW-160)

Type & Figure No.	Result	Type & Figure No.	Result
QW-462.2, TSB - S1	Pass	QW-462.2, TSB - S3	Pass
QW-462.2, TSB - S2	Pass	QW-462.2, TSB - S4	Pass

OTHER TESTS

Vickers Hardness - see attached laboratory test report # C13-745.2

Ferrite Test on Weld Cap & Root - see attached laboratory test report # C13-745.2

Welders Name Darren Jolly Certificate File No. W-19754
 Tests Conducted By SGS Ludwig Associates Ltd.
 Laboratory Test No. C13-745.2

We certify the statements in this record are correct and that the test welds were prepared, welded and tested in accordance with the requirements of Section IX of the ASME Code.

Manufacturer NATIONAL PROCESS EQUIPMENT INC.

Date June 7 2013 Certified by [Signature]



LUDWIG

LABORATORY TEST REPORT

CUSTOMER: National Process Equipment Inc.
5049 - 74th Avenue S.E.
Calgary, AB
T2C 3H2

Laboratory Test No.: C13-745.2
Date: June 4, 2013

Attention: Rick St. Louis

PQR Number: NPE-8-2
Material: SA 240 Type 304L (Heat No.: 90560)
Thickness: 19.1 mm (0.750 in.)
Thermal Condition: As Welded

Governing Specification: ASME Section IX, 2010 edition and latest addenda.

TENSILE TEST QW-150

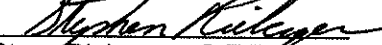
SAMPLE NUMBER	T1 QW-462.1(a)		T2 QW-462.1(a)	
	WIDTH mm (in)	19.1	(0.752)	19.2
THICKNESS mm (in)	16.2	(0.638)	16.4	(0.646)
AREA sq mm (sq in)	309	(0.480)	315	(0.488)
ULT. LOAD N (lbf)	185 474	(41,700)	187 843	(42,200)
UTS MPa (psi)	599	(86,900)	597	(86,500)
FRACTURE TYPE	Partial Cup & Cone		Partial Cup & Cone	
FRACTURE LOCATION	Weld Metal		Weld Metal	

Note: Imperial values calculated by direct conversion.

GUIDED-BEND TEST QW-160

SAMPLE TYPE - QW-462.2	Side Bend	Side Bend	Side Bend	Side Bend
SAMPLE NUMBER(S)	S1	S2	S3	S4
RESULTS	Pass	Pass	Pass	Pass

Laboratory Test Conducted In Calgary By: Oksana Sheychenko, ASET Associate / Xin (Vincent) Su, T.T.

Laboratory Test Certified By:  L-A-B Accredited Certificate Number L2057-1 Testing
Steve Rieberger, C.E.T.

This report (or certificate) is issued by the Company under its General Conditions for Inspection and Testing Services (copy available upon request). The issuance of this report (or certificate) does not exonerate buyers or sellers from exercising all their rights and discharging all their liabilities under the Contract of Sale. Stipulations to the contrary are not binding on the Company. The Company's responsibility under this report (or certificate) is limited to proven negligence and will in no case be more than ten times the amount of the fees or commission. Except by special arrangement, samples, if drawn, will not be retained by the Company for more than 30 days. The information stated in this report (or certificate) is derived from the results of inspection or testing procedures carried out in accordance with the instructions of our Client, and/or our assessment of such results on the basis of any technical standards, trade custom or practice, or other circumstances which should in our professional opinion be taken into account.

LUDWIG ASSOCIATES LTD. IS NOW PART OF SGS, THE WORLD'S LEADING INSPECTION, VERIFICATION, TESTING AND CERTIFICATION COMPANY.



LUDWIG

LABORATORY TEST REPORT

CUSTOMER: National Process Equipment Inc.
5049 - 74th Avenue S.E.
Calgary, AB
T2C 3H2

Laboratory Test No.: C13-745.2

Date: June 3, 2013

Attention: Rick St. Louis

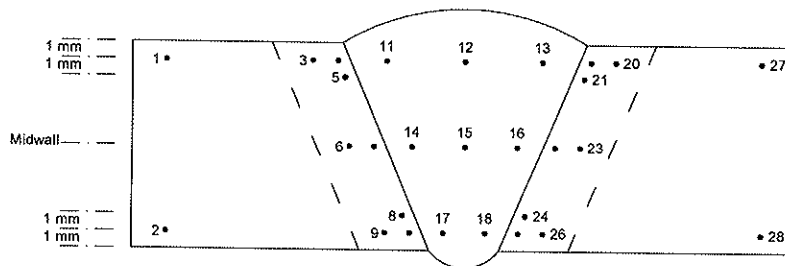
PQR Number: NPE-8-2
Material: SA 240 Type 304L (Heat No.: 90560)
Thickness: 19.1 mm (0.750 in.)
Thermal Condition: As Welded

Governing Specification: ASTM E384-11^{e1}, ANSI/NACE MR0175/ISO 15156-3:2009(E).

HARDNESS TEST

Type of Test: Vickers 10 kg (HV10)

Instrument: Mitutoyo AVK-C1



Parent Metal		HAZ		Weld Metal		HAZ		Parent Metal	
1	165	3	165	11	178	19	169	27	161
2	158	4	166	12	186	20	174	28	162
		5	168	13	175	21	165		
		6	200	14	193	22	198		
		7	192	15	211	23	199		
		8	193	16	200	24	185		
		9	199	17	210	25	192		
		10	200	18	200	26	193		

Laboratory Test Conducted In Calgary By: Yuxiang (Bill) Yao

Laboratory Test Certified By:  L-A-B Accredited Certificate Number L2057-1 Testing
Steve Rieberger, C.E.T.

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LUDWIG

LABORATORY TEST REPORT

CUSTOMER: National Process Equipment Inc.
5049 - 74th Avenue S.E.
Calgary, AB
T2C 3H2

Laboratory Test No.: C13-745.2
Date: June 3, 2013

Attention: Rick St. Louis

PQR Number: NPE-8-2
Material: SA 240 Type 304L (Heat No.: 90560)
Thickness: 19.1 mm (0.750 in.)
Thermal Condition: As Welded

FERRITE CONTENT DETERMINATION


TEST UNIT: Fischer Feritscope FMP30 **TEST PROCEDURE:** FERITSCO.000 Rev. 0
RANGES CALIBRATED: 0.54 % Fe, 3.03 % Fe, 10.4 % Fe

Location	*Ferrite Avg. (%)
Weld Cap	7.5
Weld Cap	7.3
Weld Cap	7.8
Weld Root	6.0
Weld Root	5.8
Weld Root	5.9

**Note: Average based on five readings.*

Laboratory Test Conducted In Calgary By: Oksana Shevchenko, ASET Associate.

Laboratory Test Certified By: _____


Steve Rieberger, C.E.T.

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308 LST
wire

ICMD/SMAW
Procedure



Certified Material Test Report



Controlled Products Group
A Special Metals Company
590 Seaman Street
Stoney Creek, Ontario
L8E 4H1

Date: 19 December, 2012
Purchase Order No:
Mark Order No:
Description of Material: INCO-WELD ER308LSI ✓
Type: ER308LSI ✓
Dimensions: 0.035" x 30 LB W.B. ✓

Quality Systems
This material conforms to Specification:
AWS A5.9-93 / ASME SFA 5.9
EN10204 Type 3.1

Chemical Analysis (Wt.%)

Heat: 42473
Lot: 182211

Carbon:	0.0160
Manganese:	1.9100
Silicon:	0.6900
Sulphur:	0.0090
Phosphorus:	0.0190
Nickel:	10.0600
Chromium:	19.6000
Molybdenum:	0.0500
Copper:	0.0700
Columbium*:	0.0100
Titanium:	0.0100
Nitrogen:	0.0550
Cobalt:	0.0300
Aluminum:	0.0004
Boron:	0.0009
Vanadium:	0.0900

Ferrite: 7.9 FN Delong
8.0 FN WRC
10.4 % Shaeffler

* Includes Tantalum

This is to certify that all required samplings, inspections and tests have been performed in accordance with the specification requirements. The test report represents the actual attributes of the material furnished and the values shown are correct and true. The material described by this certificate is in full compliance with all order and inspection requirements. We hereby certify that the above data are in accordance with the specification requirements.

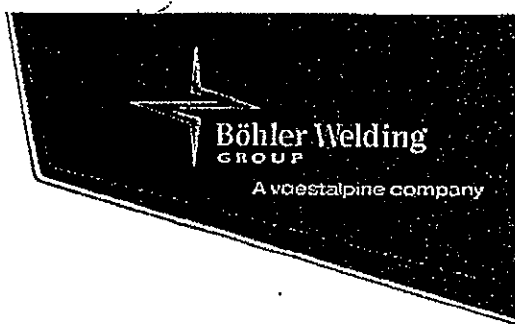
By: Paul Farion
Paul Farion - Authorized Quality Assurance Representative

INCO-WELD, INCONEL, MONEL, NI-ROD, NILO, INCO-CORED, UDIMET, DURANICKEL, 686CPT, INCOLOY, NIMONIC, INCOFLUX, NDUR-ALL WIGGEN, and 725NDUR are trademarks of the Special Metals group of companies.

Kw 535102 ~

INSPECTION CERTIFICATE

Certificate No.: 17289
 Standard: 3.1 / EN 10204



Customer :
 Bohler Welding Group USA Inc.
 10401 Greenbough Drive
 Stafford, TX 77477 USA

PHONE/FAX :+1 281-499-1212

Your Order:	4250008293	Issued Date:	5-Feb-13
Our Order :	212235		
Pack:	103687		
Product	STAINLESS STEEL WELDING MATERIAL	Article No.:	EL8109A325000
	ELECTRODES		
Trade Designation	AVESTA 308L AC/DC		
Standard Designation	AWS A5.4: 2008 E308L-17		
	ASME SFA 5.4 : 2010 E308L-17		
Size	3,25 X 350 MM 1/8" X 14"	Lot No.	13014
Quantity	553.5 kg / 1219.2 lbs		
Special Requirements	N.A		

Chemical composition-All weld metal (wt%)												
Lot No.	C	Si	Mn	P	S	Cr	Ni	Mo	Cu	N	FN	Remarks
13014	0.031	0.84	0.95	0.019	0.011	20.40	10.01	0.02	0.04	0.07	9	Fertile According to WRC-92

Tensile test (minimum values according to AWS)							
	T Test temp. °C	R _{0.2} Yield Point Mpa	R _{0.2} Yield Strength Mpa	R _m Tensile Strength Mpa	A ₅ Elongation %	Z Reduction %	Remarks
Typical Values	+25	-	425	580	44	-	As Welded

Impact test						
	T Test temp. °C	KV Absorbed energy min. values J	Average min. values J	Lateral Expansion mm	Shear Fracture %	Remarks
Typical Values	-	-	-	-	-	-

Remarks The product AVESTA 308L AC/DC, meets the requirement of the filler metal specification AWS A5.4: 2006 (ASME SFA 5.4 : 2010), Classification E308L-17 when tested in accordance with that specification.

Place Jakarta

[Handwritten Signature]



The requirements stipulated are satisfied.

PT BOHLER WELDING GROUP ASIA PACIFIC
 Jl. Industri Selatan 2 Blok JJ No. 7-10
 Kawasan Industri Jababeka Cikarang,
 Pasirsari, Cikarang Selatan
 Bekasi 17530
 INDONESIA

Quality Department
 PT BOHLER WELDING GROUP ASIA PACIFIC
 OKTA VIRILIS



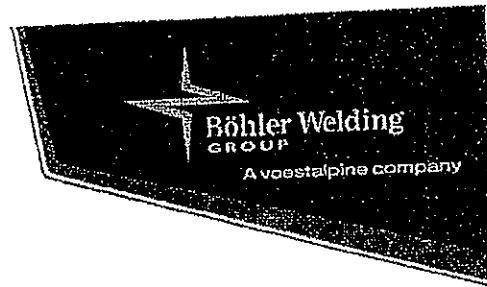
FULFILLING HIGH DEMANDS

Rev No.: 0

Par 535102

INSPECTION CERTIFICATE

Certificate No.: 16301
Standard: 3.1 / EN 10204



Customer:
Böhler Welding Group USA, Inc.
4950 Camp Road
Hamburg, NY 14075

PHONE/FAX: +1 281-499-1212

Your Order:	PO4250008005	Issued Date:	27-Feb-13
Our Order:	212105		
Pack:	103376		
Product	STAINLESS STEEL WELDING MATERIAL	Article No.:	EL8109A40000 ✓
Trade Designation	ELECTRODES AVESTA 308L/MVR 3D		
Standard Designation	AWS A5.4: 2008 E308L-17 ASME SFA 5.4: 2010 E308L-17 ✓		
Size	4,00 X 350 MM 5/32" X 14"	Lot No.	12366 ✓
Quantity	744.9 kg / 1640.7 lbs		
Special Requirements	N.A		

Chemical composition-All weld metal (wt%)												Remarks
Lot No.	C	Si	Mn	P	S	Cr	Ni	Mo	Cu	N	FN	
12366 ✓	0.028 ✓	0.81 ✓	0.79 ✓	0.021 ✓	0.011 ✓	19.88 ✓	10.73 ✓	0.001 ✓	0.01 ✓	0.06	5	Fertile According to WRC-92

Tensile test (minimum values according to AWS)							Remarks
	T Test temp. °C	R _{yk} Yield Point Mpa	R _{yk} & z Yield Strength Mpa	R _m Tensile Strength Mpa	A ₄ Elongation %	Z Reduction %	
Typical Values	+25	-	425	580	44	-	As Welded

Impact test						Remarks
	T Test temp. °C	KV Absorbed energy mit. values J	Average min. values J	Lateral Expansion mm	Shear Fracture %	
Typical Values	-	-	-	-	-	-

Remarks: The product AVESTA 308L/MVR 3D, meets the requirement of the filler metal specification AWS A5.4: 2006 (ASME SFA 5.4 : 2010), Classification E308L-17 when tested in accordance with that specification.

Place: Jakarta

The requirements stipulated are satisfied.

PT BOHLER WELDING GROUP ASIA PACIFIC
Jl. Industri Selatan 2 Blok JJ No. 7-10
Kawasan Industri Jababeka Cikarang,
Pasarreasi, Cikarang Selatan
Bekasi 17530
INDONESIA

Quality Department
PT BOHLER WELDING GROUP ASIA PACIFIC
OKTRI VIRLIS




FULFILLING HIGH DEMANDS

Rev No.: 1

DOCUMENT FRONT SHEET

PURCHASERS NAME	National Process Equipment
PURCHASE ORDER NO	PUR630251
EXHEAT REFERENCE	041168
SDR DOCUMENT NO	041168.VESSMPI
CLIENT DOCUMENT NO	
DOCUMENT TITLE	Magnetic particle inspection procedure

Doc Num	Revision	Issue	Date	Initials	Supplier's Approval Signature	Approval By
L02	1	1	25/09/2014	michb		09/10/2014

To be filled by the reviewer of this document prior to its return

Tick Box	Code	Status	Description
<input type="checkbox"/>	E1	Approved	Approval given, no comments, final issue.
<input type="checkbox"/>	E2	Approved to Proceed	Approval given for work to proceed with document to be submitted as Final Issue providing comments are incorporated
<input type="checkbox"/>	E3	Not Approved	Document rejected and must be re-submitted with incorporation of comments. Work may NOT proceed
<input type="checkbox"/>	E4	Information Only	No comments made or approval given, for information purposes only.
<input type="checkbox"/>	E5	As-Built	Approval given for work to proceed provided comments incorporated in As-Built revision.

PAGES (Including this one)

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COMMENTS

Please be aware that EXHeat will not be held responsible for late approval of documents and will not be held liable for any liquidated damages as a consequence.

Late approval of documents by the client may impact on the contractual delivery date.

EXHEAT LTD

Threxton Road Industrial Estate, Watton, IP25 6NG

Tel: +44 (0)1953 886200, Fax: +44 (0) 1953 886222, Email: accounts@exheat.com, Web: www.exheat.com



Level 3 Works Instruction - Document Number VQ00201_2

Magnetic Particle Inspection Procedure in Accordance with ASME V

PROCEDURE NO:

VQ00201_2

TITLE:

Magnetic Particle Inspection Procedure in accordance with ASME V

ISSUE NUMBER:

2

D R GRIFFIN
ASNT Level III
No. 72824

2013

Signature

PCN
DAVID GRIFFIN
PCN No 113851
www.bindt.org/PCN

Date

APPROVED BY EXTERNAL LEVEL III

[Handwritten Signature]

30/1/14

APPROVED BY ~~XXXXXXXXXXXXXXXXXXXX~~
MANAGING DIRECTOR

[Handwritten Signature: Julian Vance Jones]

30/1/2014

DEMONSTRATED & ACCEPTED AS
PRODUCING MEANINGFUL RESULTS (AI)

[Handwritten Signature]

14/2/14

Revision Status

Issue	Description	App'd	Date
0	First issue	GG	01.09.2010
1	Revised for ASME 2010 code edition 2011a addenda	JVD	18.01.2012
2	Revised for ASME 2013 code edition	JVD	30.01.2014

If during the use or review of this document, a need for amendment is identified, any employee of Vessco Engineering Limited may make the request using this form.

Please complete the form and pass to the Managing Director, Vessco Engineering Limited.

Amendment and Reason

Print name

Date

Magnetic Particle Examination Procedure In Accordance With **ASME V**

Contents:

1. Scope

1.1 References

2. Safety

3. Equipment & Consumables

4. Operator Qualifications

5. Procedure

Surface Preparation

Pre-cleaning

White background contrast paint

Magnetisation and viewing

6. Evaluation & Acceptance

Evaluation

Acceptance

7. Post Cleaning

8. Reporting

Document Number: VQ00201_2

Title: Magnetic particle examination procedure in accordance with ASME V 2013.

Purpose of Test: To find all surface breaking discontinuities using MPI within the specified area of examination.

Originator: Peter Turner **Date:** 15th January 2014

1. Scope

This procedure details the method of magnetic particle testing in accordance with ASME V 2013. Using AC energised electromagnetic yoke white background paint and black ink. Materials tested must be ferromagnetic.

A change in an essential variable specified in ASME V 2014 T-721 as described in T721.2 shall require revision of this procedure and requalification.

1.1. References

ASME Boiler & Pressure Vessel Code, Sections I, V & VIII
ASME SE-165 - Standard Test Method for Liquid Penetrant Examination.
ASME SE-1316: Standard Terminology for Non Destructive Examinations.

2. Safety

2.1. Care should be exercised to prevent any of the consumables from being splashed into the eyes, on the surface of the skin or clothing.

2.2. Consumables can contain volatile solvents, which may be relatively toxic or highly flammable. Consumables will be used at all times with caution and always in accordance with the supplier's recommendations and Company C.O.S.H.H. data sheets which are available from the Quality Office.

2.3. Consumables are not to be used in confined spaces, such as vessels. Where it is necessary for the operator to enter closed vessels or confined spaces, they must not do so without some form of forced air ventilation, the presence outside the vessel or confined space of a responsible person and no smoking or naked lights shall be permitted in or near the vessel or confined area.

2.4. All electrical equipment shall meet current legislation and be PAT tested

3. Equipment & Consumables

Testing shall be carried out using colour contrast white background paint, solvent cleaner and black magnetic particles held in liquid suspension.

AC energised electromagnetic yoke

4.5 kg test weight

Magnetic flux indicator strip strips type 1

Clean lint free cloths or absorbent paper

Consumable	Manufacturer	Product Name
Solvent Cleaner	Ardrox	9PR5
Black Magnetic Ink	Ardrox	8032
White Contrast Paint	Ardrox	8903W

All consumables shall be supplied with a Certificate of Conformity.

4. Operator Qualifications

All operators shall be approved and hold current certification in Magnetic particle Inspection in accordance with PCN Level 2 or SNT-TC-1A. As per the requirements of the Vessco ASME manual.

5. Procedure

All welds and cut edges shall be examined 100% on both internal and external surfaces, unless otherwise specified. All examinations shall be conducted with sufficient overlap to ensure 100% coverage at the required sensitivity.

5.1 Yoke lift check prior to use and whenever the yoke has been damaged or repaired using a 4.5kg test weight. The yoke shall only be used if this test is satisfactory and this test shall be documented.

5.2. Surface Preparation

5.1.1. The surfaces to be examined shall be inspected to ensure that any surface irregularities that may exist will not interfere with the effectiveness of the examination. This shall include the location of any discontinuity surface opening which may not attract and hold magnetic particles because of their width.

5.2. Pre-cleaning

5.2.1 The surface to be examined and adjacent areas within 25 mm (1inch) shall be dry and free from foreign matter such as oil, grease, scale etc., prior to the application of the white background paint. If necessary the area maybe dressed to permit the accurate interpretation of the magnetic indications. As welded surfaces are permitted provide that irregularities do not mask indications.

5.2.2. If necessary, solvent cleaner shall be used as a pre-cleaner to remove oil or grease by spraying or brushing directly on the area and wiping with clean lint free cloth or absorbent paper. The surface shall be clean and dry and left for a minimum period of 2 minutes before applying the white background paint

5.3. White background contrast paint

5.3.1. Contrast background paint shall be applied by spraying directly onto the area of inspection. This shall be a uniform evenly distributed layer to give sufficient contrast but not mask any discontinuities. This shall be allowed to dry completely

5.4 Magnetisation and viewing

5.4.1 Two separate examinations will take place using the yoke. The second with the yoke held at 90 degrees to the first examination.

5.4.2 Apply the Magnetising current and spray on the ink in a constant manner wherever possible working from the lowest point upwards allowing the excess to drain. Using the 'type 1' flux indicators to confirm sufficient field strength and direction.

5.4.3 The minimum light intensity shall be 1000 lux (100 fc) during the examination and evaluation of indications verified using a calibrated white light meter. The light source, technique used, and light level verification shall be demonstrated one time, documented, and maintained on file.

5.4.4 Examination shall be carried out by the continuous method in accordance with ASME V article 7, paragraph T-751. The magnetizing current shall remain on while the ink is being applied and while excess ink is being removed. The temperature of the ink and the surface of the part shall not exceed 50°C (122°F) the ink shall be applied by spraying.

6. Evaluation & Acceptance

Evaluation

All indications shall be evaluated in terms of the acceptance standards of the referencing Code Section

- a) A linear indication is one having a length greater than three times its width.
- b) A rounded indication is one of circular or elliptical shape with the length equal to or less than three times the width.
- c) Any questionable or doubtful indications shall be re-examined to determine whether or not they are relevant.

Acceptance Criteria

All definite defect indications shall be evaluated in terms of acceptance or rejection to the applicable contract requirements.

7. Post Examination Cleaning

When required all traces of consumables shall be removed following satisfactory examination of the surfaces. Cleaning shall be carried out as soon as practical using lint free cloths or absorbent paper and solvent cleaner until all traces of consumables are removed.

8. Reporting

The results of the examination shall be recorded on a MPI Test Report (VQ0133). The report shall be reviewed and approved by the Senior Inspector. Re-examination of repaired areas shall be in accordance with this procedure.



MAGNETIC PARTICLE REPORT

IDENTIFICATION AND SPECIFICATION DETAILS

REPORT NUMBER	
CUSTOMER	
VESCO JOB No.	
DATE OF TEST	
QUALITY PLAN REFERENCE No.	
DRAWING No.	
DESCRIPTION OF ITEM EXAMINED	
MATERIAL	
SURFACE CONDITION	
HEAT TREATMENT	
PROCEDURE No.	
ACCEPTANCE CRITERIA	

TEST DETAILS

EQUIPMENT MANUFACTURER		MODEL		SERIAL NO.	
EQUIPMENT CHECK		TEST WEIGHT		ACCEPT	
MAGNETISING METHOD	MAGNETIC FLOW		ELECTROMAGNET		PERMANENT MAGNET
TEST TYPE	COLOUR CONTRAST INK		FLUORESCENT		DRY POWDER
TEST MATERIALS	CONSUMABLE	MANUFACTURER	PRODUCT NAME	BATCH No.	
	Solvent Cleaner	Ardrox	9PR5	Insert batch number	
	Black Magnetic Ink	Ardrox	8032	Insert batch number	
	White Contrast Paint	Ardrox	8903W	Insert batch number	
TEST PARAMETERS	CONTACT SPACING	≤ 150mm	SENSITIVITY	Magnetic Flux Indicator – Type 1	
	TEST TEMPERATURE	≤50°C	DURATION	5 - 8 seconds	
SURFACE CONDITION					
TEST RESTRICTIONS					

RESULTS

Test Item / Weld Identification / Size / Thickness	ACCEPT or REJECT	NDE QUALIFICATION STAMP	DEFECT DESCRIPTION LOCATION and REMARKS

Technician:	Customer:	Authorised Inspector
Signature:	Signature:	Signature:
Qualification:		
Date:	Date:	Date:

VQ0133



NDT TECHNIQUE SHEET

Contract/Job No.:

Technique No.: NDT-TEC-MP1 Iss 1 Rev 1

GENERAL DETAILS

Title: Magnetic Particle Examination, Colour Contrast using A/C electromagnetic yoke.
Application: Welds (+ 25 mm from toes) , back gouges, preps, plate, pipe, cast & forged
Material and surface condition ferromagnetic materials (Surface to be free from surface contaminants which may affect the test)
Qualifications: /PCN Level 2 General / SNT -TC-1A
Technique in Accordance with: ASME V: 2013 Article 7 and VQ00201_2 (See senior inspector for latest revision)
Acceptance Criteria: As detailed in the contract quality plan.

TECHNIQUE AND EQUIPMENT

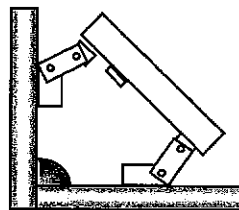
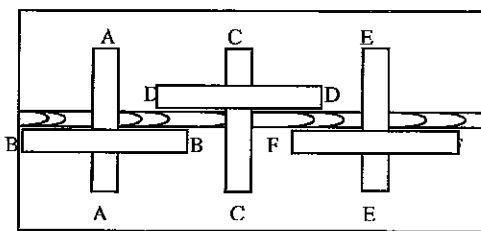
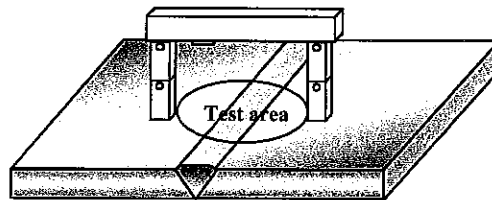
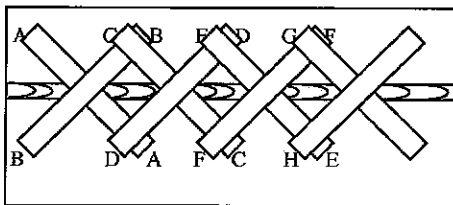
AC Electromagnet:	Y6 Yoke or equivalent	Permanent Magnet:	N/A
Flux / Field Strength Indicator:	Type 1 Indicator Strip	UV Light (if applicable):	N/A
Surface Condition:	Free from extraneous material	Viewing Conditions	> 1000 lux at test surface
Temperature:	≤50°C	Demagnetisation	N/A
Post Test Cleaning	When required		

CONSUMABLES

Contrast Paint:	Ardrox 8903W	Wet Non Fluorescent Ink:	Ardrox 8032
Solvent cleaner:	Ardrox 9PR5	Wet Fluorescent Ink:	N/A

TECHNIQUE ILLUSTRATION AND APPLICATION

1. Coat surface evenly with contrast medium. Apply ink during application of field. Apply magnetic field continuously for sufficient time to allow indications to form (5 to 8 seconds minimum).
2. Ensure magnet has current pull test record
3. ensure 10% overlap of fields



Additional Instructions:

1. Note any restrictions on test report.
2. Equivalent consumables or water based consumables may be used. Record the consumable used on the test report
3. Technique can be applied to other types of forming e.g. castings as long as the same principles for coverage apply and the technician is qualified in that sector.

APPROVAL

Vesco Engineering LTD
 Approved By:
 Signature:
 Date:

Client
 Approved By:
 Signature:
 Date:

Authorised Inspector
 Approved By:
 Signature:
 Date:



MAGNETIC PARTICLE REPORT

IDENTIFICATION AND SPECIFICATION DETAILS	
REPORT NUMBER	VQ00201_2 demonstration page 1 of 2
CUSTOMER	N/A
VESSCO JOB No.	N/A
DATE OF TEST	30/01/2014
QUALITY PLAN REFERENCE No.	N/A
DRAWING No.	N/A
DESCRIPTION OF ITEM EXAMINED	Pipe to base plate fillet weld
MATERIAL	CARBON STEEL
SURFACE CONDITION	As Welded
HEAT TREATMENT	NONE
PROCEDURE No.	VQ00201_2 Issue 2
ACCEPTANCE CRITERIA	ASME VIII div 1 2013 <i>UW-52</i>

TEST DETAILS					
EQUIPMENT MANUFACTURER	Johnson & Allen	MODEL	Y6	SERIAL NO.	JY1-0032
EQUIPMENT CHECK	LIFT TEST	TEST WEIGHT	4.6Kg	ACCEPT	✓
MAGNETISING METHOD	MAGNETIC FLOW	✓	ELECTROMAGNET	✓	PERMANENT MAGNET X
TEST TYPE	COLOUR CONTRAST INK	✓	FLUORESCENT	X	DRY POWDER X
TEST MATERIALS	CONSUMABLE	MANUFACTURER	PRODUCT NAME	BATCH No.	
	Solvent Cleaner	Ardrox	9PR5	721229	
	Colour contrast magnetic ink	Ardrox	8032	716944	
TEST PARAMETERS	CONTACT SPACING	≤ 150mm	SENSITIVITY	Magnetic Flux Indicator - Type 1	
	TEST TEMPERATURE	Ambient	DURATION	5 - 8 seconds	
SURFACE CONDITION		As Welded.			
TEST RESTRICTIONS		None			

RESULTS			
Test Item / Weld Identification / Size / Thickness	ACCEPT or REJECT	NDE QUALIFICATION STAMP	DEFECT DESCRIPTION LOCATION and REMARKS
Demonstration test of VQ00201_2 Issue 2.	N/A		Defect found in weld stop start location.

Technician: Peter Turner	Customer:	Inspection Authority:
Signature: <i>P.T.</i>	Signature:	<i>Alan Smith</i>
Qualification: PCN Level II		
Date: 30/01/2014	Date:	Date:

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DAVID GRIFFIN
 ASNT Level III
 No. 72824

DAVID GRIFFIN
 PCN No. 113851
 www.bindt.org/PCN

VQ0133 Issue A

Alan Smith 30/1/14



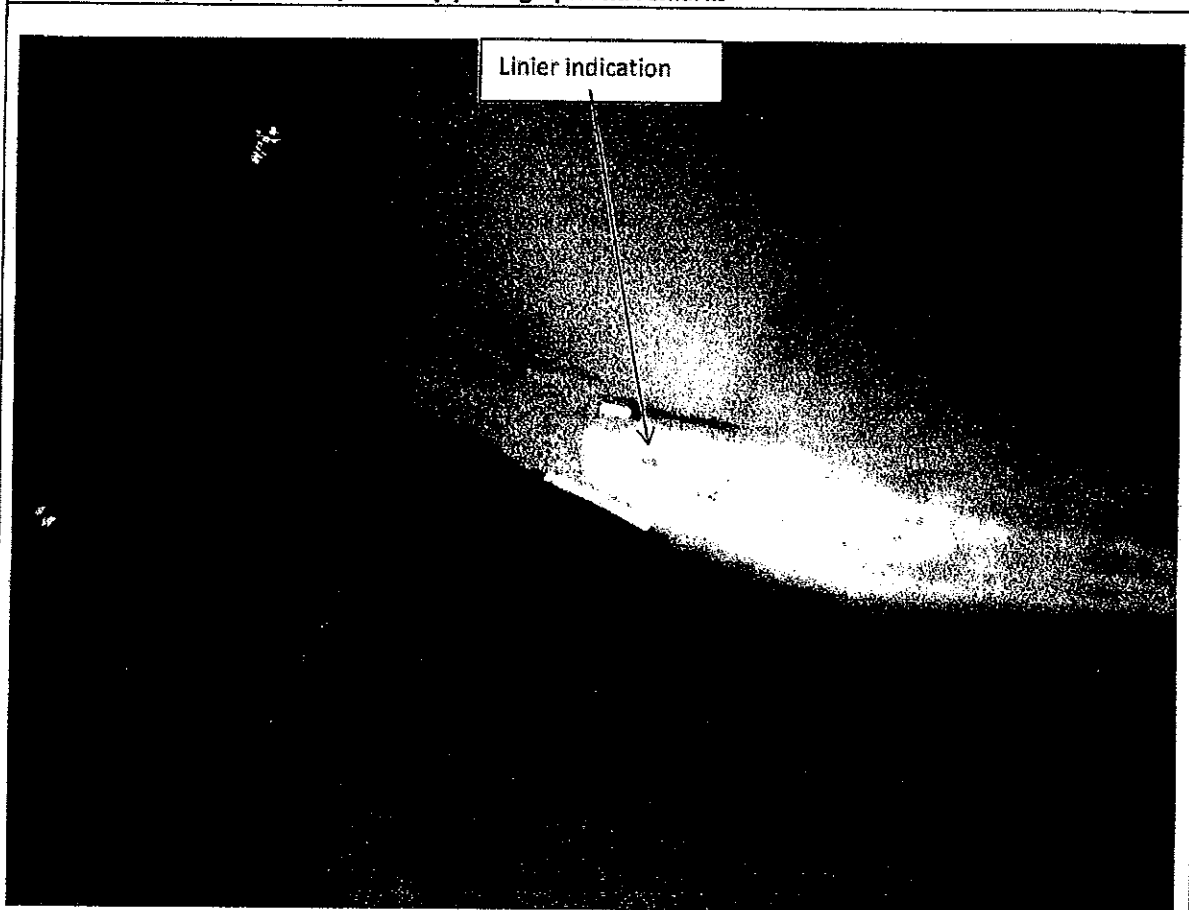
MAGNETIC PARTICLE REPORT

IDENTIFICATION AND SPECIFICATION DETAILS

REPORT NUMBER VQ00201_2 demonstration page 2 Of 2

RESULTS

Defect description , location , sketch / photograph and remarks



PCN
P.C. Turner
PCN No. 308794
www.bindt.org/PCN

Technician: Peter Turner	Customer:	Inspection Authority:
Signature: <i>PCT</i>	Signature:	<i>[Signature]</i>
Qualification: PCN Level II		
Date: 30/01/2014	Date:	Date:

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 REGISTERED NO. 0107520 (ENGLAND & WALES) REGISTERED OFFICE: 12 LALETON CLOSE, PORTHOLM, MID-DORSET, BUNTON, CF26 3JW

VQ0133 Issue A

[Handwritten signature] 30/1/14

D R GRIFFIN
ASNT Level III
No. 72824

PCN
DAVID GRIFFIN
PCN No. 113851
www.bindt.org/PCN

JAY 110V AC Magnetic Yoke function test

SERIAL NUMBER JY1-0032

Lift test preformed with a 4.6 kg Test weight

Date	Accept / Reject	Technicians initials.
21/08/13	Accept / Reject	PER
22/08/13	Accept / Reject	PER
23/08/13	Accept / Reject	PER
03/09/13	Accept / Reject	PER
06/09/13	Accept / Reject	PER
13/09/13	Accept / Reject	PER
16/09/13	Accept / Reject	PER
22/09/13	Accept / Reject	PER
01/10/13	Accept / Reject	PER
02/10/13	Accept / Reject	PER
03/10/13	Accept / Reject	PER
04/10/13	Accept / Reject	PER
08/10/13	Accept / Reject	PER
15/10/13	Accept / Reject	PER
17/10/13	Accept / Reject	PER
22/10/13	Accept / Reject	PER
04/11/13	Accept / Reject	PER
12/11/13	Accept / Reject	PER
13/11/13	Accept / Reject	PER
15/11/13	Accept / Reject	PER
21/11/13	Accept / Reject	PER
25/11/13	Accept / Reject	PER
26/11/13	Accept / Reject	PER
27/11/13	Accept / Reject	PER
29/11/13	Accept / Reject	PER
05/12/13	Accept / Reject	PER
06/12/13	Accept / Reject	PER
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18/12/13	Accept / Reject	PER
06/01/14	Accept / Reject	PER
13/01/14	Accept / Reject	PER
20/01/14	Accept / Reject	PER
22/01/14	Accept / Reject	PER
27/01/14	Accept / Reject	PER
30/01/14	Accept / Reject	PER
	Accept / Reject	
	Accept / Reject	
	Accept / Reject	
	Accept / Reject	
	Accept / Reject	



MAGNETIC PARTICLE REPORT

IDENTIFICATION AND SPECIFICATION DETAILS	
REPORT NUMBER	VQ00201_2 demonstration page 2 of 2
RESULTS	
Defect description , location , sketch / photograph and remarks	

Technician: Peter Turner	Customer:	Inspection Authority:
Signature:	Signature:	
Qualification: PCN Level II		
Date: 30/01/2014	Date:	Date:

PARTICLE

ARDROX[®]

Ardrox 8032

High sensitivity black magnetic ink

Scope

Ardrox 8032 is a ready-to-use high sensitivity black magnetic ink consisting of black iron oxide with a controlled, fine particle size, mineral oil and suspending agent in a high flash, low aromatic petroleum distillate.

Ardrox 8032 is used for revealing surface and near surface defects in ferro-magnetic materials e.g. mild and low alloy steels.

Method of use

Heavy deposits of grease, rust, scale and paint should be removed prior to inspection.

The component is then magnetised and the magnetic ink applied either by dipping, flowing or spraying. Chemetall PLC supplies a complete range of magnetising equipment from small portable to large bench units.

The component is inspected for defects in daylight or good artificial light. Defects will show as a collection of black particles.

In areas where it is difficult to see the black indications e.g., on oxidised or other dark surfaces, contrast may be greatly improved by applying a coating of Ardrox 8903 white background lacquer prior to application of the magnetic ink.

Ardrox 8032 is used as supplied without any dilution. Containers of Ardrox 8032 must be thoroughly shaken to disperse the settled ink before use.

Effects on materials

When Ardrox 8032 is used in the recommended manner no significant corrosion is likely to be encountered on any metal.

Some thermoplastics and certain rubbers may be softened or swollen with prolonged contact and intending users are advised to check the compatibility of such materials with the product.

Chemetall

Technical information

Appearance : Readily suspendible powder in a colourless, mobile liquid,
Solids Content: 2.0 ml per 100 ml of ink,
Flash Point : 101°C

These are typical values only and do not constitute a specification.

Storage Requirements: Store in a cool place.

Safety guidance

Before operating the process described it is important that this complete document, together with any relevant Safety Data sheets, be read and understood.

General information

Chemetall PLC supplies a wide range of chemical products and associated equipment for cleaning, sanitising, descaling, paint and carbon removal, metal protection and non-destructive testing. Sales Executives are available to advise on specific problems and applications.

Labour and environmental protection

All local and national regulations on the transport, storage, use and waste treatment of chemicals in concentrated or diluted form and as working solutions must be obeyed.

Further specific information on the products can be found in the EC Safety Data Sheets supplied. The user should also pay strict attention to information and hazard symbols shown on product labels.

Waste disposal

All waste waters must be treated in accordance with national legislation and local regulations prior to discharge to the sewer.

Aml June 2004

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- Click to view all folders
- Manage Folders...

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 Reply All
 Forward
 X
 Junk
 Close

Ardrox 8032
 angela.lawlor@chemetall.com [angela.lawlor@chemetall.com]

Sent: 10 February 2014 14:45
To: Peter Turner

Dear Peter,
 The only information we have on particle size for the Black Magnetic powder used in Ardrox 8032 is that the predominant particle size is 0.2 μm
 Kind regards
 Angela Lawlor
 Aerospace Technical Support


.....
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 Denbigh Road, Bletchley, Milton Keynes MK1 1PB
 United Kingdom
 Registered in England No. 252864
 Registered Office as above
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DOCUMENT FRONT SHEET

PURCHASERS NAME	National Process Equipment
PURCHASE ORDER NO	PUR630251
EXHEAT REFERENCE	041168
SDR DOCUMENT NO	041168.VESSRADIO
CLIENT DOCUMENT NO	
DOCUMENT TITLE	Radiographic test procedure

Doc Num	Revision	Issue	Date	Initials	Supplier's Approval Signature	Approval By
L05	1	1	25/09/2014	RDav		09/10/2014

To be filled by the reviewer of this document prior to its return

Tick Box	Code	Status	Description
<input type="checkbox"/>	E1	Approved	Approval given, no comments, final issue.
<input type="checkbox"/>	E2	Approved to Proceed	Approval given for work to proceed with document to be submitted as Final Issue providing comments are incorporated
<input type="checkbox"/>	E3	Not Approved	Document rejected and must be re-submitted with incorporation of comments. Work may NOT proceed
<input type="checkbox"/>	E4	Information Only	No comments made or approval given, for information purposes only.
<input type="checkbox"/>	E5	As-Built	Approval given for work to proceed provided comments incorporated in As-Built revision.

PAGES (Including this one)

20

COMMENTS

Please be aware that EXHeat will not be held responsible for late approval of documents and will not be held liable for any liquidated damages as a consequence.

Late approval of documents by the client may impact on the contractual delivery date.

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Threxton Road Industrial Estate, Watton, IP25 6NG

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**NDT-OPR-011****RADIOGRAPHIC EXAMINATION OF WELDS
(ASME V ARTICLE 2)**

UNCONTROLLED WHEN PRINTED

Prepared By: Jim McNab
Date: 06 January 2014

Approved By: John Deighan PCN LIII (100654)
Date: 06 January 2014

SUMMARY OF CHANGES SINCE PREVIOUS VERSION:

Procedure updated as a result of ASME V 2013 release. References updated. Sections 10, 13.4 and Appendix 2 updated. Appendix 4 added.

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1.0 INTRODUCTION

This document describes the method used for radiographic examination of welds in all materials when working to ASME V Article 2. It is qualified for use **only** when read in conjunction with the relevant technique.

Techniques are available on the Business Management System or on compact disk, as appropriate. In cases where the techniques do not meet local requirement they may be amended by appropriately qualified personnel as described in Section 21.

2.0 REFERENCES

The documents referenced in this procedure, below, concern the method and not the design code. The design code acceptance criteria are referenced on the technique sheet or job sheet as applicable.

Except in the case of superseded standards being specified, the current issue is applicable. Variations or customer specific requirements are detailed on technique sheets or job sheets.

Changes to standards are controlled via e-mail reminders from an Internet based system, subscribed to by Oceaneering. The procedure is reviewed on the issue of new or revised standards. If there is no impact to the method then the procedure is not updated, but the record of the review stored in the database. Where there is an impact the procedures are revised and re-issued.

ASME SECTION V	Boiler and pressure vessel code - NDT
ASTM E142	Controlling the quality of radiographic testing
ASTM E747	Test method for controlling quality of radiographic testing using wire penetrameters
ASTM E1742	Standard practice for radiographic examination
SNT-TC-1A	Personnel Qualification and Certification in Non-Destructive Testing
ASNT CP-189	Personnel Qualification and Certification in non-destructive testing
SI 1999 No 3232	Ionising Radiation Regulations 1999.
L121	Working with Ionising Radiation (Ionising Radiations Regulations 1999 ACOP)
BS EN ISO 9712	Non-destructive testing - Qualification and certification of NDT personnel
BS EN ISO 19232-1	Non-destructive testing. Image quality of radiographs. Determination of the image quality value using wire-type image quality indicators.
RAD-SPR-010	General Local Rules – Sites. Amended to the specific location
CAL-OPR-016	Calibration and Verification of Film Densitometers
NDT-OPR-019	Film Processing and Darkroom Control

3.0 DEFINITIONS

For the purpose of this procedure the following definitions apply.

Single Wall method: (SWSI) A method of radiographic examination in which the source of radiation is outside the pipe and the film is close to the inside surface of the intervening wall, or in which the source is inside the pipe and the film is close to the outside wall.

Double Wall method A method of radiographic examination in which the source of radiation is outside the pipe and the film is close to the outside of the pipe on the side remote from the source, the radiation passing through both walls of the pipe.

Double Wall, Single Image method (DWSI) An application of the double wall method providing a usable image of only a part of the weld adjacent to the film.

Double Wall, Double Image method (DWDI)	An application of the double wall method providing a usable image of both walls. Coverage of the whole weld can be accomplished on two or more films depending on pipe diameter, thickness and set-up.
Source to film distance (SFD)	The distance between the radiation source and the film measured in the direction of the radiation beam.
Source to object distance (SOD)	The distance between the radiation source and the source side of the test object measured along the central axis of the radiation beam.
Object to film distance (OFD)	The distance between the radiation side of the test piece and the film surface measured along the central axis of the radiation beam
Source size	The size of the effective focal/source size of the radiation source.

4.0 PERSONNEL

The personnel carrying out radiography shall be experienced, accustomed to the equipment to be used and to producing radiographs that will comply with this procedure. Unless otherwise specified by the client or contract, the radiographic team employed for site work shall at all times include a qualified technician to meet at least one of the following;

- BS EN ISO 9712 (PCN Level 2 or equivalent)
- CSWIP Grade 2
- SNT Level II

The qualification level is specified on the technique sheet.

Qualified technicians shall be capable of reading the letter sizes equivalent to those defined as Jaeger 1 (times roman N4.5) and shall be tested for colour blindness particularly in the colours or shades to be used in subsequent testing. This shall be carried out annually and a record of the tests shall be maintained on file.

All other personnel will at all times be under the supervision of the appointed qualified person **and** be familiar with this procedure.

All members of radiographic crews shall be classified persons as defined in the Ionising Radiations Regulations. There will be a Radiation Protection Supervisor available on site while radiography is being carried out.

Radiographic interpretation shall be carried out by suitably experienced and qualified personnel (level 2), and they must be familiar with the applicable acceptance standard.

5.0 SAFETY

All work shall be performed in accordance with Company Operating Procedures, Safety Procedures and local rules. Also, where applicable, client's local rules such as "Permit to Work" systems shall be observed.

The radiographer must have a copy of the Company Local Rules (and client Local Rules, where applicable) available during the period of the inspection.

Only classified personnel who are fully capable of ensuring the safety of themselves and others shall carry out radiography. There will be a Radiation Protection Supervisor available on site while radiography is being carried out.

Prior to radiography on site, barrier rope, warning signs & lights shall be erected and positioned around the area of exposure as a controlled area. Radiation monitors shall be used at all times to ensure that the level of radiation does not exceed a dose rate of 7.5 $\mu\text{Sv/hr}$ (micro-sieverts per hour) at the erected barriers.

6.0 EQUIPMENT

Gamma-ray containers shall be maintained in accordance with the manufacturers' recommendations and checked in accordance with the approved code of practice (ACOP) and the appropriate radiation safety procedure.

The operator, prior to and upon completion of each job, shall check delivery tubes and “wind-out” cables for damage.

X-ray generators shall be maintained in accordance with the manufacturers' recommendations and checked in accordance with Company Operating Procedures.

The radiation energy to be used shall result in radiographs which meet achieve the required density and IQI sensitivity requirements.

7.0 SURFACE CONDITION

Surfaces shall be free from spatter; attachments or any irregularities such as weld ripples, grinding/chipping marks or any others that may interfere with the interpretation of the radiographs.

Alteration to the weld or parent material finish shall only be carried out by the fabricator or maintenance contractor. Any doubtful indications shall be identified on the test report.

8.0 WELD IMAGE LOCATION

The weld shall be positioned as close to the centre of the film as the geometry of the work-piece permits. Welds in the as welded condition do not require their location shown by markers, but welds which are dressed flush must have their location shown by the use of lead arrows adjacent to the weld, a minimum of 10mm from the weld toe.

9.0 IDENTIFICATION AND MARKING

Unless specified by the client or contract, wherever practicable, identification markers shall be placed on the source side of the item under inspection. Each section of material being radiographed shall have suitable symbols affixed to uniquely identify:-

- The Job or Workpiece, (Job Number, Drawing Number, Line Number, Spool Number, Part Number as applicable),
- The weld number, or location,
- The Section of the weld,
- Date,
- Welder (if applicable).

The symbols may consist of lead letters and/or flashed identification. Numbers or pipe tapes shall be positioned so that their image shall appear on the radiograph, to ensure identification of the radiograph, and the area of the weld being inspected. Whenever possible, these shall be positioned outside the area of interest

Radiographs of weld repairs shall be suitably identified as such.

For example Repair 1 unique item identification, suffixed by ...R1
 Repair 2 unique item identification, suffixed by ...R2 etc.

Unless specified by the client or contract, a datum shall be marked on each work-piece using suitable markers not detrimental to the material being inspected (e.g. paint or wax markers). The datum shall be taken from easily describable parts of the part (e.g. 12 o'clock position moving clockwise or an intersecting weld) or a sketch may be supplied.

A record detailing the identification of the radiographs shall be made on the NDT Report

10.0 FILM SCREEN COMBINATION

Radiographic Film

Unless otherwise specified by the Client or contractual agreement a fine grain, high contrast type film shall be used. (e.g. AGFA - D7 or equivalent). The technique sheet details the requirements for the applicable standard and class of technique, as appropriate.

The table below details film types and their classifications. The relative speeds for gamma, using Ir192, for AGFA film are shown in brackets.

Film Types			Classification		
Agfa	Fuji	Kodak	ASTM E1815	ISO 11699-1	JIS K7627
D2 (8.0)	IX25	DR50	Special	C1	T1
D3 (5.0)	N/A	M100	Class I	C2	T1
D4 (3.0)	IX50	MX125	Class I	C3	T2
D5 (1.5)	IX80	T200	Class I	C4	T2
D7 (1.0)	IX100	AA400	Class II	C5	T3
D8/F8 (0.6)	IX150	CX (HS 800)	Class III	C6	T4

Intensifying Screens

Intensifying screens shall be used in all techniques except where otherwise indicated on the technique sheets

Cassettes

The film screen combination shall be encased in a flexible/rigid cassette and all precautions shall be taken to ensure good film to screen contact.

For double wall, double image methods or butt welds in plates, the cassette shall be placed as close as possible to the surface of the weld, remote from the source.

Unless otherwise specified either on the technique or on the report there is only one film per cassette.

11.0 INTERCEPTION OF SCATTERED RADIATION

In order to reduce the effects of scattered radiation the beam from the source shall be collimated, whenever possible.

Where scattered radiation is expected or suspected then the film/cassette combination shall be shielded. The effects of backscatter shall be reduced using at least 1mm thick lead sheets placed behind the film cassette. Undercut or side scatter, may be inhibited by the use of lead shot, edge blocking, or by filtration.

A method for checking for the adequacy of shielding from backscatter radiation is to place a lead letter "B" on the cassette remote from the source of radiation. The dimensions of the letter shall be at least 13mm high & 1.5mm thick.

A light image of the "B" will be cause for rejection of the film. No image or a darker image of the letter is considered as adequate protection from backscatter.

12.0 DIRECTION OF RADIATION

Unless otherwise specified, the central beam of radiation shall be directed to the centre of the diagnostic area at an angle normal to the material surface wherever possible.

Where specifically required by the client or contract, the alignment may be altered to detect defects with a specific orientation, (e.g. fusion face defects where the exposure may be made with the beam directed along the fusion face).

The relevant technique sheet shall provide a sketch, which details the direction of radiation.

13.0 MINIMUM SFD/FFD AND GEOMETRIC CONSIDERATIONS

13.1 Object to film distance

The distance between the film and the adjacent weld surface shall be kept to a minimum.

The nominal OFD (object to film distance) is normally the object or weld thickness. However, consideration shall be given to any unavoidable gap between the weld surface and film cassette and so the actual OFD shall be defined as the sum of the nominal object to film distance plus any unavoidable gap.

For the double wall, double image method, the *nominal* OFD shall be considered as the outside diameter of the pipe.

13.2 Source to film distance

The minimum source to film distance (SFD_{min}) is dictated by the maximum allowable geometric unsharpness value (Ug) and the object to film distance (OFD).

$$SFD_{min} = SOD + OFD$$

Where SFD_{min} is the minimum source (or focal) to film distance
SOD is the source (or focal) to object distance
OFD is object to film distance as described above

13.3 Geometric Unsharpness

The geometric unsharpness values required is contained in the technique sheets

The geometric unsharpness value can be determined by using the following calculation:

$$Ug = \frac{F \times OFD}{SOD}$$

Where;

Ug = geometric unsharpness
 F = source or focal spot size
OFD = object to film distance as described above
SOD = source to object distance (source to film distance less OFD).

13.4 Diagnostic film length / number of exposures

The requirements for ASME V are the incident beam not to exceed 10% of the actual thickness at the extremities of the diagnostic length. The Technique Sheets provide the details of the minimum number of exposures required or diagnostic length of each exposure and the tables to determine the required number of shots are appended to this procedure. The tables are extracted from BS EN ISO 17636 class B which is equivalent to the ASME requirements.

The maximum diagnostic film length on flat surfaces when there is an increase in penetrated thickness of 10% can be derived from the formula $Length = 1.16 \times Source\ to\ Film\ Distance$.

14.0 OVERLAP OF FILM

The separate radiographs of a welded joint shall overlap sufficiently to ensure that no portion of the joint remains un-examined. Unless otherwise specified, the minimum overlap shall be 25mm either side of the diagnostic area.

15.0 RADIOGRAPHIC DENSITY

The film density requirements of the material under examination shall be detailed on the technique sheet. When using gamma radiography the minimum density allowable is 2.0 and when using X-Rays the value is 1.8. For composite viewing of multiple films the minimum density for any on film is 1.3.

The maximum density for any of the above is 4.0. However the viewer in use must be capable of reading the density shown.

The density shall be measured using a calibrated digital or analogue transmission densitometer. The densitometer used shall be calibrated by comparison with a certified stepwedge density strip traceable to a national standard.

Densitometer calibration and validation is carried out, By the MERC department or locally as appropriate, against the requirements of CAL-OPR-016 for Merc department and Appendix 1 of this procedure if conducted locally .

16.0 IMAGE QUALITY INDICATORS (IQI'S)

The method of indicating that the required quality of radiograph has been obtained is by the use of an IQI and The method of indicating that the required quality of radiograph shall be in accordance with ASME V Article 2.

IQI's can be the wire, or hole/step type, but in the absence of further instruction the type to be used shall be the wire type, that conform to the requirements of ASTM E747.

Positioning and number of IQI's to be used shall be in accordance with ASME V Article 2 as detailed on the relevant Technique sheets.

IQI's shall be selected appropriate to the thickness of the specimen and placed as follows:

On the source side of the specimen, whenever possible. When placement on the source side is not possible then the lead symbol 'F' shall be attached to the IQI to indicate film side placement.

In contact with the weld such that the lengths of the wires lie perpendicular to the length of the weld.

Where geometric configuration permits IQI identification numbers, or where applicable, the lead letter 'F', shall not be positioned in the area of interest.

The IQI characteristics and image quality values required from the radiographic techniques of this procedure are defined in Tables 2 and 3 as follows: -

Table 1: Standard wire numbers and their respective nominal diameters.

Table 2: The minimum image quality value (essential wire diameter) required for both 'Source side' and 'Film side'. The designated visible wire to achieve the required sensitivity shall be determined from Table 3 (extracted from T-276) shown below or from ASME V Article 2, Table T276.

Any specific contract requirements shall be specified on the relevant technique sheet, which shall detail the precise standard, IQI model and type.

If required to express a value in terms of percentage sensitivity, this can be calculated as below:-

$$\% \text{ Sensitivity} = \frac{\text{Ø of the thinnest wire/hole visible} \times 100}{\text{Thickness of section being radiographed}^*}$$

* Thickness of diagnostic area, not penetrated thickness

Table 1 Standard Wire Numbers & Nominal Diameters

ASME IQI Designation				Wire Identity		
Set 'A'	Set 'B'	Set 'C'	Set 'D'	Wire number	ASME Nominal wire diameter (mm)	BS EN 19231 Nominal wire diameter (mm)
X				W 1	0.08	3.2
X				W 2	0.10	2.5
X				W 3	0.13	2.0
X				W 4	0.16	1.6
X				W 5	0.20	1.25
X	X			W 6	0.25	1.0
	X			W 7	0.33	0.8
	X			W 8	0.41	0.63
	X			W 9	0.51	0.5
	X			W 10	0.64	0.4
	X	X		W 11	0.81	0.32
		X		W 12	1.02	0.25
		X		W 13	1.27	0.2
		X		W 14	1.60	0.16
		X		W 15	2.03	0.125
		X	X	W 16	2.54	0.1
			X	W 17	3.20	0.08
			X	W 18	4.06	0.063
			X	W 19	5.08	0.050
			X	W 20	6.35	N/A
			X	W21	8.13	N/A

Note: Alternative wire IQI's designed and manufactured in accordance with other national or international standards may be used provided that the essential designated wire diameter on the 'Alternative IQI' is equal to or less than the relevant size/s detailed above.

Table 2 Minimum Image Quality Values

Single Wall Techniques – Essential IQI Wire

Nominal Thickness (t) in mm	Source Side	Film Side
Up to 6.4	W5	W4
Above 6.4 to 9.5	W6	W5
Above 9.5 to 12.7	W7	W6
Above 12.7 to 19.0	W8	W7
Above 19.0 to 25.4	W9	W8
Above 25.4 to 38.1	W10	W9
Above 38.1 to 50.8	W11	W10
Above 50.8 to 63.5	W12	W11
Above 63.5 to 101.6	W13	W12

Notes: Consideration shall be given to weld reinforcements. Where applicable, the IQI essential wire designation shall be based on the weld thickness.
Weld thickness shall be considered to be the combined total of nominal single wall thickness + any applicable estimated weld reinforcements.
Backing rings or strips shall not be considered as part of the weld thickness.

17.0 QUALITY OF RADIOGRAPHS

All radiographs shall be free from mechanical, chemical, or other blemishes to the extent that they cannot mask or be confused with the image of any discontinuity in the object being radiographed. Such blemishes include, but are not limited to:

- Fogging
- Processing defects such as streaks, water marks, or chemical stains
- Scratches, finger marks, crimps, dirtiness, static marks, smudges or tears
- Loss of detail due to poor screen-to-film contact
- False indications due to defective screens

18.0 PROCESSING

Films shall be processed manually or using automatic processors in accordance with the relevant manufacturer's recommendation.

Processing chemicals and activities shall be routinely monitored in accordance with the procedure NDT-OPR-019.

Manual Processing

Manual development of exposed film will be based on the recommended time/temperature charts using a standard of 4-8 minutes at 20°C, followed by washing in clean running water or immersion in an acid stop bath.

Fixing time shall be at least twice the clearing time and the films shall be final washed for a period of 20/30 minutes.

Films shall be dried in a warm air drying cabinet or an automatic dryer operated in accordance with the manufacturer's instructions.

Automatic Processing

Processing may be carried out using automatic equipment operated to the manufacturers' instructions

The processing chemicals and replenishments shall be in accordance with the manufacturers' recommendations.

19.0 VIEWING

Viewing shall be carried out in a darkened room.

The radiographic viewing screen shall be masked to prevent extraneous light from around the edge of a radiograph or light coming through low-density portion of the radiograph from interfering with the interpretation.

Film interpretation personnel shall allow sufficient time for their eyes to become adapted to the lighting conditions in the viewing room prior to examining any radiograph.

The illuminator used for interpretation shall conform to the requirements of ASTM 1742.

All films shall be viewed in the dry condition only.

All films shall be sentenced and reported by Oceaneering (level 2 technician) prior to submission for client acceptance.

20.0 ACCEPTANCE CRITERIA

The acceptance criteria to be applied shall be detailed by the client either on a written work request or written contract documents.

Where the client or contract does not require items to be assessed in accordance with defined acceptance criteria, an assessment to provide a factual report detailing all detected flaw indications will be carried out.

In this instance Oceaneering will not accept or reject an item. Determination of acceptability shall be the responsibility of the client.

21.0 TECHNIQUE COMPILATION

This procedure is applied in conjunction with the appropriate technique sheet/s. Standard technique sheets are available on the business management system.

Where required, by a client or contract, 'job specific' technique sheets shall be compiled and issued to address any differing parameters that may be applicable. These technique sheets shall overrule standard techniques, but they must be read in conjunction with this procedure.

Technique sheets shall be compiled and/or approved by personnel qualified to at least Level 2 in the appropriate method, sector & category

The numbering system to be used for specific techniques is to prefix the standard technique number with the contract/job number or system agreed by the client if appropriate.

The technique shall supply the following information:-

- Job Specific Technique Number, if standard techniques not used.
- Weld configuration to which technique applies (e.g. butts welds less than 90mm diameter).
- Operator qualification requirements.
- Standard on which the technique is based, including year of issue or status.
- The acceptance criteria, including year of issue or status.
- Type of material to be examined.
- Thickness range(s).
- Film type and speed (equivalents can be used).
- Screen type and thickness.
- Maximum source/focal spot size.
- Radiation type.
- Maximum KV/strength.
- Minimum FFD/SFD.
- Geometric unsharpness requirements (where applicable).
- Sensitivity standard/model(s) and type of IQI.
- Density range required.
- Sketch of set up.
- Number of shots/diagnostic film length.
- Any other specific reference documents not included in this procedure.

22.0 REPORTING

All inspections shall be the subject of a test report, which shall be issued on completion of the examination on Oceaneering standard reports, written in accordance with Company Procedures.

If another reporting format is required, such as a client's report form, it shall be detailed on the technique sheet and the relevant report supplied to the technician.

The test report shall contain the following information:

- Client
- Contract numbers – Oceaneering and client as required.
- Unique identification of welds or items (i.e. Drawing. No. Line no. and weld no. if applicable).
- Date of test.
- Heat treatment status, (if applicable).
- Procedure number, including revision status.
- Technique number, including revision status.
- Standard on which technique is based, including the year of issue.
- Acceptance criteria, including the year of issue.
- Exposure details.
- Film type and size(s).
- IQI type/model and location.
- Sensitivity or quality level.
- Density required and achieved.
- SFD/FFD.
- Screens.
- Test restrictions or necessary deviations from technique.
- Material thickness(es).
- Statement or indication of acceptance or rejection.
- Location from datum, position of defect in weld along with defect type if possible.
- Operator name & Signature (signature of the person sentencing radiographs is mandatory. The person producing radiographs may also be on the report).
- Operator qualification.
- Date of report.

23.0 RECORDS AND STORAGE

Unless otherwise agreed, the client shall be responsible for the storage of radiographs. On completion of a job, Oceaneering shall pass on to the client, all relevant test reports and associated radiographs.

The retention period for reports held shall be 6 years, unless otherwise specified by the contract.

24.0 INDEX OF TECHNIQUES

The following table provides a list of techniques available on the Business Management System or the compact disks issued by the QA department.

Technique Number	Description
NDT-TEC-R100	Double Wall Single Image (DWSI) using X Rays. Covers pipe, long seams and nozzles
NDT-TEC-R101	Double Wall Single Image (DWSI) using gamma rays. Covers pipe, long seams and nozzles
NDT-TEC-R102	Double Wall Double Image (DWDI) using X-Rays. Covers pipes less than 90mm diameter
NDT-TEC-R103	Double Wall Double Image (DWDI) using gamma rays. Covers pipes less than 90mm diameter
NDT-TEC-R104	Single Wall Single Image (SWSI) using X-Rays. Covers pipes and plates.
NDT-TEC-R105	Single Wall Single Image (SWSI) using gamma rays. Covers pipes and plates.

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APPENDIX 1 METHOD OF VALIDATING DENSITOMETERS

Calibration

- Switch on both the viewer and densitometer and allow 30 minutes for the densitometer circuitry to stabilise
- Place the densitometer on the centre of the viewer and adjust the meter to read 'Zero'.
- The calibrated strip to be used shall be a 'Master Strip' which is to be used only for calibration purposes.
- Place the strip on the viewer and using the densitometer, take a density reading from each step of the strip over the density range required.
- Enter the densitometer readings on the latest revision of Form No. NDT-FRM-030 (Calibration by MERC on new or repaired equipment) NDT-FRM-022 (calibration on site in addition to validation) and compare these to the calibrated strip.
- The tolerance of the readings shall be within ± 0.05 Density of the calibrated step.
- Densitometers, which do not comply, shall be labelled as such and returned to the store and then sent for adjustment.

Densitometers that do comply, shall be labelled with the next calibration due date.

- Initial and enter the next due date on a label and attached to the densitometer.
The completed Form shall be kept on file in the appropriate calibration register.
- The interval for calibration is three monthly.
- Calibrated strips shall be replaced five years after their initial use.

Verification

- The strip used for verification is a day to day 'Working Strip' and shall be the same type as that used for calibration purposes.
- Verification of densitometers takes place on a daily basis or whenever it is in use. Verification is not required to be recorded unless the instrument is found to be out of tolerance (± 0.05).
- The verification procedure shall be carried out in the same way as the calibration described in Section 1 above.
- Where a densitometer is found to be out of tolerance, then radiographs taken in the preceding period shall be re-checked.
- On a three monthly basis, the 'Working Strip' shall be verified against the 'Master Strip'.

APPENDIX 2 METHODS FOR DETERMINING MINIMUM REQUIREMENTS FOR ILLUMINATORS.

Scope

The purpose of this work instruction is to specify checks to be carried out to monitor the performance of radiographic viewers (illuminators) and to ensure that the viewers' illuminance is sufficient for the density of the radiographs to be viewed. This instruction has been prepared in accordance with the general requirements of BS EN 25580:1992 Minimum requirements for industrial radiographic illuminators for non-destructive testing, and ASTM E 1742, Standard practice for radiographic examination.

The maximum permissible density checks for a viewer are carried out by the manufacturer and Oceaneering will conduct this check when the viewers are repaired or when a bulb has been changed.

The diffusion and uniformity checks are aimed at the manufacturers of viewers and will only be carried out by Oceaneering on site when specified by a client or contract.

This instruction applies only to viewers, which are used in the final interpretation of radiographs.

Minimum Requirements for Luminance.

The luminance (brightness) transmitted through an illuminated radiograph shall not be less than

30 candelas/m² for film densities ≤ 2.5 and 10 candelas/m² for film densities >2.5.
Wherever possible approximately 100 candelas/m² or higher.

To determine the maximum permissible density of a viewer, use a calibrated photometer and take a reading at the centre of the screen for spot viewers or the visible dimmest are of the viewing surface for others. Note that edges can be masked to reduce the viewing area and exclude dimmer areas.

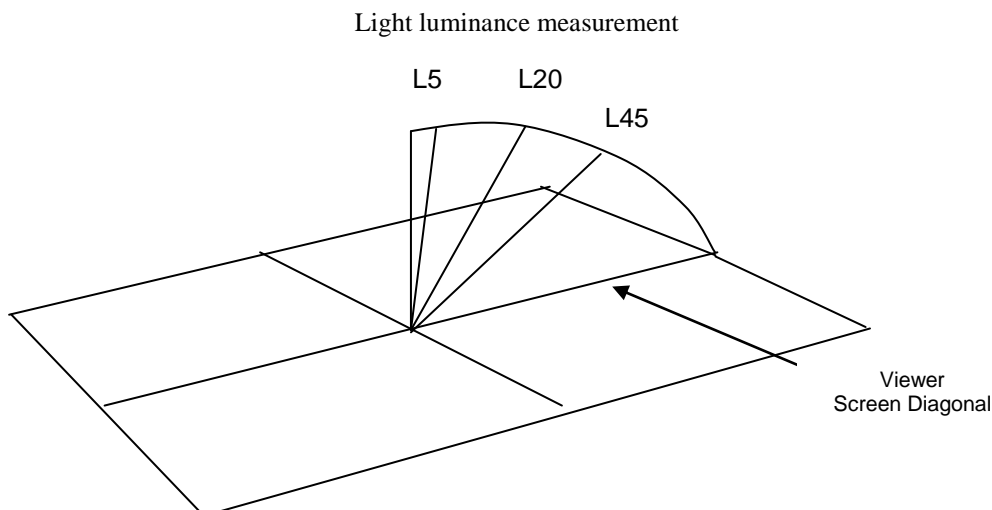
Diffusion of Light.

The luminance is measured on a semi-circle whose centre is the centre of the screen and the radius is the maximum dimension of the screen (diagonal of the rectangle) or at least 500 mm.

The readings are taken using a white light meter and three readings have to be taken at 5°, 20° and 45° as shown. The diffusion factor "f" is calculated as follows:

$$f = \frac{\text{Lux reading at } 45^\circ + \text{Lux reading at } 20^\circ}{2 \times \text{Lux reading at } 5^\circ}$$

f shall be greater than or equal to 0.7.



Uniformity of Screen Luminance

Divide the screen into squares measuring 35mm. The first square is the centre of the screen with the other squares built around this. A clear film can be used as a template for this check.

Read the luminance of each of the squares and average the highest four and the lowest four readings. The uniformity factor “g” is calculated as shown:

$$\frac{\text{Average of the lowest four readings}}{\text{Average of the highest four readings}}$$

The uniformity factor should be greater than or equal to 0.5.

5.0 Intervals and Records

5.1 A record of the above checks will be recorded on the latest revision of Form No NDT-FRM-023.

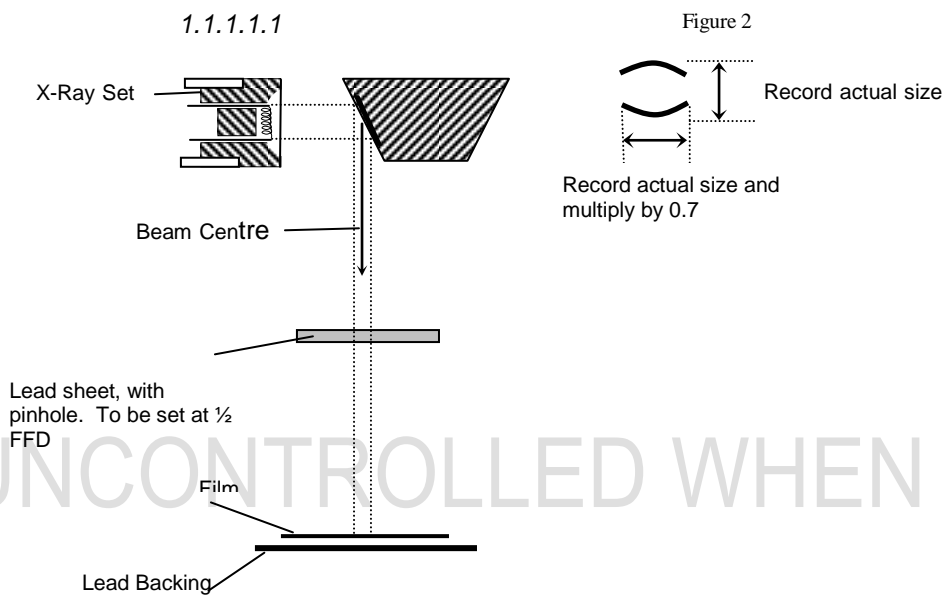
5.2 The interval for the above tests after repair or maintenance (including a change of bulb).

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APPENDIX 3 METHOD FOR ESTIMATING X-RAY FOCAL SPOT SIZE

Application:	Focal spots sizes of X-Ray equipment	Operator Qualifications:	PCN Level 2 (EN 473 equivalent) or SNT Level 2
Maximum Strength:	Half of the KV and mA output of the set	Reporting Criteria:	Record size of focal spot
Min SFD/FFD:	1 metre	Film (brand & type):	Agfa D4 or equivalent
Geometric Unsharpness:	Diameter of the hole size	Screen Type + Thickness:	None
Density Range:	1.0 to 3.6	IQI's:	None

Technique Illustration:-



1. Figure 1 above details the set-up for producing film to measure focal spot size.
2. Figure 2 above shows the required image (Crescent shaped line images) and the measurements to be taken.
3. If the line images are not visible then take the complete image, measure it's size and subtract twice the pinhole diameter to give the size.
4. Measurements are made using an optical comparator with a graticule, with 0.1mm divisions and a magnification between X5 and X10

Additional Instructions:

- The serial number of the X-Ray equipment and exposure details are to be recorded on the report.
- The film is to be retained at least until the next verification check.
- The recommended interval of this check is yearly.
- Equipment, which has been hired out, is to be re-checked on it's return.

APPENDIX 4 DETERMINATION OF DIAGNOSTIC FILM LENGTH FOR TUBULAR PRODUCTS

BS EN ISO 17636 Figure A.1

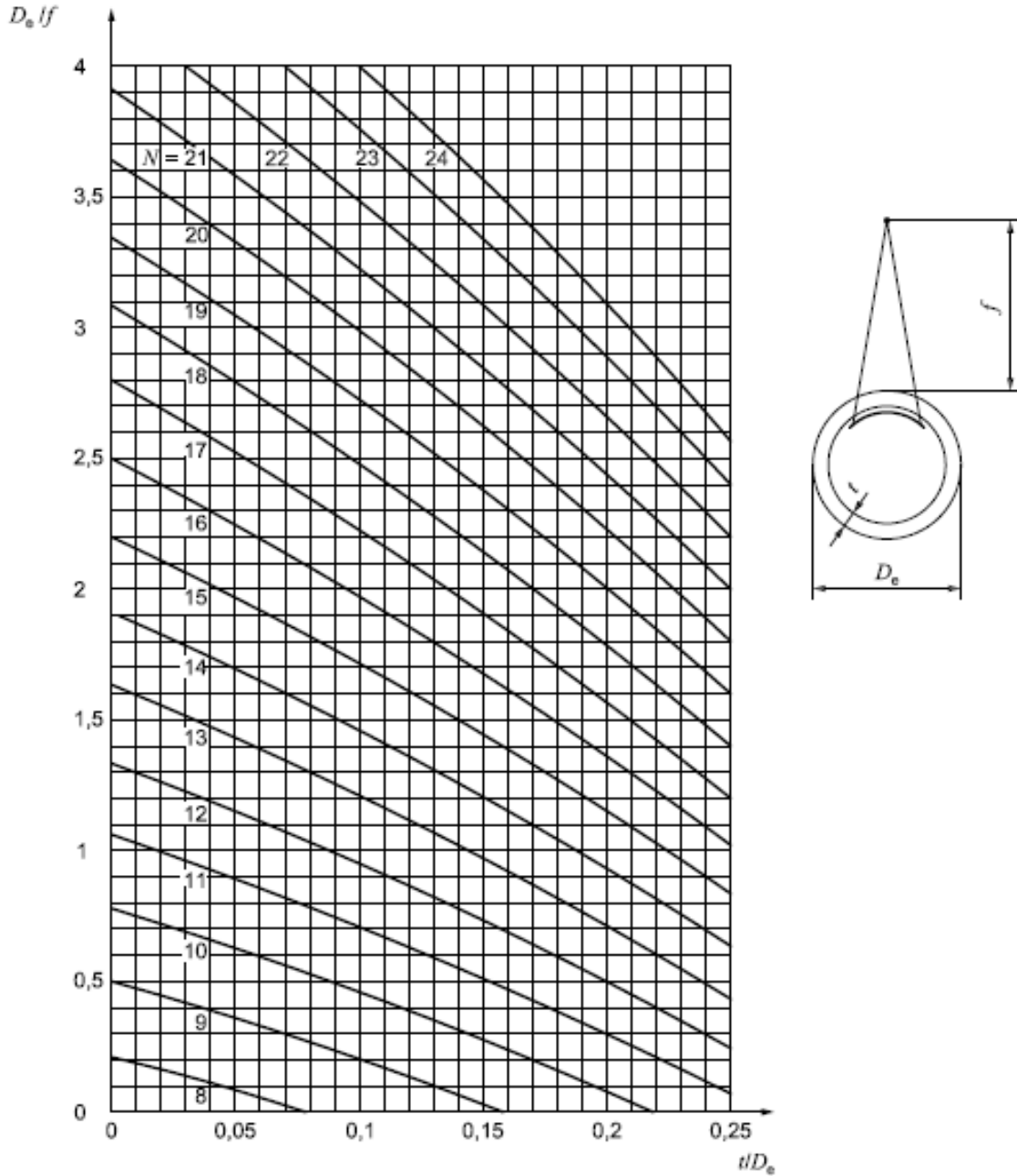
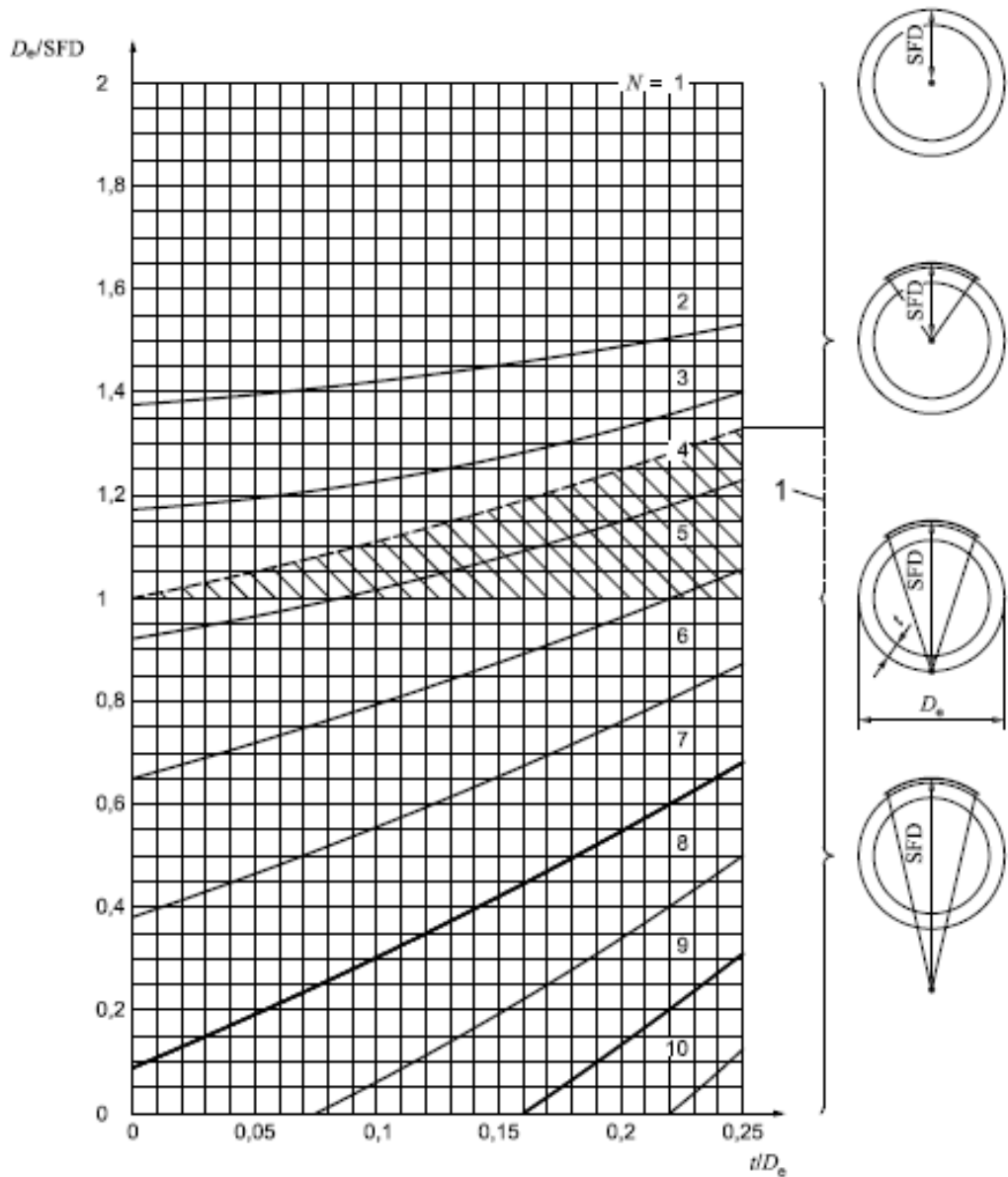


Figure A.1 — Minimum number of exposures N for single wall penetration with source outside, with a maximum permissible increase in penetrated thickness $\Delta t/t$ due to inclined penetration in the areas to be evaluated of 10 % (class B), as a function of ratios t/D_e and D_e/lf

BS EN ISO 17636 Figure A.2



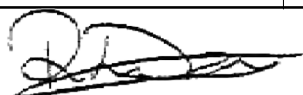
Key
 1 Inside pipe wall (not accessible)

Figure A.2 — Minimum number of exposures N for off-centre penetration with source inside and for double wall penetration, with a maximum permissible increase in penetrated thickness $\Delta t/t$ due to inclined penetration in the areas to be evaluated of 10 % (class B), as a function of ratios t/D_e and D_e/SFD

NTED

DOCUMENT FRONT SHEET

PURCHASERS NAME	National Process Equipment
PURCHASE ORDER NO	PUR630251
EXHEAT REFERENCE	041168
SDR DOCUMENT NO	041168.VESSULTRA
CLIENT DOCUMENT NO	
DOCUMENT TITLE	Ultrasonic test procedure

Doc Num	Revision	Issue	Date	Initials	Supplier's Approval Signature	Approval By
L04	1	1	25/09/2014	michb		09/10/2014

To be filled by the reviewer of this document prior to its return

Tick Box	Code	Status	Description
<input type="checkbox"/>	E1	Approved	Approval given, no comments, final issue.
<input type="checkbox"/>	E2	Approved to Proceed	Approval given for work to proceed with document to be submitted as Final Issue providing comments are incorporated
<input type="checkbox"/>	E3	Not Approved	Document rejected and must be re-submitted with incorporation of comments. Work may NOT proceed
<input type="checkbox"/>	E4	Information Only	No comments made or approval given, for information purposes only.
<input type="checkbox"/>	E5	As-Built	Approval given for work to proceed provided comments incorporated in As-Built revision.

PAGES (Including this one)

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COMMENTS

Please be aware that EXHeat will not be held responsible for late approval of documents and will not be held liable for any liquidated damages as a consequence.

Late approval of documents by the client may impact on the contractual delivery date.

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NDT-OPR-021

**ULTRASONIC EXAMINATION OF WELDS
(ASME V ARTICLE 4)**

UNCONTROLLED WHEN PRINTED

Prepared By: Sam McInness
Date: 06 January 2014

Approved By: John Deighan PCN Level III (100654)
Date: 06 January 2014

SUMMARY OF CHANGES SINCE PREVIOUS VERSION:

Reviewed against requirements of ASME V 2013. References updated and Appendix 5 amended.

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1.0 INTRODUCTION

This document describes the method used for the ultrasonic examination of welds and materials in steel when working to ASME V Article 4. It is qualified for use **only** when read in conjunction with the relevant technique. The procedure and associated technique sheets cover thickness ranges greater than 6mm. Other thickness ranges may be qualified by producing further techniques without amendment of this procedure.

Techniques are available on the Business Management System or on compact disk, as appropriate. In cases where the techniques do not meet local requirement they may be amended by appropriately qualified personnel as described in Section 8.

2.0 REFERENCES

The documents referenced in this procedure, below, concern the method and not the design code. The design code acceptance criteria are referenced on the technique sheet or job sheet as applicable.

Except in the case of superseded standards being specified, the current issue is applicable. Variations or customer specific requirements are detailed on technique sheets or job sheets.

Changes to standards are controlled via e-mail reminders from an Internet based system, subscribed to by Oceaneering. The procedure is reviewed on the issue of new or revised standards. If there is no impact to the method then the procedure is not updated, but the record of the review stored in the database. Where there is an impact the procedures are revised and re-issued.

ASME SECTION V	Boiler and pressure vessel code - NDT
ASTM 164	Standard practice for Ultrasonic Contact Examination of Weldments
ASTM E 1316	Terminology for Non-destructive Examinations
SA 578	Standard specification for straight beam ultrasonic examination of plain and clad steel plates
SA 435	Standard specification for straight beam ultrasonic examination of steel plates
SNT-TC-1A	Personnel Qualification and Certification in Non-Destructive Testing
ASNT CP-189	Personnel Qualification and Certification in non-destructive testing
BS EN ISO 9712	Non-destructive testing - Qualification and certification of NDT personnel

3.0 DEFINITIONS

For the purpose of this procedure the following definitions apply.

ASNT	American Society of Non destructive Testing
ASME	American Society of Mechanical Engineers
DAC	Distance Amplitude Correction

4.0 PERSONNEL

All personnel carrying out Ultrasonic examination in accordance with this procedure shall be approved in the technique to American Society of Non-Destructive Testing (ASNT) requirements (SNT-TC-1A) unless they are undertaking on-job training or working in an assistant capacity under the direct supervision of a certificated person.

Utilisation of other approval schemes is permitted by prior agreement between contracting parties. The approval scheme to be used shall be detailed in and form part of the specific technique sheet. Typical schemes are listed below:

- BS EN ISO 9712 Level 2
- CSWIP Grade 2
- SNT Level 2

Qualified technicians shall be capable of reading the letter sizes equivalent to those defined as Jaeger 1 (times roman N4.5) and shall be tested for colour blindness particularly in the colours or shades to be used in subsequent testing. This shall be carried out annually and a record of the tests shall be maintained on file.

5.0 EQUIPMENT

5.1 Flaw Detectors

The examination shall be carried out manually using the pulse-echo method with direct contact coupling. The flaw detector shall have 'A' scan presentation with a well-defined trace. Permanent graticule markings shall be used for both range and amplitude.

The equipment shall be capable of working at test frequencies between 1 to 5 MHz and conform to the requirements of ASME V Article 4 or other corresponding National standard.

Flaw Detectors shall be calibrated annually to ensure performance to manufacturing tolerances. On site checks are carried out as follows.

Flaw Detector Performance Checks

The following equipment checks shall be carried out as detailed in Appendix 6 of this procedure;

- a) Timebase Linearity
- b) Amplifier Linearity

Flaw Detector/Probe System Checks

- a) Resolution
- b) Dead Zone
- c) Signal to Noise

Probe performance checks

- a) Angle probe index point.
- b) Angle of Refraction.

The maximum deviation shall not exceed $\pm 1.5^\circ$

5.2 Calibration and Reference Blocks

Reference blocks for routine calibration for sensitivity shall conform to the requirements of ASME V Article 4 T434. The appropriate Calibration Block with thicknesses and hole sizes shall be selected for the material thickness under examination.

Requirements for basic piping and non-piping calibration blocks are contained in Appendix 1.

Calibration and reference blocks for routine calibration or for equipment performance shall conform to the requirements of BS EN 12223 (V1), BS EN 27963 (V2) or other corresponding National Standard that may be required.

The probes and test blocks used during calibration shall be maintained at a temperature within $\pm 14^\circ$ C of that of the joint(s) to be examined, although it is unlikely that weld testing will be conducted at temperatures higher than ambient.

Other reference blocks to be used for setting sensitivity shall comply with the standard, and will be detailed on the technique sheet.

A method of setting DAC curves is explained in Appendix 2.

5.3 Probe Selection

Probes to be used shall be compatible with the flaw detector in use and shall be in the operating frequency range 2 - 5 MHz.

There are numerous factors, which effect the selection of probes.

Factors to consider are as follows;

- Material Thickness.
- Material Attenuation Characteristics.
- Size, location and orientation of defects being sought.
- Weld preparation and Geometry etc.

The table below provides a guide to probe selection for butt welds where the client does not specify particular requirements.

Material Thickness	Compression wave probes				Shear wave probes					
	0°	Single	Twin	Freq.	45°	60°	70°	Freq.	Single	Twin
< 12	Yes		Yes	5	No	No	Yes	4	Opt.	Opt.
12 to 25	Yes		Yes	5	No	Yes	Yes	4	Yes	
25 to 38	Yes	Opt.	Opt.	4/5	Yes	Yes	Yes	4	Yes	
38 to 100	Yes	Yes	Opt.	2/5	Yes	Yes	No	4	Yes	
> 100	Yes	Yes		1/2.5	Yes	Yes	No	2	Yes	

Opt. = Optional

This table is intended only as a guide since it is not possible to cover all eventualities.

Probes indicated as optional are dependent on the other test conditions and factors. Typical examples are as below:

- When the evaluation is carried out based on length and amplitude the frequency shall be as low as possible within the above range,
- When the evaluation is based on characterization of imperfections higher frequencies may be used to improve range resolution
- On thin wall nozzle welds a 45° or 60° probe may provide better coverage of the fusion face.

The ultrasonic operator shall select the appropriate probes for the configuration of weld using the above table as a guide and taking into account, other influencing factors.

Where possible, shear wave probes with angles less than 38° should be avoided due to the probable generation of subsidiary compressional wave beams. Similarly, angles above 75°, depending on surface contour and roughness, should be avoided to minimise the production of spurious surface wave echoes.

On thicknesses > 12mm, at least two different angle probes shall be used.

The minimum number of probes to be used shall be detailed on the technique sheet. However, during inspection, additional probes may be used at the operator's discretion, provided that it is beneficial to the test. All probes used shall be recorded on the test report.

Where required by the client or contract, additional or alternative requirements may be applicable. These shall be detailed or referred to on a 'Job Specific' technique sheet.

5.4 Couplant

Coupling shall normally be achieved using proprietary couplants where surface temperatures are less than 50° C.

The couplant, including additives, shall not be detrimental to the material being examined.

Conventional Couplant

The couplant shall be a proprietary ultrasonic couplant, a suitable cellulose based wallpaper adhesive, e.g. Polycell, grease, oil or water as appropriate.

Halogen / Sulphur Free Couplant

Couplants used on nickel based alloys shall be low in sulphur and in the case of austenitic stainless steels low in halides. The maximum permitted content of each shall not exceed 250ppm.

Any change of coupling requirements for specific contracts or standards shall be detailed on the applicable technique sheet.

6.0 SURFACE CONDITION

Weld Surface

The weld surface shall be prepared as needed to present a smooth contour, avoiding sharp changes in section. Where such changes in section occur, it is possible that some difficulty in the ultrasonic interpretation may occur. Such difficulties must be recorded on the report.

Parent Material

The parent material shall be free from weld spatter, surface irregularities or foreign matter that might interfere with the examination, giving a smooth contour for a distance of at least $2\frac{1}{2}t$ on each side of the weld on each of the testing surfaces (where t is the thickness of the material under test). Where 70° angle probes are employed, the distance shall be increased to $3\frac{1}{2}t$.

The contour or waviness of the test surface shall not result in a gap greater than 0.5mm between the probe shoe and the surface. Adequate probe contact for curved surfaces is considered satisfactory when it meets the following;

$$D \geq 15a$$

where; 'D' is the diameter of the component (in mm)
'a' is the diameter/width of the probe in the direction of examination (in mm)

A probe that cannot meet the above requirement shall be adapted by contouring the probe shoe to suit the test surface. In addition, adjustments shall be made to compensate for any changes in sensitivity and/or range settings.

7.0 EXAMINATION

7.1 Range and Sensitivity Settings

The equipment is calibrated for a suitable range for the beam path length required to satisfactorily complete the examination, i.e. Full Skip Distance or two back wall echoes for shear and longitudinal waves respectively.

The sensitivity settings are established using Distance Amplitude Correction Curves as detailed below.

7.1.1 Sensitivity and Range Corrections

Range and sensitivity settings shall be established in accordance with ASME V Article 4 prior to each examination and re-confirmed at the following stages;

- At least every 4hrs during testing
- Any change in equipment
- Any change in the test parameters
- Where changes in the equivalent settings are suspected
- At the end of each inspection.

If deviations are found during the above checks, corrections shall be carried out as detailed below:

If during the calibration confirmation the sweep range of the DAC curve has changed by the following tolerances: - (i) Sweep Range - if a point of the DAC curve has moved on the timebase by more than 10% of its original timebase position, or (ii) Sensitivity Settings - if any sensitivity setting has changed by more than 20% or 2 dB from its original amplitude; then the following action shall be taken:

(i) Sweep Range

The calibration shall be corrected with a note of the correction being made on the report. If any signals have been recorded, all recorded indications shall be re-examined with the corrected calibration and their values corrected accordingly on the report.

(ii) DAC Curve

If any point on the DAC curve has decreased by 20% or 2dB all recorded data since the last valid calibration shall be marked void. A new DAC curve shall be produced with a note to this effect on the report and the voided areas shall be re-examined. If any point on the DAC Curve has increased by 20% or 2dB all recorded indications since the last valid calibration shall be reassessed following the production of the new DAC curve.

7.1.2 Primary Reference Level

Methods and blocks used for setting sensitivity are described in ASME V Article 4.

Unless otherwise specified by a client or contract, the method used shall be the DAC (Distance to Amplitude Correction) curve. The constructed curve forms the primary reference level.

Any differences between the DAC reference block and the material under test shall be corrected as detailed in Section 7.3 below. Guidance on how to construct a DAC curve is given in Appendix 2.

7.1.3 Attenuation and Transfer Loss

Allowances shall be made for differences in attenuation or transfer loss between the parent material and the test block used to plot the DAC curves. The method for establishing this factor is detailed in Appendix 3.

- Differences of < 2 dB no correction is required.
- Differences > 2dB < 12dB shall be compensated for
- Differences > 12 dB shall require further preparation of the surfaces or apply alternative NDT techniques.

The noise level during the weld examination (excluding spurious surface indications) shall be 12 dB below the relevant evaluation level.

7.1.4 Evaluation Levels

Unless otherwise specified by the client or contract, the sensitivities or scanning levels are defined as follows:

- Primary Reference Level: Is the sensitivity value (in dB) at which the DAC was plotted from a particular reference block.
- Reference Level: Is the 'Primary Reference Level' sensitivity + /- any transfer correction factors (in dB).
- Scanning Level: This is a 'search' or 'scanning' sensitivity. The minimum gain is 6dB above the 'Reference Level'.

However, a more convenient minimum scanning sensitivity is 14dB above the 'Reference Level' and the DAC line will thus represent 20% reference sensitivity.

Weld Inspection

7.1.5 Parent Metal Scan

Prior to the examination of the weld the parent metal either side of the weld, where accessible, shall be examined using a longitudinal wave probe. This test is to locate any laminar type defects in the parent metal, which will interfere with or restrict the subsequent test.

Unless otherwise specified by the client or contract, a sensitivity of 2nd Back Wall Echo (BWE) to Full Screen Height (FSH) shall be applied.

The extent of the scans for plate defects must cover the full area of plate to be scanned from, therefore the extent of scan equals the ½ or full skip distance plus ½ the weld cap width plus 10mm heat affected zone.

The skip distances are calculated for the shallowest angle probe to be used and the choice of ½ or full skip is dependant on whether access for scanning is from one side, or from both sides of the plate.

The method for calculating skip distances is detailed below.

Full skip distance = 2 x thickness x tan angle of probe
e.g. 70° probe on a 25mm plate

½ skip	=	25 x 2.747	Full skip	=	2 x 25 x tan 70
	=	68.68mm		=	50 x 2.747
				=	137.37mm.

In this way it can be determined prior to testing that the extent of parent metal scanning is sufficient.

Other useful trigonometric functions are detailed on Appendix 4.

7.1.6 Weld Examination

There are numerous scans for testing weld metal and associated fusion faces and these are mainly dependent on the configuration of the weld and accessible surfaces. The precise scanning requirements are detailed on the applicable technique sheets.

The majority of welds tested are in the 'as welded' condition.

In cases where there are no weld caps, such as those that are dressed flush, a compression wave scan shall be carried out across the weld and subsequent shear wave scans shall also be carried out across the weld metal.

Where possible Transverse scans shall be carried out in accordance with the standard technique or in accordance with contract specific techniques.

The curvature of a component can restrict a test; Appendix 5 details the limitations.

When welds with vertical weld preparations or J preps are being tested the use of tandem or creep techniques will be considered and included in the technique as appropriate.

In the case where critical root scan forms part of an examination, scribed datums must be added to the parent metal at the weld fit up stage.

7.1.7 Scanning Speed and Overlap

The scanning speed when testing welds shall not exceed the following;

Parent and Weld Metal	150mm/second
Critical root scan	25mm/second

The crystal path overlap shall be at least 10% of each previous path to ensure that the area under examination is completely covered.

7.2 Location and Sizing of Imperfections

Imperfections shall be positioned using a flaw location slide or a suitable full scale drawing of the weld. Since the angle of the probe is known and the timebase of the flaw detector is calibrated to show the distance travelled by the sound, it is possible to accurately position and size defects on the accurate drawing of the weld.

The investigation may require scanning from other positions and with different probe angles and is highly subjective in its nature and should be carried out with extreme care.

There are several established methods used in the sizing and assessment of defects and these are as follows:

- 6 dB drop or ½ amplitude method
- 20 dB drop method
- Maximum amplitude method
- Reference reflector methods

Unless otherwise specified by the client or contract, the method employed shall be appropriate to the size, type and orientation of the reflector and will normally be 6dB drop for length and 20 dB drop or maximum amplitude for through thickness dimensions. The method used is detailed on the test report.

Unless otherwise specified by the client or contract, the following shall be used;

With the sensitivity set initially at 'Reference Level Sensitivity'. All reflectors > 20% of the DAC curve shall be investigated. The purpose of this is to determine the nature of the indication i.e. Volumetric, planar or geometric etc.

Dependent on the acceptance criteria to be applied planar defects may be rejected at this stage.

Sensitivity levels shall be checked periodically throughout the test.

Where the DAC block is not available at the test station the gain setting for the DAC shall be referenced to the calibration block used on site.

8.0 TECHNIQUES

This procedure is applied in conjunction with the appropriate standard technique sheet/s detailed in Section 10 , which are based on the requirements of ASME V Article 4.

Where required, by a client or contract, 'job specific' technique sheets shall be compiled and issued to address any differing parameters that may be applicable.

Technique sheets shall be compiled and/or approved by personnel qualified to at least Level 2 in the appropriate method, sector and category.

The numbering system to be used for specific techniques is to prefix the standards technique numbers with the contract or job number..

The technique shall supply the following information:-

- Client
- Contract Number/s
- Technique Number
- Weld configuration to which technique applies
- Operator qualification requirements
- Standard on which the technique is based, including year of issue or status.
- The acceptance criteria, including year of issue or status.
- The calibration and reference blocks to be used
- The material to be examined
- The thickness range the technique covers

- The scanning requirements - i.e. probes, surfaces to be scanned from, extent of scans, limitations (if possible at this point).
- Sizing techniques to be used if specified by contract
- Any other specific reference documents not included in this procedure
- Any other specific instruction not covered above (e.g. the use of creep or tandem techniques or the use of scribed datums for critical root scanning etc.)

NOTE: The 'record and reject levels' form part of the standard on which the techniques are based and these must be referred to.

9.0 ACCEPTANCE CRITERIA

The levels of acceptance shall be in accordance with the relevant section of the referencing code specified by the Client.

10.0 RECORDS AND REPORTING

10.1 Informing the Client

Upon completion of the examination the operator shall advise the client of the acceptability or otherwise of the items under test.

10.2 Reporting

All inspections shall be the subject of a written test report, which shall be issued on completion of the examination on a standard reports format, written in accordance with company procedures.

If another reporting format is required, such as a client's report form, it shall be detailed on the technique sheet and the relevant report supplied to the operator.

The test report shall generally contain the following information as appropriate:-

- Client
- Contract number
- Unique identification of welds/item i.e. Drg. No. Line no. and weld no. if applicable
- Date of test
- Heat treatment status, if applicable
- Procedure number, including revision status
- Technique number, including revision status
- Standard on which technique is based, including the year of issue
- Acceptance criteria, including the year of issue
- Test restrictions or necessary deviations from technique
- Material thickness(es)
- Flaw detector model and serial number
- Couplant
- Probe(s) used giving serial nos. angles, crystal dimensions and frequency
- Sensitivity i.e. basic sensitivity, scanning sensitivity, transfer correction.
- Calibration blocks used and serial number
- Reference blocks used and serial number, if available
- Recording level
- Reject level
- Sizing techniques used
- Datum points from a feature of the workpiece e.g. intersection with another weld or a sketch detailing its position.
- Sketches showing defect location from datum, position of defect in weld, defect type if possible and through thickness dimensions of defect.
- Statement or indication of acceptance or rejection
- Operator name & Signature
- Operator qualification
- Date

INDEX OF STANDARD TECHNIQUES

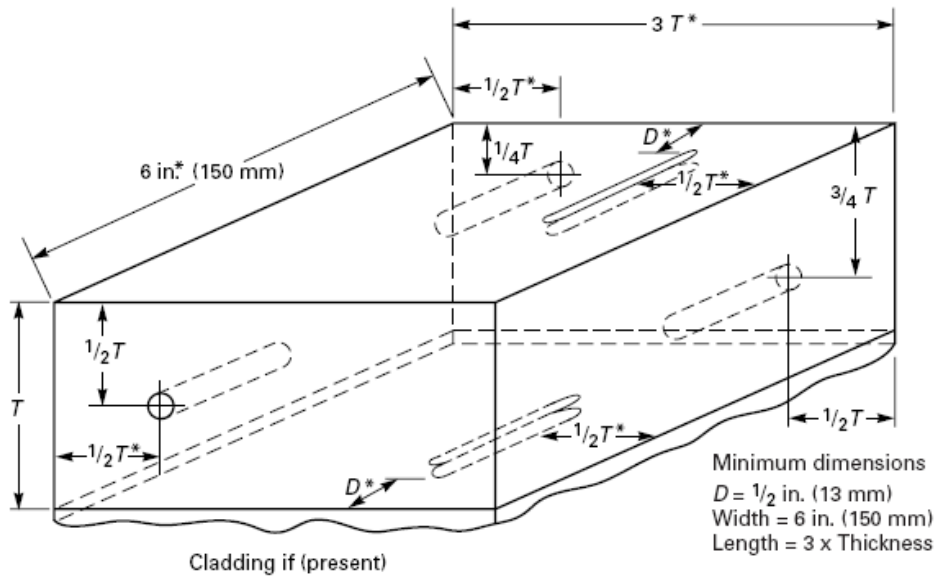
The following table provides a list of techniques available on the Business Management System or the compact disks issued by the QA department.

Technique Number	Description
NDT-TEC-U102	UT of butt welds in plate/pipe greater than 6mm thickness
NDT-TEC-U103	UT of T butt welds
NDT-TEC-U104	UT of butt welds in nozzles
NDT-TEC-U106	UT examination of materials.

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APPENDIX 1

Non Piping Calibration Block from ASME V



Weld Thickness (t), in. (mm)	Calibration Block Thickness (T), in. (mm)	Hole Diameter, in. (mm)	Notch Dimensions, in. (mm)
Up to 1 (25)	$\frac{3}{4}$ (19) or t	$\frac{3}{32}$ (2.5)	Notch depth = $2\% T$ Notch width = $\frac{1}{4}$ (6) max. Notch length = 1 (25) min.
Over 1 (25) through 2 (50)	$1\frac{1}{2}$ (38) or t	$\frac{1}{8}$ (3)	
Over 2 (50) through 4 (100)	3 (75) or t	$\frac{3}{16}$ (5)	
Over 4 (100)	$t \pm 1$ (25)	[Note (1)]	

* Minimum dimension.

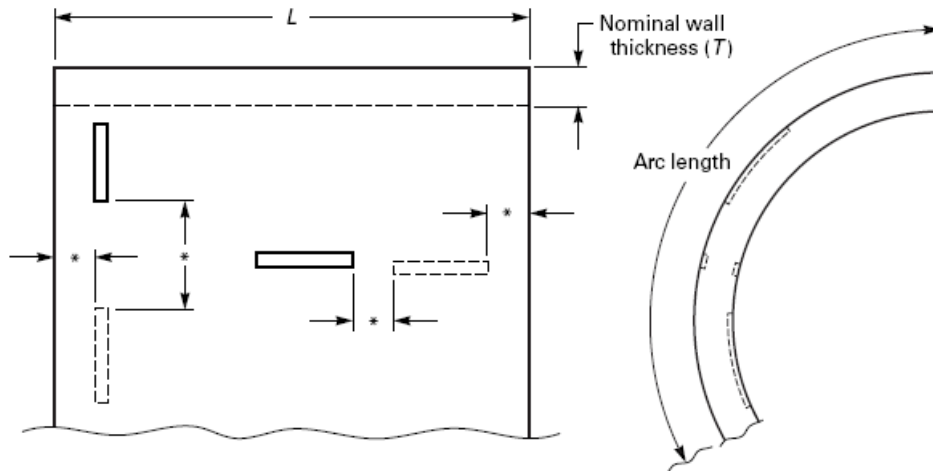
GENERAL NOTES:

- (a) Holes shall be drilled and reamed 1.5 in. (38 mm) deep minimum, essentially parallel to the examination surface.
- (b) For components equal to or less than 20 in. (500 mm) in diameter, calibration block diameter shall meet the requirements of T-434.1.7.2. Two sets of calibration reflectors (holes, notches) oriented 90 deg from each other shall be used. Alternatively, two curved calibration blocks may be used.
- (c) The tolerance for hole diameter shall be $\pm \frac{1}{32}$ in. (0.8 mm). The tolerance for hole location through the calibration block thickness (i.e., distance from the examination surface) shall be $\pm \frac{1}{8}$ in. (3 mm).
- (d) For blocks less than $\frac{3}{4}$ in. (19 mm) in thickness, only the $\frac{1}{2} T$ side-drilled hole and surface notches are required.
- (e) All holes may be located on the same face (side) of the calibration block, provided care is exercised to locate all the reflectors (holes, notches) to prevent one reflector from affecting the indication from another reflector during calibration. Notches may also be in the same plane as the inline holes (See Appendix J, Fig. J-431). As in Fig. J-431, a sufficient number of holes shall be provided for both angle and straight beam calibrations at the $\frac{1}{4} T$, $\frac{1}{2} T$, and $\frac{3}{4} T$ depths.
- (f) Minimum notch depth shall be $1.6\% T$ and maximum notch depth shall be $2.2\% T$ plus the thickness of cladding, if present.
- (g) Maximum notch width is not critical. Notches may be made by EDM or with end mills up to $\frac{1}{4}$ in. (6.4 mm) in diameter.

NOTE:

- (1) For each increase in weld thickness of 2 in. (50 mm) or fraction thereof over 4 in. (100 mm), the hole diameter shall increase $\frac{1}{16}$ in. (1.5 mm).

Piping Calibration Block from ASME V



* Notches shall be located not closer than T or 1 in. (25 mm), whichever is greater, to any block edge or to other notches.

GENERAL NOTES:

- (a) The minimum calibration block length (L) shall be 8 in. (200 mm) or $8T$, whichever is greater.
- (b) For OD 4 in. (100 mm) or less, the minimum arc length shall be 270 deg. For OD greater than 4 in. (100 mm), the minimum arc length shall be 8 in. (200 mm) or $3T$, whichever is greater.
- (c) Notch depths shall be from 8% T minimum to 11% T maximum. Notch widths shall be $\frac{1}{4}$ in. (6 mm) maximum. Notch lengths shall be 1 in. (25 mm) minimum.
- (d) Maximum notch width is not critical. Notches may be made with EDM or with end mills up to $\frac{1}{4}$ in. (6 mm) in diameter.
- (e) Notch lengths shall be sufficient to provide for calibration with a minimum 3 to 1 signal-to-noise ratio.

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APPENDIX 2 METHOD OF CONSTRUCTION OF DAC CURVE

A 'DAC' (Distance to Amplitude Correction) reference block is required that has a series of reflectors at different sound path distances over the timebase range to be used for the test.

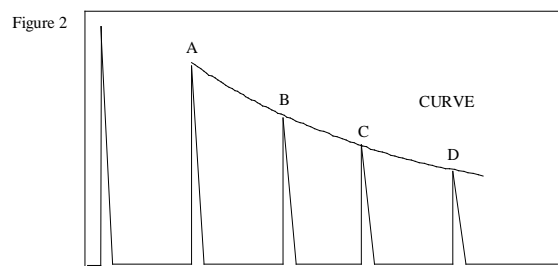
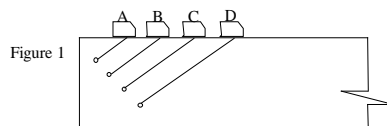
The size and configuration of the block to be used are specified in ASME V Article 4 shown above (the method below is representative of the construction of the curve).

The DAC block shall be either:

- A general-purpose block of uniform low attenuation and specified surface finish, having a thickness and curvature within $\pm 10\%$ of the test object where practicable.
- A block of the same acoustic properties, surface finish, shape and curvature as the test object.

The steps required are as follows:

- Calibrate the time base to accommodate the full testing range to be used.
- Select the target holes to be used for the DAC curve and adjust the probe position to obtain maximum echo height from the hole that gives the highest amplitude. This will be dependent on near zone and so will not necessarily be the shortest target distance.
- Adjust the gain to give an 80% full screen height (FSH) - Point 'A' on Fig. 1.. Mark this point on the screen - Point 'A' on Fig. 2
- Without adjustment to the gain, obtain signals from the remaining holes in the block - Points 'B', 'C', & 'D' on Fig. 1. Mark and join these points on the screen - Points 'B', 'C', & 'D' on Fig. 2
- Note the gain setting for point 'A'. This is the basic or primary sensitivity and the DAC curve for that particular probe and the reference block used.
- Record the sensitivity at which the DAC curve was plotted by reference to the gain setting and echo height from a suitable test block, e.g. the 100mm radius of a calibration block. This will enable the sensitivity to be easily reset to the DAC level without the use of the special DAC test block.
- If the difference in height between the largest and smallest echoes exceeds the range 20% to 80% FSH, the line shall be split and separate curves plotted at different gain settings. The difference in gain between the two curves shall be recorded on the screen.
- When in continuous use the probes should be checked daily, but when used infrequently the probes shall be checked weekly or on the days in use, whichever if the period is in excess of a week.



APPENDIX 3 METHOD OF ASSESSING TRANSFER/ATTENUATION LOSSES

General

When setting the minimum scanning sensitivity or when measuring echo heights in relation to the DAC curve, allowance shall be made for differences in excess of 2dB in attenuation or coupling efficiency between the parent material of the weld and the test block used to plot the DAC curve.

The methods for normal and angle probes detailed in below involve the use of a single correction value incorporating compensation for **both** attenuation and transfer loss.

Method for Longitudinal (Normal) Probes

The steps required shall be as follows:

- a) Calibrate the time base over the appropriate test range.
- b) Position the 0° probe on the Calibration or DAC test block to obtain a series of back wall echoes A1, A2, A3, A4 etc.
- c) Note the gain setting (in dB) required to bring each echo in turn up to 80% full screen height and plot this value against the beam path range for each echo.
- d) Reposition the probe on the material to be measured to obtain a series of back wall echoes B1, B2, B3, etc. and repeat step c) plotting curve B.
- e) Extrapolate both curves back to zero range.
- f) The loss in echo amplitude due to attenuation and reduced coupling deficiency is the difference in gain between the two curves at the appropriate range.

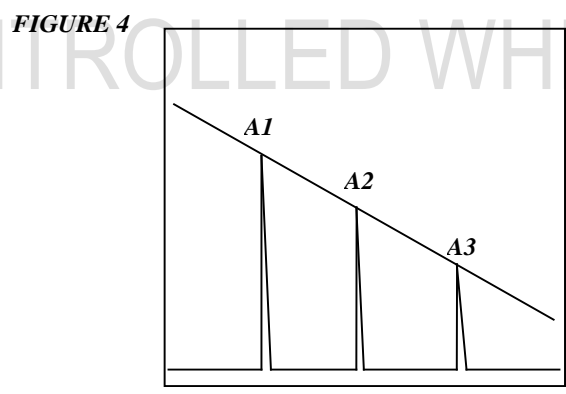
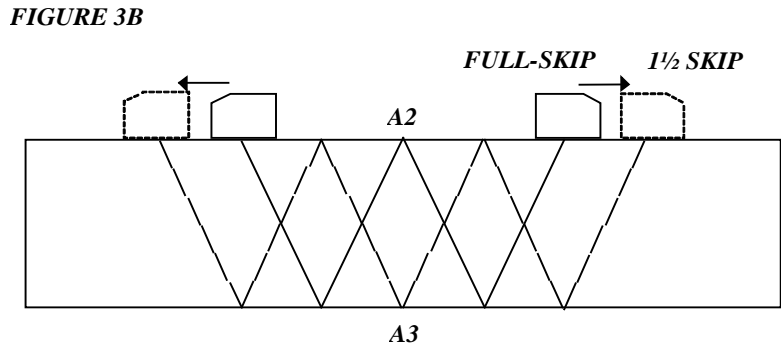
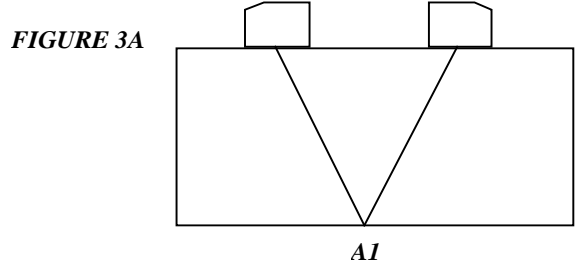
Method for Shear Probes

This method requires the use of an identical pair of shear wave probes having a beam angle within the range 40-50 deg. and the same frequency as the probe(s) to be used for the subsequent weld examination.

The steps required are as follows:

- a) Calibrate the time base using one of the single angle probes to be used for this assessment.
- b) Position the two probes (one transmitting, one receiving) on the DAC test block to produce a 'V' beam path as shown in Fig 3 (a). Maximise the signal and record the gain setting 'A1' to bring the signal to 80% full screen height. Plot the point on the screen.
- c) Reposition the two probes on the DAC block to give a W beam path as shown in Fig 3 (b). Maximise the signal and plot point A2 on the screen.
A third point is obtained by extending the beam path length to 1.5V or 1.5 skips, which gives point A3, which in turn is plotted on the screen.
- d) Plot through points 'A1' & 'A2' and 'A3' as shown in Fig. 4.
- e) Extrapolate both curves back to zero range.
- f) Repeat steps 2 and 3 with the probes on the material to be examined under test, and note the dB required for the signals obtained to reach the curve.

This value is the transfer correction factor and is to be added to the basic sensitivity. This means that the 'DAC' curves being used are basic sensitivity *plus* transfer correction.



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APPENDIX 4 TRIGONOMETRY AND ULTRASONICS

Angle	sine	Cosine	tangent
38	0.616	0.788	0.781
45	0.707	0.707	1.0
60	0.866	0.500	1.732
70	0.939	0.342	2.747

There are several variables, which can be calculated from the above functions of the angles. These are as follows:-

1/ Full Skip Beam Path Distance = 2 x thickness x tan of probe angle

2/ Surface distance (Stand-off) from probe index;

Stand-off = Beam path length x sine of probe angle

3/ Depth of indication;

Depth = Beam path length x cosine of probe angle

4/ Expected beam path length-

Expected beam path = $\frac{\text{Thickness (or Depth)}}{\text{cosine of probe angle}}$

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APPENDIX 5 EFFECTS OF CURVATURE ON ULTRASONIC TESTING

The curvature of a component can limit an ultrasonic test.

The table below gives maximum testing depths and beam path ranges as a function of the component outside radius.

Angle	Maximum testable Depth	Beam Path Range
38	0.38 x radius	0.79 x radius
45	0.30 x radius	0.70 x radius
60	0.13 x radius	0.50 x radius
70	0.06 x radius	0.34 x radius

It is also possible to calculate the optimum angle to test the bore of a pipe by using the following calculation:-

$$\text{Sine of optimum angle} = \frac{\text{Inside diameter}}{\text{Outside diameter}}$$

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APPENDIX 6 ULTRASONIC EQUIPMENT CHECKS

General

Ultrasonic flaw detection equipment shall be routinely checked at the following times:

- When new, prior to use on production work.
- Immediately following repair or annual calibration.
- At intervals as listed in the table below.

The Flaw Detectors serial or plant number must be clearly indicated.

The suppression control shall be set to zero during all checks.

Daily Checks: (See Notes 1 & 4)	Timebase Linearity	Probe Angle
	Amplifier Linearity	Angle Probe Index Point Angle Probe Squint
Weekly Checks: (See Note 2)	Sensitivity and Signal to noise.	Pulse Duration
Monthly Checks (if required):	Resolution (probe)	Dead zone (probe)
<p>Notes:</p> <ol style="list-style-type: none"> 1) Results of daily checks shall be recorded as appropriate. They can be entered on either the test reports (tick box) or on the latest revision of Form No: NDT/FRM/031 2) Results of weekly checks must be recorded on the latest revision of Form No: NDT/FRM/031 3) Form No: NDT/FRM/031 shall be retained on file 4) Timebase linearity checks will be carried out as appropriate up to a maximum of a 1m range unless requirements for longer ranges become part of a contract. In this instance, and where practical, a technique will be produced to address the requirements. 		

Calibration Blocks

Blocks used for the above checks shall have a current validation/calibration certificate and must be kept clean and in good condition.

The blocks to be used for daily or weekly checks shall be as follows;

- A2 - (This may also be referred to as an 'V1' or 'Block 1').
- A4 - (This may also be referred to as an 'V2' or 'Block 2').

The blocks to be used for monthly checks (when applicable by contract)shall be as follows;

- A6 - Dead Zone & Resolution.
- A7 - Resolution as required.

Visual Inspection

A visual inspection is carried out on all the equipment to be used for physical damage and/or wear that is likely to affect performance and reliability of the subsequent testing.

The items to be checked are as follows:

Flaw Detector	Check for visual damage the screen, graticule and controls
Probes	Check shoes, faces and cable connection for damage or wear
Cables	Check for breaks and instability of electrical connections
Calibration/Reference Blocks	Check for physical damage

Faulty or damaged equipment that is likely to affect performance and reliability shall detailed in writing and returned for repair or servicing. Items which can be locally repaired e.g. probe re-shoe is carried out and recorded against the probe records.

FLAW DETECTOR CHECKS

Timebase Linearity

Timebase linearity shall be checked using either calibration block 1 or 2).

Place the probe on the block in a position (side or face) where the range to the sixth backwall echo is equal to or more than the compressional wave range over which the linearity has to be checked (i.e. the maximum range likely to be used in subsequent testing).

Obtain 6 back wall echoes. Adjust the timebase so that the 1st echo coincides the first scale mark on the graticule and the 6th echo at the last scale mark (position 10).

Set the 1st echo to 80% full screen height, then in turn, bring the successive echoes to approximately 80% full screen height. The leading edge of each signal should line up with the appropriate graticule (i.e. the four echoes between the first and last should coincide with 2, 4, 6 and 8 positions).

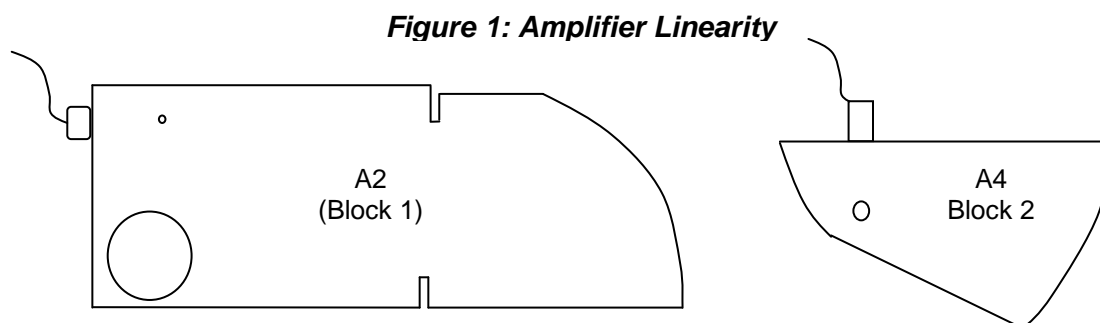
Record any deviations, measured at half screen height, from the expected position.

Unless otherwise specified by the testing standard, deviations in excess of + or - 2% of the full screen width are cause for rejection and the equipment should be returned for adjustment.

Amplifier Linearity

This check monitors the linearity of the amplifier and the accuracy of the calibrated gain control.

Position the probe on either Block 1 or Block 2 to obtain a signal from the 1.5 mm (or 5mm if applicable) diameter hole taken from it's deepest side. See Figure 1 below;



Adjust the signal to 80% FSH (Full Screen Height) and note the value (in dB).

Increase the gain by inserting 2 dB. The signal should increase to FSH (100%).

Restore the gain to the original value then reduce it by 6 dB. The signal should be at 40% FSH.

Reduce the gain by a further 12 dB. The signal should be at 10% FSH.

Reduce the gain by a further 6 dB. The signal should fall to 5% FSH

The expected results for the above procedure are given in Table below.

Gain (dB)	Expected Screen Height (%)	Limits (% FSH)
+2	100	Not less than 95%
0	80	Reference Line
-6	40	37% to 43%
-12	20	17% to 23%
-18	10	8% to 12%
-24	5	Visible below 8%

Deviations outside the limits given above should be taken into account in subsequent testing.

Note 1 For logarithmic amplifiers, the amplifier should give equally spaced dB steps throughout the graticule height.

PROBE CHECKS

Angle Probe Index Point

Remove any previous index point markings.

Keep the probe parallel to the side of the block, and maximum the reflection from the 100mm quadrant of Block 1 or the 50mm quadrant of Block 2.

When the signal is maximised the probe index will correspond to the engraved line on the block which marks the geometric centre of the quadrant.

Clearly mark the index point on the side of the probe.

The index should be known within ± 1 mm.

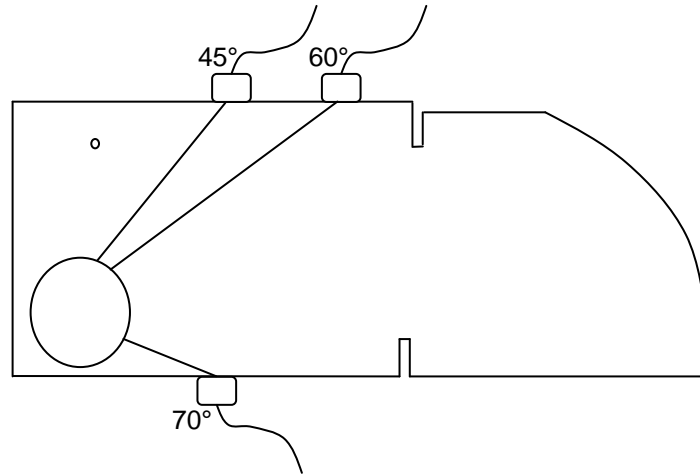
The frequency of the check should be at least daily, but dependent on usage and the test surface roughness, more frequent verification may be required.

Angle Of Refraction

Block 1 Method

Calibrate the timebase for appropriate beam path.

Place the probe at the appropriate position to maximise the signal from the plastic insert as shown in Figure 2 below.



If the index point coincides with the engraved reference marks on the block, this verifies the angle is at its nominal angle

If the index point does not coincide with the engraved reference marks on the block, measure the deviation by transferring the probe index point to the side of the block and accurately note the distance between the reference mark to the transferred index point.

To determine the actual angle of the probe, compare the deviation measurement obtained with the figures in the Table 2 below;

Calculated Deviations From Nominal Angles Using Block 1									
Probe Angle	43°	43.5°	44°	44.5°	45°	45.5°	46°	46.5°	47°
Deviation(mm)	-5	-3.5	-2.5	-1	-	+1	+2.5	+3.5	+5
Probe Angle	58°	58.5°	59°	59.5°	60°	60.5°	61°	61.5°	62°
Deviation(mm)	-9	-7	-5	-2	-	+2	+5	+8	+11
Probe Angle	68°	68.5°	69°	69.5°	70°	70.5°	71°	71.5°	72°
Deviation(mm)	-8.5	-7.5	-4.5	-2.5	-	+2.5	+4.5	+7	+10

When using probes that are not listed above the angle can be calculated without the use of a calibrated timebase by using equation:

$$\frac{X - 35}{D} = \text{TAN } B$$

Where X = Distance from end of block to index point (in mm).
 D = Depth of centre of Perspex block. (i.e. 30mm or 70mm depending on side probe is positioned).

The allowable deviation from the nominal angle is not to exceed $\pm 2^\circ$.

Block 2 Method

The angle shall be checked against the engraved markings on the side of the block.

Maximise the signal from the side drilled hole and read the angle from the engraved markings on the block.

If it becomes apparent that the angle is outwith its tolerance, it shall be rechecked using Block 1 for verification.

Angle Probe – Squint

Using either Block 1 or 2, obtain a corner echo from its long edge and maximise the signal.

Lay a straight edge along the side of the probe and draw a line to intersect the edge of the block.

Using a protractor, measure the angle that this line makes with the edge.

The maximum permitted deviation is 2°.

COMBINED EQUIPMENT CHECKS

Sensitivity and Signal to Noise Ratio

The purpose of these checks is to indicate the potential deterioration in performance of combined equipment compared against a base value level. The base levels are established on a combination of flaw detector, probe and cable types and the procedure for establishing the levels and comparing the performance in service are identical.

Using either Block No. 1 or 2, calibrate for a 100mm range.

Maximise a signal from the 1.5mm or 5mm diameter hole as applicable and adjust the calibrated attenuator to set the signal at 20% FSH (Full Screen Height).

This is the 'System Sensitivity' (NOT TO BE CONFUSED WITH TEST SENSITIVITY).

Note the depth of the target hole used and also the gain setting (in dB).

Remove the probe from the calibration block and wipe the probe face to remove any couplant.

Place the probe on its side and increase the gain control until the overall system noise at the same range as the target hole reaches 20% FSH and note the new gain setting (in dB).

Record the difference in dB between the signal from the target hole and the overall system noise.

This is the signal to noise of the system.

The signal to noise ratio shall be within 6dB of the base measurement made when the probe/set combination was first used.

Pulse Duration

The pulse duration measured by the following procedure shall be compared to the base level previously established by the user when the operator first obtains the probe. The base levels are established on a combination of flaw detector, probe and cable types and the procedure for establishing the levels and comparing the performance in service are identical.

If the pulse length is greater than the requirements listed below the probe shall be replaced.

	Frequency (MHz)	Max. Pulse Length (mm of steel)
Compression	0.9 – 1.8	18
	1.8 – 3.5	10.5
	3.5 & greater	7.5
Shear	4.0 (single crystal)	4.0
	4.0 (twin crystal)	5.0
	2.0 (single crystal)	5.5

Pulse duration shall be measured using Block 2 as follows;

Compression Wave Probes.

Calibrate for a 50mm range.
 Adjust the back wall echo to 100% full screen height.
 Measure the width of the signal in millimetres at 10% full screen height.

Shear Wave Probes

Calibrate over 0 -100mm using block 2.
 Adjust the signal from the 25mm radius to 100% full screen height.
 Measure the width of the signal in millimetres at 10% full screen height.
 The pulse duration shall not be greater than 1.5 times the value of the base level.

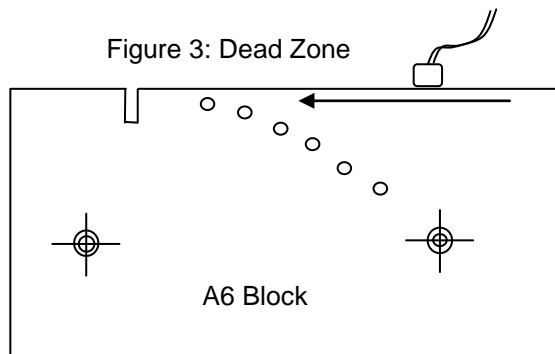
DEAD ZONE CHECKS

Dead Zone checks shall be carried out **only** when specified contractually.

Combined Double Compression Probes – Dead Zone Measurement

Calibrate the time base to represent 0~50 mm full screen width.

Using the A6 Block, position the probe as shown in Figure 3 below and scan the series of 1.5 mm diameter holes.



Adjust the height of each signal in turn to 40% full screen height.

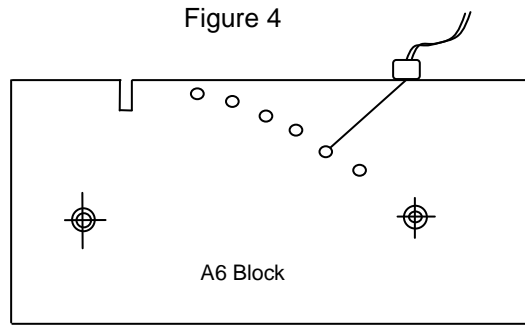
Record the depth of the shallowest detectable hole i.e. 1,2,3,5,10 or 15mm.

Shear Wave Probes – Dead Zone Measurement

Calibrate the time base to represent 0~500 mm full screen width.

Using the A6 Block, position the probe as shown in Figure 4 below and scan the series of 1.5 mm diameter holes.

Adjust the height of each signal in turn to 40% full screen height.



Record the depth of the shallowest hole located.

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RESOLUTION CHECKS

Resolution checks shall be carried out **only** when specified contractually.

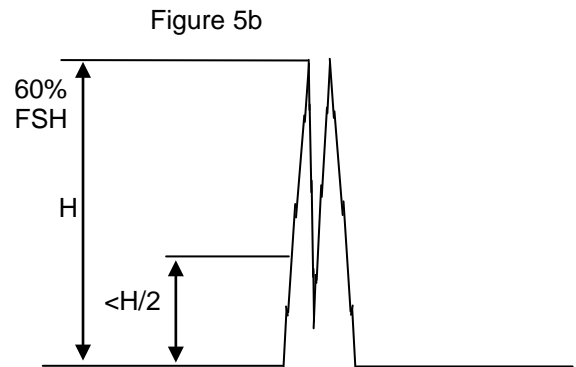
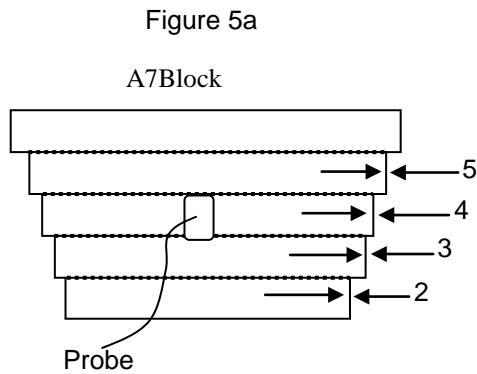
Single Compression Probes & Combined Double Compression Probes >15mm Diameter.

Calibrate the time base to represent 0-100 mm full screen width.

Depending on probe frequency, place the probe over the appropriate step on the A7 block as shown in Fig 5a below;

- 4 MHz or higher: Place the probe over the 3 mm step
- Lower than 4 MHz; Place the probe over the 5 mm step.

Equalise the signal heights and adjust to 60% full screen height as shown in Fig. 5b.



The step is resolved if the signals are clearly separated at half the height of the echoes or lower. See Figure 5b.

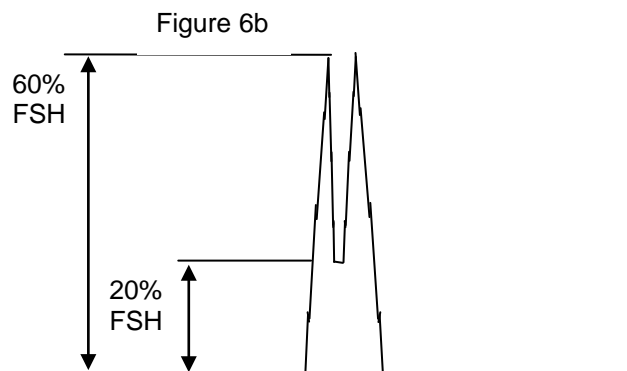
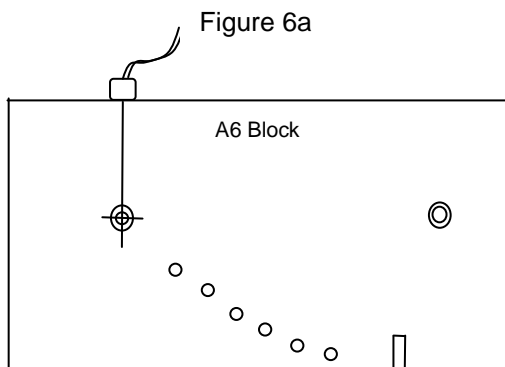
Resolution Check For Miniature. Twin Compression Probes - A6 Block

Calibrate the time base to represent 0-50mm full screen width.

Using the A6 Block, place the probe over the 3 mm step holes as shown in Fig 6a.

Equalise the signal heights and adjust to 60% full screen height.

The step is resolved if the signals are clearly separated at 20% full screen height or lower. See Figure 6b.



Record either yes or no to indicate satisfactory results.

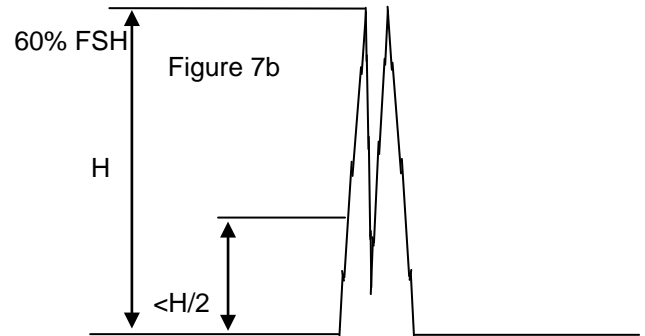
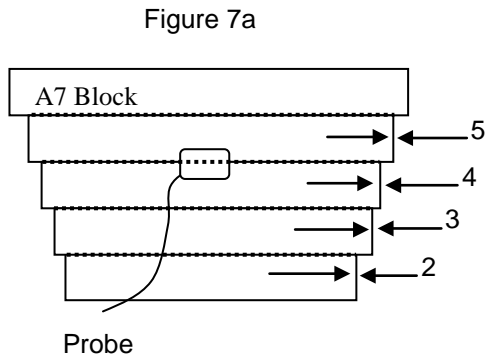
Resolution Check for Shear Wave Probes

Calibrate the time base to represent 0-100 mm full screen width.

Depending on probe frequency, place the probe over the appropriate step on the A7 block as shown in Fig 7a below;

- Higher than 2 MHz: Place the probe over the 2 mm step
- 2 MHz or lower: Place the probe over the 4 mm step.

Equalise the signal heights and adjust to 60% full screen height as shown in Fig. 7b.



The step is resolved if the signals are clearly separated at half the height of the echoes or lower. See Figure 7b.

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NONDESTRUCTIVE TESTING QUALITY CONTROL & PROCEDURES MANUAL

OF

INSPECTRUM TESTING INC.

MANUAL IT-121

DYNACORP

JANUARY 2015 (VERSION 1.5)

CODE COVER STATEMENT

The follow are the current editions of codes and standard that are referenced in this manual:

- (a) ASME Boiler and Pressure Vessel Codes, 2013 Edition
- (b) ASME B.31.3 Oil & Gas Pressure Piping Codes, 2012 Edition
- (c) ASME B.31.1 Power Piping Codes, 2012 Edition
- (d) CSA Z-662 Canadian Oil & Gas Pipeline Systems, 2011 Edition
- (e) API 650 Welded Steel Tanks For Oil Storage, 2013 Edition
- (f) CGSB Standard 48.9712 NDT Personnel Certification in Canada, 2006 Edition

The current written practices of *Inspectrum Testing Inc.* meet the requirements stated in SNT-TC-1A 2006 Edition. The personnel certification standard that covers the AMSE code work conducted by *Inspectrum Testing Inc.* is SNT-TC-1A 2006 Edition. It is the currently accepted in:

- (a) ASME Section I as stated in Table A-360
- (b) ASME, Section VIII, Division 1 as stated in table U3.
- (c) ASME B 31.3 as stated in Appendix E.
- (d) ASME B 31.1 as stated in Appendix F.

If a code or standard is referenced in this quality control manual it shall be assumed that the latest accepted code edition is being referenced unless otherwise stated.

GENERAL

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1.0 NOTICE TO USER

This quality control manual is the property of *Inspectrum Testing Inc.*

This manual or any information contained within it shall not be loaned out, copied or reproduced in any manner without prior written permission from *Inspectrum Testing Inc.*

Inspectrum Testing Inc. reserves the right to request this manual be returned at any time.

2.0 SCOPE

The following procedure manual contains established and approved procedures defining the minimum standards and requirements for performing non-destructive testing. These procedures shall be used in conjunction with referencing codes and client specifications when applicable.

No single document can encompass all possible inspection situations. In the event that an application falls outside these procedures or specific client request additional procedures and techniques shall be developed.

3.0 REFERENCES AND STANDARDS

The following are currently accepted reference documents for these procedures that are common to our client's requirements:

ASME Boiler and Pressure Vessel Codes

ASME B.31.3 Oil & Gas Pressure Piping Codes

ASME B.31.1 Power Piping Codes

CSA Z-662 Canadian Oil & Gas Pipeline Systems

API 650 Welded Steel Tanks For Oil Storage

CGSB Standard 48.9712 NDT Personnel Certification in Canada

ASNT SNT-TC-1A

If a code or standard is referenced in this quality control manual it shall be assumed that the latest accepted code edition is being referenced unless otherwise stated.

4.0 SAFETY

All personnel will be responsible for full compliance with *Inspectrum Testing Inc.* safety policies and procedures when working under this manual. Safety shall be the first priority during all NDT operations. All personnel are expected to comply with:

- 4.1 Current Provincial and Federal health and safety regulations.
- 4.2 All examinations shall be carried out complying with the requirements of the *Inspectrum Testing Inc.* health and safety manual.
- 4.3 Industry standard safe work practices
- 4.4 Client specific safety requirements

5.0 REVISIONS

Any revision to this manual shall be approved by the Level III designate and *Inspectrum Testing Inc.*'s document reviewer. This shall be documented in the revision log for each individual procedure.

6.0 NON CONFORMANCE

If the technician is unable to perform operations stated in this manual due to unforeseen circumstances they shall contact his supervisor for guidance. Any procedural change shall be documented, approved and signed by the client. Non-conformance may be documented on Form NCR-01.

Form NCR-01

QUALITY CONTROL NONCONFORMANCE REPORT

PRIORITY	<input type="checkbox"/>	Level 0 - Serious/ Resolve Immediately	NCR # _____
	<input type="checkbox"/>	Level 1 - Major / Resolve within 14 days	<i>Refer to Inspection Report #</i> _____
	<input type="checkbox"/>	Level 2 - Minor / Resolve within 30 days	Client: _____
	<input type="checkbox"/>	Level 3 - Client Recommendation	NCR Identified By: _____
			NCR to be Actioned By: _____
			NCR to be Resolved By: _____

DESCRIPTION OF NONCONFORMANCE (To be completed by person identifying the NCR) Please attach photos when applicable

CAUSE OF NONCONFORMANCE

<input type="checkbox"/> Noncompliance with Inspectrum Testing Inc. Quality Control	<input type="checkbox"/> Noncompliance with Code, Act or Regulation
<input type="checkbox"/> Noncompliance with Client Specs	<input type="checkbox"/> B31.1 <input type="checkbox"/> B31.3 <input type="checkbox"/> Sect VIII <input type="checkbox"/> Sect I
<input type="checkbox"/> Other _____	<input type="checkbox"/> Sect V <input type="checkbox"/> CSA <input type="checkbox"/> Z662 <input type="checkbox"/> Other

RECOMMENDED ACTION

Describe actions required to resolve the NCR.

Prepared by (Please Print) _____	Signature _____	Date _____
----------------------------------	-----------------	------------

Resolution Completed

<input type="checkbox"/> Acceptable	<input type="checkbox"/> Unacceptable	<input type="checkbox"/> Corrective Action Required
Identify if actions were acceptable or if additional actions are required:		

7.0 STATEMENT OF AUTHORITY

This manual describes the standard practice to be used for Nondestructive Testing. This manual is, to the best of my knowledge, in compliance with the currently accepted code editions of ASME, CSA, SNT-TC-1A, and CAN/CGSB 48.9712.

All personal performing and interpreting Nondestructive testing results shall be certified in accordance with this manual and applicable code and/or standard.



Signature RT, UT, MT, PT Level III Examiner

January 10, 2015

Date

8.0 CONTACT INFORMATION

INSPECTRUM TESTING INC. CONTACT DETAILS

MAILING ADDRESS

INSPECTRUM TESTING INC.
P.O BOX 736
GRANDE PRAIRIE, ALBERTA
T8V 3R5

GRANDE PRAIRIE, ALBERTA

LOCAL SERVICES RT UT MT PT HT

PHONE: 780-539-0000
TOLL FREE: 866-NDT-XRAY
866-638-9729
FAX: 780-539-1777
E-MAIL: jkish@inspectrumtesting.com

LEVEL III APPOINTMENT & CERTIFICATIONS

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SNT LEVEL III APPOINTMENT FOR *INSPECTRUM TESTING INC.*

Inspectrum Testing Inc. does hereby designate:

JOEL A. NORMAN

(Name of RT, UT, MT, PT Level III Examiner)

as our LEVEL III examiner responsible for establishing Nondestructive Testing Certification according to the recommended practices and guidelines of the American Society for Nondestructive Testing (ASNT), SNT-TC-1A, (currently accepted edition). We have determined the individual's qualifications as related to our specific needs and find that his background experience, training and education, as assessed, qualifies him to establish, organize and administer our SNT-TC-1A Level I and Level II Certification in Radiography, Ultrasonics, Magnetic Particle and Liquid Penetrant.

This appointment is by examination and shall be revoked at termination of employment or at such times as *Inspectrum Testing Inc.* deems it to be otherwise.

Dated this 2nd day of January 2014

Signed:



Joel Kish – Authorized
Signatory for *Inspectrum Testing Inc.*

Joel A. Norman as Level III appointee for *Inspectrum Testing Inc.* hereby certifies that the procedures set out in the body of this manual are approved and meet the requirements of the applicable codes referenced.


Dated this 2nd day of January 2014

Signed:




(Signature RT, UT, MT, PT Level III Examiner)

Joel A. Norman	CGSB 48.9712	Level III	RT - UT - MT - PT	#6951
	SNT	Level III	RT - UT - MT - PT	

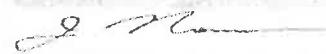
 Natural Resources Canada / Ressources naturelles Canada


Name/ Nom: **Joel Aaron Norman**
 Reg. No. / No. matricule: **6951**
 Issue Date/ Date d'émission: **2013/12/07**




This card does not identify the stated individual to be an employee or representative of Natural Resources Canada, Government of Canada. Cette carte n'identifie pas l'individu d'être un employé ou un représentant de Ressources naturelles Canada, Gouvernement du Canada.

Corrective lenses for [] near [] far vision.
 Verres correctifs pour la vision de [] près [] distance.

Signature: 

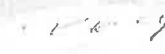



 Natural Resources Canada / Ressources naturelles Canada

Certified to/ Certifié selon: CAN/CSA-48.9712

Method/ Méthode	Level/ Niveau	Sector/ Secteur	Cert. Date/ Date cert.	Date recert./ Date recert.	Expires/ Expiration
MT	3	EMC	2005/01/07		2016/12/31
PT	3	EMC	2005/01/26		2016/12/31
RT	3	EMC	2004/12/22		2016/12/31
UT	3	EMC	2006/06/06		2016/12/31


For verification of certification status, policies and definitions, visit website: <http://ndb.nrcan.gc.ca/> Pour la vérification de la certification, les politiques, et les définitions, visiter le site web: <http://ndb.nrcan.gc.ca/>

Manager, Certifying Agency / Gestionnaire, Organisme de certification: 

 **SNT CERTIFICATION**

Joel Norman


has met the requirements of SNT certification in accordance with *Inspectrum Testing Inc.* written practice that meets the requirements of ASNT recommended practice SNT-TC-1A 2006 edition, in the nondestructive testing methods listed on the reverse side of this card.

 **SNT CERTIFICATION**

Technician: **Joel Norman**

SNT Method	Level	Expiry Date
RT	III	December 31, 2016
MT	III	December 31, 2016
PT	III	December 31, 2016
UT	III	December 31, 2016

Authorized Signatory: **Joel Kish**

Signature of Authorized Signatory: 

Date of Issue: **January 1, 2014**

Canada

Natural Resources Canada
Ressources Naturelles Canada

RADIOGRAPHIC TESTING
CONTRÔLE PAR RADIOGRAPHIE
ENGINEERING MATERIALS & COMPONENTS SECTOR/
SECTEUR DES MATÉRIAUX ET COMPOSANTS INDUSTRIELS
LEVEL 3 NIVEAU DATE DECEMBER 2004

this certifies that / la présente atteste que

JOEL AARON NORMAN

has successfully met the requirements set by the Canadian General Standards Board in Standard CAN/CGSB 48 9712:2000, for the Level and Sector indicated hereabove. The validity of this certification is subject to the conditions for its renewal and recertification.

Materials Technology Laboratory
Natural Resources Canada
Ottawa, Canada

a satisfait aux exigences établies par l'Office des Normes Générales du Canada CAN/CGSB 48 9712:2000, et visant le Niveau et Secteur indiqué ci-dessus. La validité de ce certificat est sujette aux conditions de son renouvellement.

Laboratoire de la technologie des matériaux
Ressources Naturelles Canada
Ottawa, Canada

Richard V. Murphy
NDT Certifying Agency / Organisme de certification en END



Canada

Materials Resources
Canada



**MAGNETIC PARTICLE
TESTING**
**CONTRÔLE PAR
MAGNÉTOSCOPIE**
ENGINEERING MATERIALS & COMPONENTS SECTOR/
SECTEUR DES MATÉRIAUX ET COMPOSANTS INDUSTRIELS
LEVEL 3 NIVEAU DATE JANUARY 2005

this certifies that / la présente atteste que

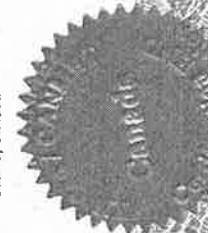
JOEL AARON NORMAN

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Materials Technology Laboratory
Natural Resources Canada
Ottawa, Canada

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Laboratoire de la technologie des matériaux
Ressources Naturelles Canada
Ottawa, Canada



Richard V. McLaughlin
NDT Certifying Agency / Organisme de certification en END



Canada

Natural Resources Canada
Ressources naturelles Canada

**LIQUID PENETRANT
TESTING**
**CONTRÔLE PAR
RESSUAGE**
ENGINEERING MATERIALS & COMPONENTS SECTOR/
SECTEUR DES MATÉRIAUX ET COMPOSANTS INDUSTRIELS
LEVEL 3 NIVEAU DATE JANUARY 2005

this certifies that / la présente atteste que

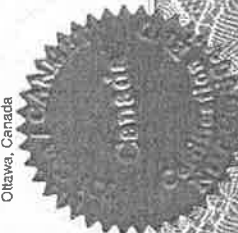
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Ottawa, Canada



Richard W. Murphy
NDT Certifying Agency / Organisme de certification en END

Canada

Natural Resources / Ressources naturelles
Canada

**CONTRÔLE PAR
ULTRASON**

**ULTRASONIC
TESTING**

**ENGINEERING MATERIALS & COMPONENTS SECTOR/
SECTEUR DES MATÉRIEAUX ET COMPOSANTS INDUSTRIELS**

LEVEL 3 NIVEAU DATE JUNE 2006

THIS CERTIFIES THAT / LA PRÉSENTE ATTESTE QUE

JOEL AARON NORMAN

has successfully met the requirements set by the Canadian General Standards Board in Standard CANCGSB 48.9712-2000, for the Level and Sector indicated hereabove. The validity of this certificate is subject to the conditions for its renewal and recertification.

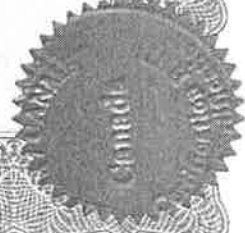
a satisfait aux exigences établies par l'Office des Normes Générales du Canada CANCGSB 48.9712-2000, et visent le Niveau et Secteur indiqué ci-dessus. La validité de ce certificat est sujette aux conditions de son renouvellement.

Materials Technology Laboratory
Natural Resources Canada
Ottawa, Canada

Laboratoire de la technologie des matériaux
Ressources Naturelles Canada
Ottawa, Canada



NDT Certifying Agency / Organisme de certification en END



**NDT PERSONNEL CERTIFICATION TO THE STANDARD
CAN/CGSB 48.9712-2006 & ASNT SNT-TC-1A 2001 & 2006
ANNUAL EYE EXAMINATION REPORT**

In accordance with the Standard CAN/CGSB 48.9712 "Non-destructive Testing – Qualification and Certification of Personnel" and ANST recommended practice SNT-TC-1A, this Eye Examination Report, consisting of three vision requirements: Near Vision, Distance Vision, and Colour Vision for examination in any of the of NDT Methods

APPLICANT'S NAME: JOEL NORMAN **REGISTRATION NUMBER:** #6951

I am submitting for the following: (Please check)

EXAMINATION

RENEWAL

RE-CERTIFICATION

NEAR VISION ACUITY: shall permit reading of a Times Roman N4.5 (Jaeger number 2) or equivalent letters at not less than 30 cm with one or both eyes, either corrected or uncorrected.

I CONFIRM THAT THE CANDIDATE:

- Meets *without* correction
 Meets *with* correction
 Does not meet

DISTANCE VISION ACUITY: shall be equal to or better than Snellen Fraction 20/30 with one or both eyes, either corrected or uncorrected.

I CONFIRM THAT THE CANDIDATE:

- Meets *without* correction
 Meets *with* correction
 Does not meet

Joel Kish

Examiners Name

President

Appointment/Title



Examiners Signature

January 8, 2015

Date of Eye Examination

COLOUR & GRAYSCALE CONTRAST DIFFERENTIATION

The following tests must be completed:

- (1) Colours using the HHR 4th Edition 24 tablet test for colour blindness for the NDT method(s) concerned.
(2) Grayscale using Kodak Industrex Calibrated step tablet, density strip, 1-10 for the NDT method(s) concerned.

I CONFIRM THAT THE CANDIDATE CAN DISTINGUISH BETWEEN THE COLOURS AND CONTRASTS OF THE ABOVE TESTS IN THE NDT METHOD(S) CONCERNED:

Joel Kish

Examiners Name

President

Appointment/Title



Examiners Signature

January 8, 2015

Date of Eye Examination

INSPECTRUM TESTING INC.

Quality Control & Procedures Manual

SNT CERTIFYING & COMPETENCY STATEMENT

Technician: Joel Norman

Date: January 1, 2014

Joel Norman has worked in the Non Destructive Testing field since January 1997 and has been continuously employed by Inspectrum Testing Inc. since January 2010. In this time period he has demonstrated satisfactory performance.

Certification Level

Method	RT	UT	MT	PT
SNT Level	Level III	Level III	Level III	Level III
ISO 9712 Level	CGSB Level III	CGSB Level III	CGSB Level III	CGSB Level III

An ISO 9712 certification of CGSB, ASNT, PCN or equivalent does not require a written or practical examination unless assessment by the level III specifies additional training or examination is required.

SNT Examinations

Method	RT	UT	MT	PT
General Written Exam(s)	CGSB Level III	CGSB Level III	CGSB Level III	CGSB Level III
Specific Written Exam(s)	CGSB Level III	CGSB Level III	CGSB Level III	CGSB Level III
Practical Exam(s)	CGSB Level III	CGSB Level III	CGSB Level III	CGSB Level III

Training & Education

Method	Institution	Hours	Date Complete	Copy Available
Radiography Level I	SAIT	40	April-99	Yes
Radiography Level II	SAIT	80	May-99	Yes
Radiography Level III	SAIT	40	September-04	Yes
Ultrasonic Level I	SAIT	40	July-00	No
Ultrasonic Level II	SAIT	80	April-02	Yes
Ultrasonic Level III				
Magnetic Particle Level I&II	SAIT	40	May-00	Yes
Magnetic Particle Level III				
Liquid Penetrant Level I&II	SAIT	40	May-02	Yes
Liquid Penetrant Level III				
Materials & Processes	SAIT	40	May-99	Yes
Level III Basic	INTEG	40	October-04	Yes

Documentation Checklist

- Copy of SNT certificate available
- Copy of ISO 9712 certification card available
- Copy of vision examination current available


Certifying Statement & Competency Assessment

Technician: Joel Norman

- has demonstrated satisfactory technical performance for SNT re-certification.
- is certified to work at qualification levels indicated above.
- requires additional training and/or experience to meet the Inspectrum Testing Inc. SNT written practice requirements.

As the President of Inspectrum Testing Inc., I acknowledge by my signature that statements made in this document and document copies have been verified.


Joel Kish
Inspectrum Testing Inc. President


Signature

January 1, 2014
Date

As the SNT Level III Appointee, I acknowledge by my signature that statements made in this document and document copies have been verified.


Joel Norman
Inspectrum Testing Inc. Level III


Signature




January 1, 2014
Date

MAGNETIC PARTICLE TESTING

TECHNICAL PROCEDURE MT-1, REV. 3

	Name	Signature
To the best of my knowledge this procedure meets the requirements of AMSE Section V 2013 Edition	Joel Norman	

DOCUMENT APPROVAL

	Name	Signature	Date
Prepared by	Joel Norman		Dec. 12, 2010
Reviewed by	Joel Kish		Dec. 12, 2010
Approved by Level III	Joel Norman		Dec. 12, 2010

REVISION RECORDS

Rev. #	Date	Changes Since Last Revision	ASME Essential Variable	Prepared By	Reviewer(s)
1	Nov 17, 2010	Removed UV light equipment that is not used.	No	Joel Norman	Joel Kish
2	Dec 5, 2010	Wording changes & addition of particle application and removal paragraph.	Yes	Joel Norman	Joel Kish
3	Dec 12, 2010	Minor wording error fixes.	No	Joel Norman	Joel Kish

PROCEDURE MT-1 TABLE OF CONTENTS

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1.0 SCOPE

The following procedure covers magnetic particle, portable AC current yoke, procedures and techniques for surface examinations performed by *Inspectrum Testing Inc.* Magnetic particle testing may be completed on ferrous carbon steel; castings, forgings, plate material, and welds. The magnetic particle examination may be applicable to new construction and in-service surface inspections.

This procedure is to be used in conjunction with a technique sheet.

When a performance demonstration of this procedure is required to prove industry standard, regulatory, and code compliance the results shall be documented.

2.0 REFERENCES AND STANDARDS

This procedure shall be controlled by revision number. Any changes or revisions shall be recorded in the revision cover sheet, dated and initialled by the document owner.

The following are reference documents for this procedure:

ASME Section I	Power Boilers
ASME Section VIII	Pressure Vessels
ASME B 31.3	Process Piping
ASME B 31.1	Power Piping
CSA Z-662	Oil & Gas Pipeline Systems
API 650	Welded Steel Tanks For Oil Storage
ASME Section V, Article 7	Non Destructive Testing – Mag. Particle
ASME Section V, Article 25 – SE 709	Non Destructive Testing – Mag. Particle
CGSB Standard 48.9712	Centralized NDT Personnel Certification in Canada
ASNT SNT-TC-1A	NDT Personnel Certification

Unless otherwise instructed by purchase order, contract documents or specifications, the latest issues of the referenced codes and specifications will apply. Verbal instructions will not be acceptable.

3.0 TERMS

ASME	=	American Society of Mechanical Engineers
C	=	Centigrade
CGSB	=	Canadian Government Standards Board
CSA	=	Canadian Standards Association
F	=	Fahrenheit
FC	=	Foot Candles
ID	=	Inside Diameter
NDT	=	Nondestructive Testing
OD	=	Outside Diameter
UV	=	Ultraviolet
WCP	=	White Contrast Paint

4.0 SAFETY

All personnel will be responsible for full compliance with *Inspectrum Testing Inc.* safety policies and procedures when working under this document. The following are notable safety concerns specific to magnetic particle testing:

- 4.1 All tests shall be carried out in a well ventilated area. When this is not possible the proper respiratory equipment shall be used.
- 4.2 Avoid contact from consumable product with the skin and eye. Appropriate personal protective equipment shall be worn. i.e. safety glasses and gloves.
- 4.3 Aerosol cans must be stored with the manufactures recommended temperature range.
- 4.4 Prevent direct eye exposure unfiltered UV radiation from ultraviolet lights.
- 4.5 Clean up and dispose of all waste in compliance with federal, provincial and corporate regulations.

5.0 PERSONNEL TRAINING

Examinations shall be performed under the direct supervision of personnel qualified to NDT Level II or III CAN / CGSB 48.9712 for CSA codes and/or *Inspectrum Testing Inc.* written practice using SNT-TC-1A (Current Accepted Edition) for ASME codes.

6.0 EQUIPMENT & MATERIALS

6.1 AC Yoke

The AC yoke shall be used for this procedure. The equipment shall be capable of producing a magnetizing force that will nearly saturate the area under examination. The following AC yoke are approved for use with this procedure:

- (a) Parker Research - Model B-300
- (b) Parker Research - Model B-310
- (c) Magnaflux - Model Y-1
- (d) Magnaflux - Model Y-6

AC current electromagnetic yoke shall be capable of lifting 4.5 Kg (10lbs) with a leg spacing of maximum pole spacing used. This quality control standard shall be verify at a minimum of 1 year intervals or when the yokes a lifting ability is in question. Any yokes not meeting this standard shall be immediately removed from service.

6.2 Materials

All particles acceptable to this procedure shall be aerosol can form (sealed manufacture prepared baths). No settling tests or contamination tests shall be required as the sealed concentrations of the particle are preset to meet specifications. The following materials in Table 6.2 are approved for use with this procedure.

Product	Manufacture	Method	Color	Average Particle Size	Upper Temp. Limit	Lower Temp. Limit
No. 8A	Magnaflux	Visible Dry	Red	180µm	315°C (600°F)	-20°C (-4°F)
No. 2	Magnaflux	Visible Dry	Yellow	180µm	260°C (500°F)	-20°C (-4°F)
No. 1	Magnaflux	Visible Dry	Grey	180µm	315°C (600°F)	-20°C (-4°F)
8901W	Ardrox	Visible Wet	White	N/A	60°C (140°F)	4°C (40°F)
8031	Ardrox	Visible Wet	Black	1.5µm	60°C (140°F)	4°C (40°F)
8800A	Ardrox	Fluorescent Wet	Fluorescent	7µm	60°C (140°F)	4°C (40°F)

Note¹: If additional materials are to be used additional demonstration shall be required.

Note²: Examination outside the specified temperature range is not permitted.

6.3 Ultraviolet Lamps

The following ultraviolet lamps are acceptable to this procedure:

- (a) Spectroline BIB-150 P

The reflector and filters shall be checked and, if necessary, cleaned prior to use. Cracked or broken filters shall be replaced immediately. Electrical cords shall be checked for cracks or breaks and replaced or repaired when required.

6.4 Light Meters

The following light meters and light sensors are acceptable to this procedure:

- (a) Spectroline DSE 100X

These instruments are capable of measuring both white light intensity and ultraviolet light intensity. The instrument shall be calibrated or have calibration verified within the last 12 months.

7.0 SURFACE PREPARATION

- 7.1 Satisfactory surface results are usually obtained when the surfaces are in as-welded, as-rolled, as-cast, or as forged conditions. Surface preparation by grinding or machining may be necessary where surface irregularities could mask relevant indications.
- 7.2 Prior to inspection, the surface area of interest shall be examined plus a minimum of 25mm (1"). This area shall be free of all dirt, grease / oil, lint, scale, welding flux, weld splatter, and any other extraneous matter that could interfere with the examination.
- 7.3 Cleaning may be accomplished using detergents, organic solvents, rescaling solutions, paint remover, vapor degreasing, sand or grit blasting, or ultrasonic cleaning.
- 7.4 If the surface is unusually rough or has undercut adjacent to the weld edge, interpretation may be difficult because the inspection medium may be trapped mechanically. In such cases, grinding may be necessary to determine if actual indications are present.
- 7.5 Nonmagnetic surface contrasts may be applied to uncoated surfaces, only in amounts sufficient to enhance particle contrast. When nonmagnetic surface contrast enhancement is used, it shall be demonstrated that indications can be detected through the enhancement. Thickness measurement of this nonmagnetic surface contrast enhancement is not required.
- 7.6 Ensure the component it is within the approved temperature range.

8.0 LIGHTING REQUIREMENTS

The following lighting requirements shall be followed when using this procedure:

8.1 Fluorescent (Ultraviolet) Lighting

- 8.1.1 Shall be performed in a darkened area.
- 8.1.2 Examiners shall be in the darkened area for a minimum of 5 minutes prior to performing an examination. This will enable there eye to adjust to the lighting.
- 8.1.3 Tinted or photosensitive eye wear lens are unacceptable. Spectroline specialized yellow tint glass (for ultraviolet inspection use) that reduce operator eye fatigue are acceptable as they have been proven not to decrease contrast in viewing.
- 8.1.4 Ultraviolet lights shall achieve a minimum of 1000 $\mu\text{W}/\text{cm}^2$ on the surface of the part being examined throughout the examination. The ultraviolet light shall have wavelengths in the range of 320nm to 380nm. The white light shall no exceed 20 lux (2 fc).

8.1.5 The ultraviolet light intensity shall be measured with a ultraviolet light meter:

- (a) prior to use.
- (b) whenever the light's power is interrupted or changed.
- (c) at the completion of the examination or series of examination.

8.2 Visible Lighting

When colour contrast inspection methods are used the minimum white light intensity at the surface of the component to be inspected shall be 1000 lux (100 fc). Tinted or photosensitive eye wear lenses are unacceptable.

9.0 EXAMINATION PROCEDURE

9.1 General

Magnetic particle inspection shall only be utilized with ferromagnetic materials. Final magnetic particle examination shall be performed after the completion of all operations that could cause surface connected discontinuities. Where the particle suspension may be detrimental to the future service of a part or component, plug or mask any point of entry.

9.2 Component Identification

Identify all inspection areas on the component surface with a unique identifier. A contrasting marking stick (usually a white or yellow paint marker) shall be used to display MT-1, MT-2, MT-3 etc. A zero start point shall be marked with an arrow indicating the direction of measure. This identification system shall be used unless specific written instructions are given by the client.

9.3 Particle Application & Removal

9.3.1 Wet Particle Application - Particles applied from aerosol spray cans may be applied before and/or after magnetizing current is applied. Wet particles may be applied during the application of magnetizing current if they are not applied directly to the examination area and are allowed to flow over the examination area or are applied directly to the examination area with low velocities insufficient to remove accumulated particles.

9.3.2 Dry Particles Application - Dry powders shall be applied by air puffer applicators in a light uniform dust-like coating. Dry particles shall not be applied by pouring, throwing or spreading with the fingers. The magnetizing current shall remain on while the examination medium is being applied.

9.3.3 Dry Particles Removal- The magnetizing current shall remain on while the examination medium is being applied and while any excess of the examination medium is removed.

9.4 General Inspection Procedure

- 9.4.1** Visually pre-inspect the area of interest plus an additional 25mm (1") for any notable indications that may effect the inspection.
- 9.4.2** *When applicable specified by the technique sheet*, apply white contrast aid paint to the surface of the component covering the area of interest and a minimum of an additional 25mm. The contrast aid aerosol can shall be thoroughly agitated by shaking of the can prior to use. Application of the paint shall be completed from 9-12" from the surface in an even, continuous sweeping motion. Inspect the paint for any uneven areas or runs. Remove paint and reapply when necessary. Ensure the paint is dry prior to particle inspection.
- 9.4.3** Position the yoke over the area of interest. Place the leg poles a flat as possible to the surface. Leg spacing shall not exceed 240mm (10"). The continuous magnetic particle method shall be used. Energize the coil and apply an ample supply of particle medium on the component surface. Current shall be applied for 2-5 seconds.
- The particle aerosol can shall be thoroughly agitated by shaking of the can prior to use when applicable.
- 9.4.4** Observe formation of any indication while the current is on and immediately after the current is turned off. Evaluate, interpret, mark and record any areas of interest.
- 9.4.5** Rotate the poles 90 degrees to the first examination energize the coil and apply an ample supply of particle medium on the component surface. Current shall be applied for 2-5 seconds.
- 9.4.6** Observe formation of any indication while the current is on. Evaluate, interpret, mark and record any areas of interest.
- 9.4.7** Repeat this process along the area of interest ensuring there enough overlap to obtain 100% coverage of the component.
- 9.4.8** Complete examinations of all requested areas.

Note: It may be necessary to add additional magnet fields other than the minimum 2 fields, 90 degree to each other, to characterize an indication.

10.0 EVALUATION OF INDICATIONS

Experience and training give the NDE inspector the ability to evaluate indications revealed by magnetic particle testing, but there are certain guidelines that may assist technicians:

- 10.1 All relevant indications shall be measured in length, width when applicable, and characterized. Such indications shall be evaluated in terms of the acceptance standards of the referencing Code section.
- 10.2 Discontinuities on or near the surface are indicated by retention of the examination medium. However, localized surface irregularities due to machining marks or other surface conditions may produce false indications.
- 10.3 Closely inspect fillet radii and internal corners, where defects may be masked by suspension accumulations.
- 10.4 Broad areas of particle accumulation, which might mask indications from discontinuities, are prohibited, and such areas shall be cleaned and re-examined.
- 10.5 Re-magnetize and re-inspect whenever doubtful indications appear. Prove or disprove the relevancy.

11.0 POST INSPECTION

11.1 Demagnetization

Demagnetization of the component shall be completed required by purchase order or client specification requirements. To use a yoke for demagnetization, slowly remove the yoke from the test article with the current remaining on until the influence of the magnetic field is well away from it. The residual field should be checked with a field indicator to verify sufficient demagnetization.

11.2 Post Cleaning

If required by the client the inspection medium shall be removed as soon after the examination as possible. The use of an air stream, solvent, water or other suitable means may be used for this process. If specific cleaning instructions are required they shall be supplied in writing with the contract document.

12.0 ACCEPTANCE CRITERIA

All indications shall be interpreted and evaluated in accordance with the applicable referencing code or standard. Below are common acceptance criteria utilized with this procedure:

- | | | |
|-----|------------------------|---|
| (a) | ASME Sec. I | Paragraph A-260.4 - <i>Power Boilers</i> |
| (b) | ASME Sec. VIII, Div. I | Appendix 6, Paragraph 6-4 - <i>Pressure Vessels</i> |
| (c) | ASME B.31.1 | Paragraph 136.4.3 (b)- <i>Power Piping</i> |
| (d) | ASME B.31.3 | Table 341.3.2 - <i>Process Piping</i> |

13.0 DOCUMENTATION & REPORTING

A report of the examinations shall be made and include at a minimum the following:

- 13.1 Client name
- 13.2 Job number or contract number
- 13.3 Date of the examination
- 13.4 Procedure & technique identification and revision number
- 13.5 Material and thickness
- 13.6 Magnetic particle equipment and current type
- 13.7 Magnetic particle (visible or fluorescent, wet or dry)
- 13.8 Examination personnel identity & qualification level
- 13.9 Lighting equipment
- 13.10 Map or record of indication -- rejectable indications shall at a minimum document:
 - (a) type as linear or rounded
 - (b) location
 - (c) length and/or diameter
 - (d) characterization

Note: Acceptable reports are detailed in Figure 13.0

14.0 NON CONFORMANCE

If the technician is unable to perform operations stated in this procedure due to unforeseen circumstances they shall contact his supervisor for guidance. Any procedural change shall be documented, approved and signed by the client. Any non-conformance shall be documented on the final report.

Figure 13.0 – Acceptable Reports

<p>P.O.Box 736 Grande Prairie, AB. T8V 3R5 Fax # 780 539.1777 PH # 780 539.0000</p>		<p>Magnetic Particle Inspection</p>
---	--	---

<p>Client: Location: Item Inspected: Acceptance Code: Material Type: Magnetizing Equipment: Method of Magnetization: Blacklight: Background Contrast: Magnetic Particles: Visible Light Aid:</p>	<p>Date: Job #: Procedure Technique: Material Thickness: Manufacturer: Cal. Date: Surface Condition: Manufacturer: Manufacturer:</p>	<p>Type: Type:</p>
<p>Job Scope:</p>		
<p>Inspection Results:</p>		
<p>Reference Pictures:</p>		
<p>Inspection Performed By: Certification Level:</p>		

Magnetic Particle Technique #1 / Wet Black on White Colour Contrast	
Technique Description	<ul style="list-style-type: none">• Wet Black on White Colour Contrast
Specification	<ul style="list-style-type: none">• ASME Section V, Article 7
Material	<ul style="list-style-type: none">• Carbon steel or other ferrous material
Surface Condition	<ul style="list-style-type: none">• As-welded, as-rolled, as-cast, or as forged
Particle Type	<ul style="list-style-type: none">• Visible / Wet
Particle Suspension	<ul style="list-style-type: none">• Light oil / Aerosol can
Particle Color	<ul style="list-style-type: none">• Black
Magnetizing Current	<ul style="list-style-type: none">• AC yoke – minimum 4.5Kg (10 lb) lifting force
Magnetizing Field	<ul style="list-style-type: none">• Continuous
Yoke Leg Spacing	<ul style="list-style-type: none">• Maximum spacing of 240mm (10")
Contrast Background Required	<ul style="list-style-type: none">• Yes
Equipment	<ul style="list-style-type: none">• AC current yoke• Approved white contrasting background aid - aerosol can• Approved black magnetic suspension - aerosol can• Lint free rags or absorbent towels• Ruler• Approved Light Source
Temperature Range	<ul style="list-style-type: none">• 4°C (40°F) minimum / 60°C (140°F) maximum
Lighting Type	<ul style="list-style-type: none">• Visible
Lighting Requirement	<ul style="list-style-type: none">• 1000 lux (100 fc) at the surface of the component
Acceptance Criteria	<ul style="list-style-type: none">• As per referencing Code
Reporting	<ul style="list-style-type: none">• As per 13.0 of this procedure
Post Cleaning	<ul style="list-style-type: none">• By client request only
Demagnetization Required	<ul style="list-style-type: none">• By client request only

Magnetic Particle Technique #2 / Dry Colour Contrast	
Technique Description	<ul style="list-style-type: none"> • Dry Colour Contrast
Specification	<ul style="list-style-type: none"> • ASME Section V, Article 7
Material	<ul style="list-style-type: none"> • Carbon Steel or other ferrous material
Surface Condition	<ul style="list-style-type: none"> • As-welded, as-rolled, as-cast, or as forged
Particle Type	<ul style="list-style-type: none"> • Visible / Dry
Particle Suspension	<ul style="list-style-type: none"> • None
Particle Color	<ul style="list-style-type: none"> • Yellow, Red or Grey (Grey is only to be used with contrasting background)
Magnetizing Current	<ul style="list-style-type: none"> • AC Yoke – minimum 4.5Kg (10 lb) lifting force
Magnetizing Field	<ul style="list-style-type: none"> • Continuous
Yoke Leg Spacing	<ul style="list-style-type: none"> • Maximum spacing of 240mm (10")
Contrast Background Required	<ul style="list-style-type: none"> • No
Equipment	<ul style="list-style-type: none"> • AC current yoke • Dry Powder • Dry Powder Puffer • Lint free rags or absorbent towels • Ruler • Approved Light Source
Temperature Range	<ul style="list-style-type: none"> • -20°C (-4°F) minimum / 260°C (500°F) maximum
Lighting Type	<ul style="list-style-type: none"> • Visible
Lighting Requirement	<ul style="list-style-type: none"> • 1000 lux (100 fc) at the surface of the component
Acceptance Criteria	<ul style="list-style-type: none"> • As per referencing Code
Reporting	<ul style="list-style-type: none"> • As per 13.0 of this procedure
Post Cleaning	<ul style="list-style-type: none"> • By client request only
Demagnetization Required	<ul style="list-style-type: none"> • By client request only

Magnetic Particle Technique #3 / Wet Fluorescent	
Technique Description	<ul style="list-style-type: none">• Wet Fluorescent
Specification	<ul style="list-style-type: none">• ASME Section V, Article 7
Material	<ul style="list-style-type: none">• Carbon steel or other ferrous material
Surface Condition	<ul style="list-style-type: none">• As-welded, as-rolled, as-cast, or as forged
Particle Type	<ul style="list-style-type: none">• Fluorescent / Wet
Particle Suspension	<ul style="list-style-type: none">• Light oil / Aerosol can
Particle Color	<ul style="list-style-type: none">• Fluorescent
Magnetizing Current	<ul style="list-style-type: none">• AC yoke – minimum 4.5Kg (10 lb) lifting force
Magnetizing Field	<ul style="list-style-type: none">• Continuous
Yoke Leg Spacing	<ul style="list-style-type: none">• Maximum spacing of 240mm (10")
Contrast Background Required	<ul style="list-style-type: none">• No
Equipment	<ul style="list-style-type: none">• AC current yoke• Spectorline ultraviolet lamp• Spectorline ultraviolet light meter• Approved fluorescent suspension - aerosol can• Lint free rags or absorbent towels• Ruler or measuring device
Temperature Range	<ul style="list-style-type: none">• 4°C (40°F) minimum / 60°C (140°F) maximum
Lighting Type	<ul style="list-style-type: none">• Ultraviolet
Lighting Requirement	<ul style="list-style-type: none">• 1000 $\mu\text{W}/\text{cm}^2$ at the surface of the component
Acceptance Criteria	<ul style="list-style-type: none">• As per referencing Code
Reporting	<ul style="list-style-type: none">• As per 13.0 of this procedure
Post Cleaning	<ul style="list-style-type: none">• By client request only
Demagnetization Required	<ul style="list-style-type: none">• By client request only

*Revised
03 March 2014*

HEAT TREATMENT PROCEDURE
FURNACE POST WELD HEAT TREATMENT



HEAT TREATMENT PROCEDURE

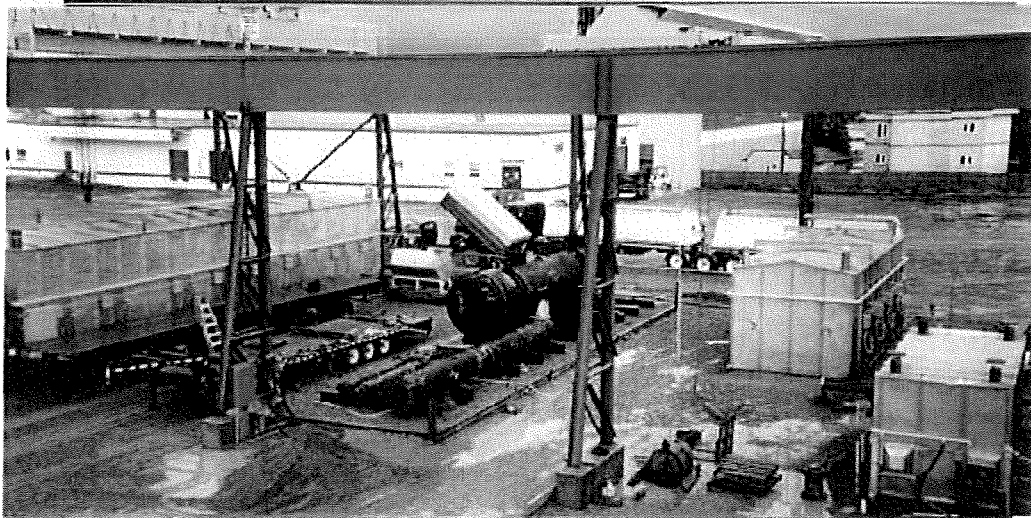
FURNACE POST WELD HEAT TREATMENT



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*Extra Large Furnace 60' x 13' x 13' High	◆ 60 Tons plus Loading Facilities
*Large Furnace 29' x 9' x 10' High	◆ Computerized Controllers
Medium Furnace 14' x 6' x 8' High	◆ Strip Chart with Each Furnace Load
Small Furnace 6' x 6' x 4' High	◆ Recorder Certification Quarterly
*Furnaces have dual loading beds	Mobile Units for On-Site Heat Treating also available - Call for Details

HEAT TREATMENT PROCEDURE
FURNACE POST WELD HEAT TREATMENT

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Section 1	Introduction to Continental Stress Furnace Division
Section 2	Statement of Authority
Section 3	Equipment
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Section 6	Furnace Testing
Section 7	Non-Conformance
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Section 9	Documentation, Charts and Forms

*Revised
03 March 2014*

HEAT TREATMENT PROCEDURE
FURNACE POST WELD HEAT TREATMENT



SECTION 1

INTRODUCTION

HEAT TREATMENT PROCEDURE

FURNACE POST WELD HEAT TREATMENT

AN INTRODUCTION TO

CONTINENTAL STRESS RELIEVING SERVICES LTD. (CALGARY)

Continental Stress Relieving was formed in the beginning of 1981 to provide furnace heat treating services in the Calgary, Alberta area.

These services are provided with four (4) different sized Heat Treating Furnaces as follows:

- ☆ **Coupon Furnace:** 6' x 4' x 4' High
- Small Furnace:** 14' x 6' x 8' High
- ** **Large Furnace:** 29' x 9' x 10' High
- ** **Ex-Large Furnace:** 60' x 13' x 13' High

- ☆ *Specialized Furnace with removable door for U-Bundle capabilities*
- ** *Have dual (2) loading beds*

The furnaces are Natural Gas Fired with fan controlled burners, located in an off-set manner on each furnace to ensure proper air movement, which ensures equal heating.

The furnace temperatures are monitored using Multi-Point Stamp type self-calibrating for ambient temperature and external resistance recorders. Documented strip charts are supplied with each furnace load. All temperatures are in "Celsius" degrees.

The following is a list of some of the clients that Continental Stress Relieving has provided heat treating for:

Propak Systems Ltd.

Strike Energy Services Inc.

Metro Machine Works Ltd.

Superior Pressure Vessels Inc.

Suncor Energy Inc.

Rostel Industries Ltd.

Devon Canada Ltd.

Ideal Welders Ltd.

Plains Fabrication & Supply

Tara Oilfield Services Ltd.

Shell Canada Energy

Clemro Industries Ltd.

Enerflex Systems Ltd.

Opsco Energy Industries Ltd.

Calhex Industries Ltd.

Foremost Industries LP

HEAT TREATMENT PROCEDURE
FURNACE POST WELD HEAT TREATMENT



SECTION 2

STATEMENT OF AUTHORITY

HEAT TREATMENT PROCEDURE
FURNACE POST WELD HEAT TREATMENT

STATEMENT OF AUTHORITY

It is the policy of Continental Stress Relieving to maintain and implement Quality procedures that meet the requirements of the applicable codes or that meet the performance requirements of our contracts.

Quality control is implemented throughout the training program and through follow-up by the Quality Control Manager who is ultimately responsible for the quality control and has the training and authority to initiate, recommend and provide solutions to any quality control problems and/or issues.

The recommended Heat Cycles are basically within the guidelines set by the American Society of Mechanical Engineers (ASME) and the American National Standards Institute (ANSI).

The stated procedures in this manual are strictly enforced by the President and the Quality Control Manager.

S. Huegler-Williksen
S. Huegler-Williksen

January 01, 2012
Date:

HEAT TREATMENT PROCEDURE
FURNACE POST WELD HEAT TREATMENT



SECTION 3

EQUIPMENT

HEAT TREATMENT PROCEDURE
FURNACE POST WELD HEAT TREATMENT

EQUIPMENT USED FOR
FURNACE HEAT TREATING

1. **FURNACES:**

Furnaces are fabricated from Stainless Steel in the top-hat design and are insulated on the inside with six (6) inches x eight (8) pound density insulation. All furnaces have deflector plates installed at the location of the burners to ensure that pieces being heat treated are protected from a direct flame impingement. The furnace floors are uniform fire brick and/or sand base and come with twelve (12) inch I-Beam supports spaced at six (6) foot intervals and/or closer if required.

2. **BURNERS:**

Burners are natural gas fired, complete with fans to ensure proper air movement. They are also equipped with Flame –Fail Sensors to ensure proper ignition.

3. **CONTROLS & RECORDING SYSTEMS:**

Furnaces are controlled by a time / temperature process controller and each load is monitored by a strip chart recorder. Recording instruments are calibrated every six (6) months or sooner as per customer specification and also checked on a monthly basis. Recording chart speed is as per customer specification or two (2) inches (50 mm) and/or six (6) inches (150 mm) per hour. Temperature ranges are 0° to 1200° Celsius. Thermocouples are Type “K” Chromel Alumel.

HEAT TREATMENT PROCEDURE
FURNACE POST WELD HEAT TREATMENT



SECTION 4

HEAT TREATING PROCEDURES

HEAT TREATMENT PROCEDURE
FURNACE POST WELD HEAT TREATMENT

PROCEDURE FOR PROVIDING

POST WELD HEAT TREATING IN FURNACE

1. Obtain the following information from the Clients Quality Control Department:

Heat Treatment Instruction Sheet and/or Code Specification to be followed. ***
Material Composition, Wall Thickness and the Weight of the work piece.

*** If the client does not provide a Heat Treatment Instruction Sheet (Heat Cycle), the load will be heat treated in accordance with the ASME Code Section VIII, UW40, UCS 56 and a form will be sent to the client electronically and/or facsimile for approval.

2. Load the piece and/or pieces into the furnace and supported so that no movement or distortion occurs. Place the piece and/or pieces in a manner that ensures that there will be no direct flame impingement from the burners
3. Thermocouples are to be attached directly to the piece by the capacitor discharge flash contact method. The thermocouple reference point is to be fully insulated from the direct heat.

Thermocouples shall be located as follows; where one or more pressure vessel assemblies and/or pressure vessel parts and/or piping are to be Post Weld Heat Treated in one (1) furnace charge the thermocouples shall be placed on the vessels at each head, on the pipe at each end as well as one in the centre, (i.e. at the bottom left, at the centre and at the top right, or in the other zones of possible temperature variation so that the temperature indicated shall be true for all the vessels and/or parts in those zones unless additional locations have been specified by the client.

4. Protect all flange faces and machined surfaces from oxidation using Arcair Protex surface compound, as per customer specification and/or request.
5. Perform the Heat Treatment procedure and supply the client with a furnace work order and strip chart. The strip chart is to show the following information:
 - Date
 - Client and Client Reference Number
 - Material
 - Furnace Operators Name and Signature
 - Recorder Number
 - Work Piece ID Number
 - Chart Speed with the Soak / Hold Time Identified

HEAT TREATMENT PROCEDURE
FURNACE POST WELD HEAT TREATMENT



SECTION 5

CALIBRATION PROGRAM

HEAT TREATMENT PROCEDURE
FURNACE POST WELD HEAT TREATMENT

CALIBRATION PROGRAM

All of Continental Stress Relieving furnace recorders are calibrated a minimum of once every six (6) months or more frequently if necessary to meet specific contract requirements.

Recorders are calibrated by REDING INSTRUMENTS. in Calgary, Alberta and Accutech Rentals Instrumentation & Services Ltd., or Kingsway Scientific and Industrial Instruments Ltd. in Edmonton, Alberta.

A bar chart is used by the Quality Control Manager to ensure that the program of calibration of each recorder is performed as per the scheduled date. When the service company completes a recorder, they place a sticker on the front window of the recorder showing the calibration due date. Continental Stress Relieving retains all original Certificates of Conformance and copies are sent with each strip chart for each furnace load.

When a recorder is brought in prior to the six (6) month period due to a mechanical problem, then the recorder is calibrated at that time and recorded on the Bar Chart and a new calibration due sticker is placed on the recorder front window. When a mechanical problem is found with a recorder, it is placed in a box and marked "Not for Use" and is immediately taken to the service company for repair and calibration. If a recorder is found to be out of calibration by more than 10°C, the service company is to immediately contact our Quality Control Manager who is to in turn follow up on the jobs that may have been completed with the recorder being out of calibration and would review the situation with the client. We have never in our past history had a recorder that was out of calibration by more than 5°C.

All mechanical thermocouples are made up of Chromel-Alumel wire with a fusion welded reference point. Also available is the Capacitor Discharge Flash Contact method which attaches directly to the work piece as a reference point (thermocouple wire Certificate of Conformance are available upon request).

The calibration of all standards and measuring instruments used in this calibration are traceable to the National Research Council of Canada in Ottawa or the National Bureau of Standards in Washington, DC.

HEAT TREATMENT PROCEDURE
FURNACE POST WELD HEAT TREATMENT



SECTION 6

FURNACE TESTING

HEAT TREATMENT PROCEDURE
FURNACE POST WELD HEAT TREATMENT

FURNACE TEST

Enclosed is a copy of a chart showing the temperatures attained in our Large Furnace.

Large Furnace:

The test heat cycle was run with three (3) thermocouples to check for equal heat distribution throughout the furnace.

The thermocouples were placed in the furnace in the following locations;

- One (1) thermocouple on each head of the vessel.
- One (1) thermocouple on the shell in the middle of the vessel.

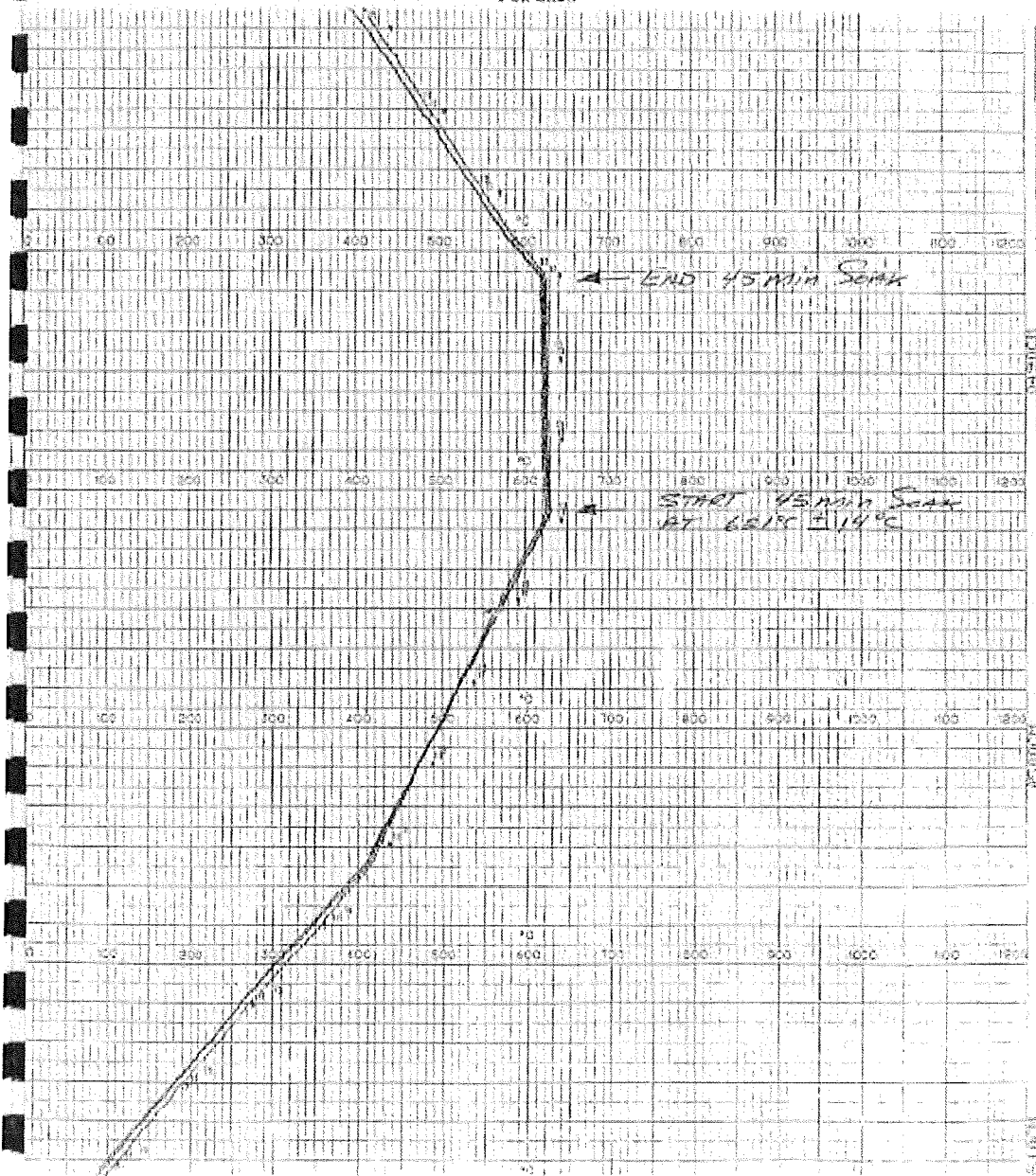
The test results show that the heat distribution throughout the furnace is well within all of the code requirements.

HEAT TREATMENT PROCEDURE

FURNACE POST WELD HEAT TREATMENT

"Large Furnace Heat Chart"

January 16, 2001 Large Furnace . 26' x 9' x 9'8" High
18,000 pounds Horizontal Vessel 72" Diameter x 23' Long, 1/2" Wall Thickness
3 Thermocouples attached as follows - 1 on each Head
1 on Shell



HEAT TREATMENT PROCEDURE
FURNACE POST WELD HEAT TREATMENT



SECTION 7

NON-CONFORMANCE

HEAT TREATMENT PROCEDURE
FURNACE POST WELD HEAT TREATMENT

NON- CONFORMANCE

Non-conformity is any condition which does not meet the Code and/or Client requirements and/or Specifications.

When non-conformity is found, the Quality Control Manager (Continental Stress) is to immediately stop the work, initiates an non-conformance report (NCR) and reports to the client / customer contact, further, the client / customer contact may initiate a non-conformance report (NCR) of their own and the disposition of this non-conformance (NCR) would be resolved by all parties. The agreed disposition would be noted on the non-conformance report (NCR) initiated by Continental Stress and at the time of completion of the disposition the non-conformance report (NCR) initiated by Continental Stress would be signed off by Continental Stress and the customer. The client / customer non-conformance (NCR) initiated when applicable, would be signed off at the time when the customer receives a signed copy of the completed non-conformance report (NCR) initiated by Continental Stress. The Quality Control Manager of Continental Stress is to keep the original copy.

HEAT TREATMENT PROCEDURE
FURNACE POST WELD HEAT TREATMENT

SAMPLE #4 NONCONFORMANCE REPORT

Issued to: _____ Date: _____
Plant/Location: _____ Equip/Line #: _____
Description: _____
cc: Job File _____

DESCRIPTION OF NONCONFORMANCE

Recommended: Scrap ___ Rework ___ Use as is ___

Inspector: _____
(print) (signature)

Disposition Required By Date: _____

PROPOSED DISPOSITION OF NONCONFORMANCE
(to be completed by addressee)

Name: _____ Date: _____
(print) (signature)

ACCEPTANCE OF PROPOSAL

Comments: _____

Cust. Required: Yes ___ No ___

QA Manager: _____ Date: _____
(print) (signature)

Cust. Insp.: _____ Date: _____
(print) (signature)

COMPLETION OF DISPOSITION

Action Taken: _____

Inspector: _____ Date: _____
(print) (signature)

FINAL SIGN OFF

QA Manager: _____ Date: _____

Cust. Insp.: _____ Date: _____

HEAT TREATMENT PROCEDURE
FURNACE POST WELD HEAT TREATMENT



SECTION 8

BRINELL HARDNESS TESTING

HEAT TREATMENT PROCEDURE
FURNACE POST WELD HEAT TREATMENT

BRINELL HARDNESS TESTING

Brinell Hardness Tests are performed by Continental Stress Relieving personnel only upon request from the client, who would state the location, method and number of tests to be performed.

HEAT TREATMENT PROCEDURE
FURNACE POST WELD HEAT TREATMENT



SECTION 9

DOCUMENTATION, CHARTS and FORMS

HEAT TREATMENT PROCEDURE
FURNACE POST WELD HEAT TREATMENT

DOCUMENTATION, CHARTS and FORMS

The following are examples of documents used:

- Furnace Work Order / Quotation Sheet
- Chart Information Sticker
- Brinell Hardness Report
- Heat Cycle Standardization & Celsius / Fahrenheit Conversion Temperatures
- Pipe Wall Thickness ASA B36 10-1959
- Temperature Conversion Table

HEAT TREATMENT PROCEDURE

FURNACE POST WELD HEAT TREATMENT



318 Monument Place SE
 Calgary Alberta T1Y 2J6
 Telephone: (403) 273 - 5105
 Fax: (403) 248 - 6497
 Email: calgary@continentalstress.com

Furnace Work Order

Client: _____ Date: _____
 Address: _____ Owning Company: _____
 Attention: _____ Date Required: _____
 Phone: _____ Client Reference: _____
 Fax: _____ Purchase Order: _____
 Email: _____ Furnace Work Order #: _____

Description	Quantity

Total Overtime Hours = _____ @ _____ Per Hour = _____
 Furnace Number _____ Furnace Charges: _____
 Other Charges(s): _____
 COST: _____
 GST: _____
 TOTAL COST: _____

Heat Cycle
(In Degrees Celsius)

Material: _____ Code: _____
 Heat from Ambient to _____ at a Moderate Rate.
 Heat from _____ to _____ at _____ per Hour Maximum
 Soak at _____ +/- _____ for _____ Hours.
 Cool to _____ at _____ per Hour Maximum
 Cool from _____ to _____ at _____ per Hour Maximum
 From _____ Air Cool In furnace.

Comments:

- NOTE: 1. An extra charge will apply for any additional supporting or blocking if required.
 2. Customer will not hold Continental Stress Relieving Services Ltd. responsible for any damage of distortion caused by heat treatment process.

Thank you for the opportunity of quoting.
 Continental Stress Relieving Services Ltd.

Name: _____ Signed: _____

HEAT TREATMENT PROCEDURE
FURNACE POST WELD HEAT TREATMENT

CONTINENTAL STRESS RELIEVING SERVICES LTD.
Telephone: 403-273-5105

Date: _____

Client: _____

Owning Co.: _____

Chart Speed: _____

Material: _____

Procedure: _____

Furnace Load #: _____

Client Job #: _____

P.O. #: _____

Comments: _____

Operator Name: _____

Operator Signature: _____

Temperature in °C: _____ Recorder #: _____

HEAT TREATMENT PROCEDURE

FURNACE POST WELD HEAT TREATMENT

HEAT CYCLE STANDARDIZATION and FAHRENHEIT / CELSIUS TEMPERATURE CONVERSION

MATERIAL COMPOSITION	P-NO	TRANSFORMATION TEMP.	REC'D MIN. PREHEAT TEMP.	HEATING RATE / HR. PER INCH OVER 800°F/425°C	HOLD TEMP.	HOLD. TIME HRS / INCH	MIN. HOLD TIME HRS	COOLING RATE HR PER INCH TO 800°F/425°	REC'D MAX. FINAL BRINELL HARDNESS
CARBON STEEL (P1)	1	1333°F 722°C	60°F 16°C	400°F 222°C	1150°F 620°C	1	1	500°F 278°C	200
CARBON ½ Moly (P3)	3	1340°F 727°C	60°F 16°C	400°F 222°C	1200°F 650°C	1	1	500°F 278°	225
1¼ CHROME 1 MOLY (P4)	4	1480°F 805°C	300°F 150°C	400°F 222°C	1350°F 732°C	1	2	400°F 278°C	225
2¼ CHROME 1 MOLY (P5A)	5	1480°F 805°C	400°F 205°C	400°F 222°C	1400°F 760°C	1	2	400°F 278°C	241
5% CHROME ½ MOLY (P5B)	5	1505°F 818°C	500°F 260°C	400°F 222°C	1400°F 760°C	1	2	400°F 278°C	241
7% CHROME ½ MOLY (P5B)	5	1520°F 827°C	500°F 260°C	400°F 222°C	1400°F 760°C	1	2	400°F 278°C	241
9% CHROME 1 MOLY (P5B)	5	1490°F 810°C	500°F 260°C	400°F 222°C	1400°F 760°C	1	2	400°F 278°C	241

C = 5 / 9 (F - 32) ± 25 °F = ± 14 °C
 F = 9 / 5 (C + 32) ± 50 °F = ± 28 °C

HEAT TREATMENT PROCEDURE

FURNACE POST WELD HEAT TREATMENT

9.04 PIPE WALL THICKNESS ASA B36 10-1959

Nominal Pipe Size	O.D.	STD.	XS	XXS	20	30	40	60	80	100	120	140	160
½	.840	.109	.147	.294			.109		.147				.188
1	1.315	.133	.179	.358			.133		.179				.250
2	2.375	.154	.218	.436			.154		.218				.344
3	3.500	.216	.300	.600			.216		.300				.438
4	4.500	.237	.337	.674			.237		.337		.438		.531
5	5.563	.258	.375	.750			.258		.375		.500		.625
6	6.625	.280	.432	.864			.280		.432		.562		.719
8	8.625	.322	.500	.875	.250	.277	.322	.406	.500	.594	.719	.812	.906
10	10.750	.365	.500	1.000	.250	.307	.365	.500	.594	.719	.844	1.000	1.125
12	12.750	.375	.500	1.000	.250	.330	.406	.562	.688	.844	1.000	1.125	1.312
14	*	**	**		.312	.375	.438	.594	.750	.938	1.094	1.250	1.406
16					.312	.375	.500	.656	.844	1.031	1.375	1.438	1.594
18					.312	.438	.562	.750	.938	1.156	1.365	1.562	1.781
20	*	**	**		.375	.500	.594	.812	1.031	1.281	1.500	1.750	1.969
22					.375	.500	.688	.875	1.125	1.375	1.625	1.874	2.125
24					.375	.562	.688	.969	1.219	1.531	1.812	2.062	2.344
26	*	**	**		.500	.625							
28					.500	.625							
30					.500	.625							
32	*	**	**		.500	.625	.688						
34					.500	.625	.688						
36					.500	.625	.750						
42					.500	.625	.750						

* As Nominal Pipe Size ** As for 12"

HEAT TREATMENT PROCEDURE

FURNACE POST WELD HEAT TREATMENT

Temperature Conversion Table

To convert temperature reading shown in center column,
read right-hand column for Fahrenheit, left-hand column for Celsius.

C	F	C	F	C	F	C	F	C	F	C	F	C	F
-129	-200	177	350	662	571	1060	1940	966	1770	3218	1360	2480	4496
-118	-180	182	360	680	577	1070	1958	971	1780	3236	1366	2490	4514
-107	-160	188	370	698	582	1080	1976	977	1790	3254	1371	2500	4532
-95.6	-140	193	380	716	588	1090	1994	982	1800	3272	1377	2510	4550
-84.4	-120	199	390	734	593	1100	2012	988	1810	3290	1382	2520	4568
-73.3	-100	204	400	752	599	1110	2030	993	1820	3308	1388	2530	4586
-70.6	-95	210	410	770	604	1120	2048	999	1830	3326	1393	2540	4604
-67.8	-90	216	420	788	610	1130	2066	1004	1840	3344	1399	2550	4622
-65.0	-85	221	430	806	616	1140	2084	1010	1850	3362	1404	2560	4640
-62.2	-80	227	440	824	621	1150	2102	1016	1860	3380	1410	2570	4658
-59.5	-75	232	450	842	627	1160	2120	1021	1870	3398	1416	2580	4676
-56.7	-70	238	460	860	632	1170	2138	1027	1880	3416	1421	2590	4694
-53.9	-65	243	470	878	638	1180	2156	1032	1890	3434	1427	2600	4712
-51.1	-60	249	480	896	643	1190	2174	1038	1900	3452	1432	2610	4730
-48.3	-55	254	490	914	649	1200	2192	1043	1910	3470	1438	2620	4748
-45.6	-50	260	500	932	654	1210	2210	1049	1920	3488	1443	2630	4766
-42.8	-45	266	510	950	660	1220	2228	1054	1930	3506	1449	2640	4784
-40.0	-40	271	520	968	666	1230	2246	1060	1940	3524	1454	2650	4802
-37.2	-35	277	530	986	671	1240	2264	1066	1950	3542	1460	2660	4820
-34.4	-30	282	540	1004	677	1250	2282	1071	1960	3560	1466	2670	4838
-31.7	-25	288	550	1022	682	1260	2300	1077	1970	3578	1471	2680	4856
-28.9	-20	293	560	1040	688	1270	2318	1082	1980	3596	1477	2690	4874
-26.1	-15	299	570	1058	693	1280	2336	1088	1990	3614	1482	2700	4892
-23.3	-10	304	580	1076	699	1290	2354	1093	2000	3632	1488	2710	4910
-20.6	-5	310	590	1094	704	1300	2372	1099	2010	3650	1493	2720	4928
-17.8	0	316	600	1112	710	1310	2390	1104	2020	3668	1499	2730	4946
-15.0	+5	321	610	1130	716	1320	2408	1110	2030	3686	1504	2740	4964

HEAT TREATMENT PROCEDURE

FURNACE POST WELD HEAT TREATMENT

-12.2	+10	+50	327	620	1148	721	1330	2426	1116	2040	3704	1510	2750	4982
-9.44	+15	+59	332	630	1166	727	1340	2444	1121	2050	3722	1516	2760	5000
-6.67	+20	+68	338	640	1184	732	1350	2462	1127	2060	3740	1521	2770	5018
-3.89	+25	+77	343	650	1202	738	1360	2480	1132	2070	3758	1527	2780	5036
-1.11	+30	+86	349	660	1220	743	1370	2498	1138	2080	3776	1532	2790	5054
1.67	+35	+95	354	670	1238	749	1380	2515	1143	2090	3794	1538	2800	5072
4.44	40	104	360	680	1256	754	1390	2534	1149	2100	3812	1543	2810	5090
7.22	45	113	366	690	1274	760	1400	2552	1154	2110	3830	1549	2820	5108
10.0	50	122	371	700	1292	766	1410	2570	1160	2120	3848	1554	2830	5126
12.8	55	131	377	710	1310	771	1420	2588	1166	2130	3866	1560	2840	5144
15.6	60	140	382	720	1328	777	1430	2606	1171	2140	3884	1566	2850	5162
18.3	65	149	388	730	1346	782	1440	2624	1777	2150	3902	1571	2860	5180
21.1	70	158	393	740	1364	788	1450	2642	1182	2160	3920	1577	2870	5198
23.9	75	167	399	750	1382	793	1460	2660	1188	2170	3938	1582	2880	5216
26.7	80	176	404	760	1400	799	1470	2678	1193	2180	3956	1588	2890	5234
29.4	85	185	410	770	1418	804	1480	2696	1199	2190	3974	1593	2900	5252
32.2	90	194	416	780	1436	810	1490	2714	1204	2200	3992	1599	2910	5270
35.0	95	203	421	790	1454	818	1500	2732	1210	2210	4010	1604	2920	5288
38	100	212	427	800	1472	821	1510	2750	1216	2220	4028	1610	2930	5306
43	110	230	432	810	1490	827	1520	2768	1221	2230	4046	1616	2940	5324
49	120	248	438	820	1508	832	1530	2786	1227	2240	4064	1621	2950	5342
54	130	266	443	830	1526	838	1540	2804	1230	2250	4082	1627	2960	5360
60	140	284	449	840	1544	843	1550	2822	1238	2260	4100	1632	2970	5378
66	150	302	454	850	1562	849	1560	2840	1243	2270	4118	1638	2980	5396
71	160	320	460	860	1580	854	1570	2858	1249	2280	4136	1643	2990	5414
77	170	338	466	870	1598	860	1580	2876	1254	2290	4154	1649	3000	5432
82	180	356	471	880	1616	866	1590	2894	1260	2300	4172	1654	3010	5450

DOCUMENT FRONT SHEET

PURCHASERS NAME	National Process Equipment
PURCHASE ORDER NO	PUR630248
EXHEAT REFERENCE	041167
SDR DOCUMENT NO	WI.09.110
CLIENT DOCUMENT NO	
DOCUMENT TITLE	Hydrostatic Test Procedure - Heater

Doc Num	Revision	Issue	Date	Initials	Supplier's Approval Signature	Approval By
H03	1	1	03/07/2014	RDav		17/07/2014

To be filled by the reviewer of this document prior to its return

Tick Box	Code	Status	Description
<input type="checkbox"/>	E1	Approved	Approval given, no comments, final issue.
<input type="checkbox"/>	E2	Approved to Proceed	Approval given for work to proceed with document to be submitted as Final Issue providing comments are incorporated
<input type="checkbox"/>	E3	Not Approved	Document rejected and must be re-submitted with incorporation of comments. Work may NOT proceed
<input type="checkbox"/>	E4	Information Only	No comments made or approval given, for information purposes only.
<input type="checkbox"/>	E5	As-Built	Approval given for work to proceed provided comments incorporated in As-Built revision.

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2

COMMENTS

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WI/09/110

Hydrostatic Pressure Testing Procedure

1.0 Purpose

- 1.1 To detect the presence of leaks.
- 1.2 To prove that the equipment under test can withstand internal or external pressure without structural failure or permanent deformation.
- 1.3 To prove the effectiveness of sealing arrangements.

2.0 Scope

- 2.1 This procedure shall apply to all hydrostatic testing carried out by the Company.
- 2.2 Test Method 1 - Hydrostatic pressure applied to all immersed surfaces.
- 2.3 Test Method 2 - Hydrostatic pressure applied internally to an enclosure.

3.0 References

For specific contract and standard requirements, refer to the assembly drawing of the equipment on test.

4.0 Definitions

Not applicable.

5.0 Procedure

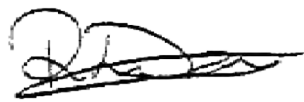
- 5.1 All pressure gauges used for hydrostatic testing shall be calibrated.
 - 5.1.1 2 pressure gauges shall be used for hydrostatic testing.
- 5.2 All connections to be blanked off using blank flanges and suitable gaskets and full quantity of bolting.
- 5.3 On filling, the test or service vessel shall be adequately vented from its highest point to ensure removal of all air.
- 5.4 The water temperature shall not be below 7°C.
- 5.5 The pressure shall be applied gradually until the specified test pressure is reached.
- 5.6 At no stage shall the equipment on test be approached for close inspection until the pressure has been reduced to a lower level than that previously attained.
- 5.7 The specified test pressure shall be maintained for the period specified on the drawing or certification documents.
- 5.8 After inspection the pressure will be gradually reduced to atmospheric.
- 5.9 Adequate venting shall be ensured before draining.
- 5.10 After draining, the equipment will be cleaned, dried and inspected.
- 5.11 The results shall be recorded in a test log and a test certificate (see attachment 6.1) issued where required by client.

6.0 Documentation

- 6.1 Attachment 6.1 Hydrostatic Test Certificate

DOCUMENT FRONT SHEET

PURCHASERS NAME	National Process Equipment
PURCHASE ORDER NO	PUR630251
EXHEAT REFERENCE	041168
SDR DOCUMENT NO	041168.VESSHYDRO
CLIENT DOCUMENT NO	
DOCUMENT TITLE	Vessel Hydrostatic Test Procedure

Doc Num	Revision	Issue	Date	Initials	Supplier's Approval Signature	Approval By
H04	1	1	25/09/2014	RDav		09/10/2014

To be filled by the reviewer of this document prior to its return

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<input type="checkbox"/>	E4	Information Only	No comments made or approval given, for information purposes only.
<input type="checkbox"/>	E5	As-Built	Approval given for work to proceed provided comments incorporated in As-Built revision.

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BS EN ISO 9001:2008 Quality Management System

Level 3 Works Instruction - Document Number VQ0018

Hydrostatic Pressure Testing

Revision Status

Rev	Description	App'd	Date
0	First issue	JVD	8/3/07
1	Review / Update	JVD	1/3/09
2	Update	MVD	17/09/14

If during the use or review of this document, a need for amendment is identified, any employee of Vessco Engineering Limited may make the request using this form. Please complete the form and pass to the Managing Director, Vessco Engineering Limited.

Amendment and Reason

Print name

Date

Contents

Section 1	Scope
Section 2	Equipment
Section 3	Personal Protective Equipment
Section 4	Test Pressure
Section 5	Procedure
Appendix A	Typical Hydraulic Test Assembly
	Employee Acknowledgement

1. Scope

- 1.1. Applies to all pressure testing of pressure vessels using water as the test medium.

2. Equipment

- 2.1. Hydraulic test pump bucket.
- 2.2. Calibrated gauge. This must be within 12 months of its last calibration. Select the gauge such that the test pressure is between 20% and 80% of its full scale.
- 2.3. Bolting must be high tensile, the correct size, with all bolt holes used.
- 2.4. Test flanges should be standard supply of the correct size and rating. Manufactured flanges should be produced in line with the dimensions of the equivalent standard flange.
- 2.5. Hoses and fittings must be in good condition, any obvious damage must be reported to the line manager immediately.

3. Personal Protective Equipment

- 3.1. Overalls, safety boots, and full-face visor.

4. Test Pressure

- 4.1. New build test pressures are determined by the greatest of the design code or PED (where applicable).
- 4.2. Hydrotest pressure is stated on the specific vessel GA drawing – VQ0510 & VQ0513 respectively.

6" shell line heater: 12909 KPa.g
10" shell line heater: 12909 KPa.g

5. Procedure

5.1. Assembly and filling. Potable water shall be used.

- 5.1.1. Determine which connections will be used for filling and venting.
- 5.1.2. Fit all test flanges, blinds, plugs, etc, ensuring all bolting and threaded connections are secure and of the correct size and specification.
- 5.1.3. The test bucket / filling components should be assembled as the sketch in appendix A, to allow filling and draining.
- 5.1.4. The assembly must be checked by, and a competent person experienced in hydraulic pressure testing must perform the following steps.
- 5.1.5. With the water supply connected and valve A and B open (valve C closed), proceed to fill the equipment being tested. Whilst reducing and controlling the water supply, ensure the unit is fully vented, moving and orienting if necessary to eliminate all potential air pockets. Finite filling can be achieved using the test bucket once the water supply has been isolated.

5.1.6. Isolate valve B and turn off the supply.

5.1.7. Securely blank off the vent connection once bled / vented.

5.2. Safety of others.

5.2.1. Before any pressure test takes place, advise others in the area local to the test area, vacate where possible. Place red/white tape around the hydrotest area and place signage in prominent position.

5.3. Proof test.

5.3.1. Slowly increase the pressure to 2 barg, pause and inspect for leaks.

5.3.2. If there is evidence of leakage, identify the area for remedy and take off test (as 5.4.8). Otherwise proceed with full test.

5.4. Full test.

5.4.1. Slowly increase to 50% of the final test pressure, pause and inspect for leaks.

5.4.2. If all is ok at 50%, slowly increase to the full test pressure and isolate valve A.

5.4.3. Inspect for leaks, and if sound leave for the test period. Hydrotest will take place for **1 hour** minimum.

5.4.4. After the test period, check that the test is still sound.

5.4.5. The final test is to be witnessed by another competent person.

5.4.6. Record the actual test pressure on the works instructions, with both the tester and the witness signing and dating the document.

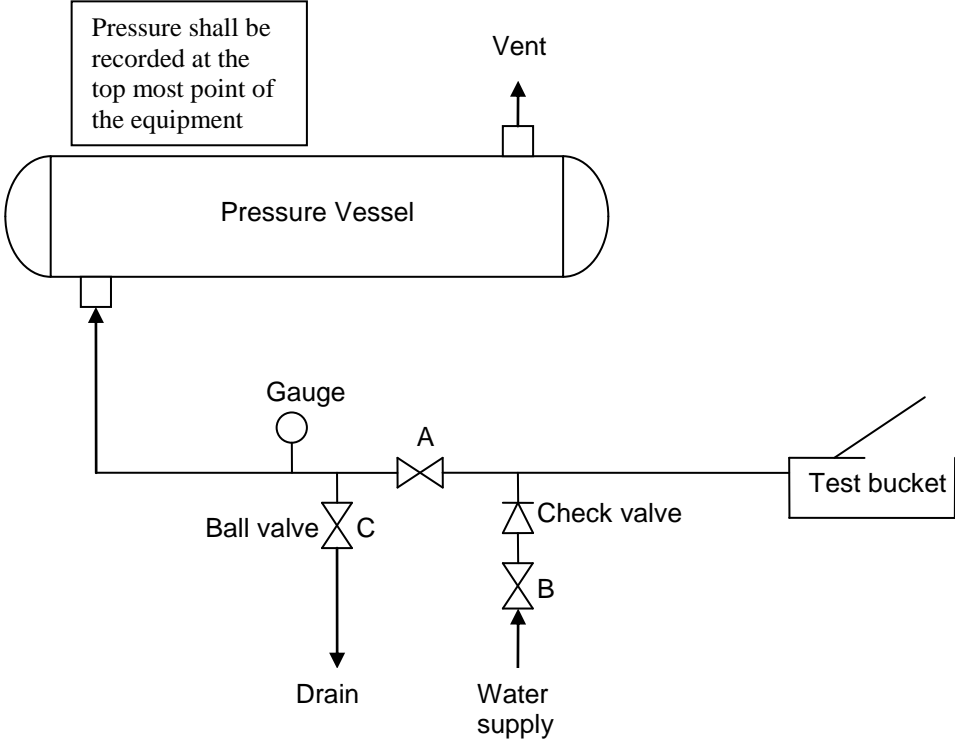
5.4.7. Also record the gauge Equipment Number.

5.4.8. Slowly open the isolation valve C, releasing the pressure to drain.

5.4.9. Fully drain the unit, carefully dismantle the test assembly and return items to their correct place of storage.

5.4.10. After hydrotest the equipment shall be dried with the continuous blow of hot air not more than 66°C. Humidity of the outgoing air to be checked to ensure the complete dryness of the equipment.

Appendix A - Typical Hydraulic Test Assembly





Standard Leak Test Procedure

Pneumatic leak testing performed by National Process Equipment shall be completed as per the following procedure.

1.0 Limitations of Procedure

- 1.1 Leak test shall not be performed if volume of air in the test system is greater than one cubic foot.
- 1.2 Test pressure shall not exceed 110 percent of test system design pressure or 25 PSIG, which ever is the lesser value.
- 1.3 Testing shall not be performed on any system stored in temperatures below -10°C unless system enclosure has been preheated to ensure system ambient temperature is within an acceptable range.

2.0 Testing Procedure

- 2.1 Prior to test the Quality Control Manager shall notify the Owner’s Inspector when any Leak Testing is to be conducted and complete a Pressure Test Report Form (QAF-036e).
- 2.2 All open connections shall be closed using proper test covers, fittings and gaskets where applicable.
- 2.3 Testing of the joints shall be performed using Snoop.
- 2.4 Testing –
 - A) Gradually increase pressure until system pressure reaches ½ the test pressure or 25 PSIG, which ever is the lesser value.
 - B) Once system has stabilized, perform a preliminary check of all possible leak sources. Mark all leaks for repair.
 - C) Depressurize gradually and repair all leaks found. Repeat leak test steps **A** and **B** until no leaks are detected.
 - D) Gradually increase pressure to 25 PSIG or 110 percent of test system design pressure, which ever is the lesser value.
 - E) Hold pressure for a minimum of 15 minutes and perform a final test of all possible leak sources. If a leak is detected at any time; the leak is to be marked, the system safely depressurized, the leak repaired and test begun again (return to step A).
 - F) If no leaks are detected, the test is successfully completed. Gradually depressurize system until atmospheric pressure is reached.

3.0 Reporting Procedure

- 3.1 The Quality Control Manager or designate, and the Owner’s Inspector shall sign the pressure test report (Form QAF-036e) stating that they have witnessed and accepted the test.

FORM # QAP-033C	LEAK TEST PROCEDURE	REV # 3	DATE Sep 22/14	ORIGINATOR QA	REVIEW SERVICE/ PRODUCTION	APPROVAL SM
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Shell Canada Energy
Carmon Creek CMT
NG Pressure Reduction
Factory Acceptance Test Plan and Protocol

Project Tag: 0735A-08030

Rev. 0

1 October, 2015

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1. Test Protocol

1.1 Introduction

This document outlines the Factory Acceptance Test, and includes what tests are to be performed, the procedure for carrying out each test, the expected results of each test, and verification that each test has been performed as outlined.

1.2 Scope

This FAT Procedure covers the following components:

- Physical and Electrical Control Panel Inspections
- Instrumentation Power and Configuration
- SIL Safety Functions
- PLC Control System Logic Functions

This FAT is designed to ensure electrical and software compliance and safety in regards to the PLC and SIL units. It also insures compliance and completeness in respect to control cabinet wiring, grounding, and labelling.

1.3 Roles and Responsibilities

Each test will have a Lead Technician responsible for performing the test. It is the responsibility of the Lead to understand how each test is to be performed and carried out.

Required Technicians are to assist the Lead in completing each test.

Witness is required to verify that each test is completed in a satisfactory manner.

Technician roles vary from test to test, as listed below:

Section	Name	Lead Technician	Required Technicians
2	Panel Inspection	Electrical Technician	
3	Control Panel Ground Testing	Electrical Technician	
4	PDP-21620 (600 VAC Power Distribution)	Electrical Technician	
5	LPN-21620 (120/208 VAC Power Distribution)	Electrical Technician	
6	Control Panel Power Distribution	Electrical Technician	
7	Control Panel Start-Up	Electrical Technician	
8	PLC Start-Up	PLC Technician	Electrical Technician
9	PLC Inspection	PLC Technician	
10	HMI Inspection	PLC Technician	
11	Discrete IO	PLC Technician	Electrical Technician
12	Analog IO	PLC Technician	Electrical Technician/ Instrument Technician
13	Data Transfer Points	PLC Technician	
14-19	Function Test	PLC Technician	Electrical Technician

1.4 Equipment Required

The following equipment is required for this FAT

- Laptop
- Ethernet Cabling
- SIL Serial Cable
- RSLogix 5000 software V21.11
- Moore STA Software V2.1
- Factorytalk View ME software V7.0
- Multimeter with Sourcing capabilities

Electrical Test Equipment		
Make / Model	Serial Number	Calibration Date
FLUKE/773	14690043	Oct-22-2015
FLUKE/375	20430165	Oct-22-2015
MATRIX/IRTN424-2L	E0071001241	Oct-22-2015

1.5 Reference Documents

The following documents should be present during the FAT procedure for reference.

Document Number	Document Name	Rev	Code
CCK-4512109130-0735-K05-00001-000	Pre-FAT testing report (Natpro's internal FAT)		
CCK-4512109130-0735-C03-00001-001	ELECTRICAL SINGLE LINE DIAGRAMS - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE		
CCK-4512109130-0735-C05-00001-001	INST TELECOMMS SYSTEM SCHEMATIC DIAGRAMS - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE		
CCK-4512109130-0735-E01-00001-01	INTERCONNECTION DIAGRAM - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE		
CCK-4512109130-0735-E01-00001-02	INTERCONNECTION DIAGRAM PAGE 2 OF 10 - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE		
CCK-4512109130-0735-E01-00001-03	INTERCONNECTION DIAGRAM PAGE 3 OF 10 - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE		
CCK-4512109130-0735-E01-00001-04	INTERCONNECTION DIAGRAM PAGE 4 OF 10 - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE		
CCK-4512109130-0735-E01-00001-05	INTERCONNECTION DIAGRAM PAGE 5 OF 10 - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE		
CCK-4512109130-0735-E01-00001-06	INTERCONNECTION DIAGRAM PAGE 6 OF 10 - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE		
CCK-4512109130-0735-E01-00001-07	INTERCONNECTION DIAGRAM PAGE 7 OF 10 - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE		
CCK-4512109130-0735-E01-00001-08	INTERCONNECTION DIAGRAM PAGE 8 OF 10 - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE		
CCK-4512109130-0735-E01-00001-09	INTERCONNECTION DIAGRAM PAGE 9 OF 10 - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE		
CCK-4512109130-0735-E01-00001-10	INTERCONNECTION DIAGRAM PAGE 10 OF 10 - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE		
CCK-4512109130-0735-E01-00001-11	INTERCONNECTION DIAGRAM, DWG 214067-7342		

Project 0735A-08030 Factory Acceptance Test

CCK-4512109130-0735-E01-00001-12	INTERCONNECTION DIAGRAM, DWG 214067-7602A / PLC/SIL/CONTACT PANEL LAYOUT AND WIRING SCHEMATICS		
CCK-4512109130-0735-E01-00001-13	INTERCONNECTION DIAGRAM, DWG 214067-7604		
CCK-4512109130-0735-E10-00001-004	Miscellaneous Schematic		
CCK-4512109130-0735-E02-00001-001	PANEL / CABINET LAYOUT, 1 OF 2		
CCK-4512109130-0735-E02-00001-001	PANEL / CABINET LAYOUT, 2 OF 2		
CCK-4512109130-0735-E02-00002-001	PLC/SIL/CONTACT PANEL LAYOUT AND WIRING SCHEMATICS, 1 OF 4		
CCK-4512109130-0735-E02-00002-002	PLC/SIL/CONTACT PANEL LAYOUT AND WIRING SCHEMATICS, 2 OF 4		
CCK-4512109130-0735-E02-00002-003	PLC/SIL/CONTACT PANEL LAYOUT AND WIRING SCHEMATICS, 3 OF 4		
CCK-4512109130-0735-E02-00002-004	PLC/SIL/CONTACT PANEL LAYOUT AND WIRING SCHEMATICS, 4 OF 4		
CCK-4512109130-0735-E05-00001-001	CABLE SCHEDULE - CMT - NATURAL PRESSURE REDUCTION SKID PACKAGE		
CCK-4512109130-0735-E05-00001-002	CABLE SCHEDULE PAGE 2 OF 2 - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE		
CCK-4512109130-0735-E10-00001-001	INSTRUMENT LAYOUT DRAWINGS, 1 OF 4		
CCK-4512109130-0735-E10-00001-002	INSTRUMENT LAYOUT DRAWINGS, 2 OF 4		
CCK-4512109130-0735-E10-00001-003	INSTRUMENT LAYOUT DRAWINGS, 3 OF 4		
CCK-4512109130-0735-E10-00001-005	INSTRUMENT LAYOUT DRAWINGS, 4 OF 4		
CCK-4512109130-0735-C14-00001-000	Process Cause & Effect Charts- CMT - Natural Gas Pressure Reduction Skid Package		
CCK-4512109130-0735-C14-00002-000	Fire & Gas Cause & Effect Charts- CMT - Natural Gas Pressure Reduction Skid Package		
CCK-4512109130-0735-C15-00001-000	Control Philos. and Block Logic Diagrams- CMT - Natural Gas Pressure Reduction Skid Package		
CCK-4512109130-0735-C01-00001-001	P&ID		
CCK-4512109130-0735-E09-00001-000	Instrument Data Sheets		
CCK-0735-MS-7303-000-00001-000	Material Requisition		
CCK-0000-IN-4302-000-00001-000	CMT Alarm and Trip Summary		
CCK-0000-IN-4327-000-00002-000	CMT Input – Output List		
CCK-4512109130-0735-K04-00001-000	Electrical QAQC Document/ Megger Test Report		
	IPS Panel Schematic CP-21602		
CCK-4512109130-0735-C18-00003-001	CCI Control Panel		

1.6 Appendixes

Certain tests reference an Appendix. Each Appendix contains a table that must be verified, and each line initialed, before the corresponding test can be signed off. The list of appendixes is:

- Appendix A – Discrete IO List
- Appendix B - Analog IO List
- Appendix C - Data Transfer Points Summary
- Appendix D - Function List

2. Panel Inspection

Each Panel is to be physically inspected. Panels should all be powered down at this point.

2.1 List of Panels and Documentation

The following Panels will be inspected, and the following documents will be used as reference.

Panel Tag	Description	Layout	Power Distribution Schedule
CP-21601	PLC Panel	CCK-4512109130-0735-E02-00002-002	CCK-4512109130-0835-E01-00001-002
CP-21602	IPS Panel	CCK-4512109130-0735-E02-00002-004	CCK-4512109130-0735-E01-00001-008 CCK-4512109130-0735-E01-00001-013
CP-21603	CCI Control Panel		CCK-4512109130-0735-C18-00002-001
CP-21604	Contacto Panel	CCK-4512109130-0735-E02-00002-001	CCK-4512109130-0735-E02-00002-002-02 CCK-4512109130-0735-E02-00002-004-02
UPS-21601	Uninterruptible Power Supply (Hayley)		CCK-4512109130-0735-C18-00003-001
LPN-21620	Lighting Distribution Panel		CCK-4512109130-0735-E02-00001-002-02
PDP-21620	Power Distribution Panel		
SW-21620	Power Junction Box		
XJB-21601	Junction Box	CCK-4512109130-0735-E01-00001-011.	
XJB-21602	Junction Box	CCK-4512109130-0735-E01-00001-011.	

2.2 Description of Tests

- Physical Damage: Inspect the cabinet for any physical damage such as paint, dents, warping, etc.
- Cabinet Approval: Each applicable cabinet will be checked for a CSA approval label. Confirm that the contents of the label are correct.
- Layout: Confirm that the internal and external layout matches the reference drawings.
- Schedule: Confirm the panel schedule complies with the reference drawings.
- Wire Management: Confirm that proper wire management has been observed.
- Labels/Lamacoids: Confirm that wires have been tagged properly, and lamacoids have been applied according to the reference drawings.
- Review electrical QAQC documents.

2.3 Panel Inspection Tests

Panel	Physical Damage	CSA Approval	Layout	Schedule	Wire Management	Labels/Lamacoids	Comments
CP-21601							
CP-21602							
CP-21603							
CP-21604							
UPS-21601							
LPN-21620							
PDP-21620							
SW-21620							
XJB-21601							
XJB-21602							

2.4 Section Sign-Off

Comments/Notes:	
Test Section is: () Passed () Failed	Deficiencies:
Test Executed By (Initial & Date):	Test Witnessed By (Initial & Date):

3. Control Panel Ground Testing

Each panel will be tested for proper grounding visually. Isolation ground bar to be tested using multi-meter to test resistance.

3.1 Panel Tests

Panel	Ground Bar Isolation	Chassis/ AC Test	Isolated Instrument Ground	Panel Ground	AC Ground Lug Testing	Comments
CP-21601						
CP-21602						
CP-21603						
CP-21604						
UPS-21601			N/A			
LPN-21620			N/A			
PDP-21620			N/A			
SW-21620			N/A			
XJB-21601			N/A			
XJB-21602			N/A			

3.2 Section Sign-Off

Comments/Notes:	
Test Section is: () Passed () Failed	Deficiencies:
Test Executed By (Initial & Date):	Test Witnessed By (Initial & Date):

4. 600VAC Power Distribution Start-up (PDP-21620)

Once inspection has been completed the 600 VAC Power Distribution Panel will be powered up and tested as outlined. Temporary power will be supplied to the exterior power JB (SW-21620) with 600VAC 3PH 60HZ @ 50Amps for individual testing of the Units heaters, building transformer and the CCI NG heater controller.

4.1 Individual Breaker Tests

Do Not Test the Natural Gas heater (H-08071) without process gas or **damage** to the heater will occur.

Testing of the (CP-21603) CCI controller with 600VAC will be conducted by **first removing** the (H-08071) Natural Gas Heater power wiring from the load side of the (CP-21603) CCI controller to energize the hardware and test the controls.

Apply power to an individual feed breaker, and verify the appropriate voltage is being measured at the terminals of the corresponding cabinet or equipment. Turn breaker off and confirm that voltage has been removed.

Shop Test Voltage: _____. Measured voltage anticipated to be the same as the shop test voltage. There may be some variation from the shop test Voltage. If Measured Voltage is +/- 2% re-test shop test voltage.

	Measured Voltage (VAC)	LED Indication	Verified	Comments
(H-08170) Electrical Room Unit Heater				
(H-08167) Natural Gas Room Unit Heater				
(XFMR-21620) Building Transformer				
(CP-21603) CCI Controller				
(H-08071) NG Process Heater	NA	NA		EXHEAT Manufacturer's FAT docs

4.2 Section Sign-Off

Comments/Notes:	
Test Section is: () Passed () Failed	Deficiencies:
Test Executed By (Initial & Date):	Test Witnessed By (Initial & Date):

5. 120/208 VAC Power Distribution Start-up (LPN-21620)

Once inspection has been completed the 120/208 VAC Power Distribution Panel will be powered on and tested as outlined. Before initial power-up, each breaker should be placed into the "Off," position.

5.1 Individual Breaker Tests

Apply power to an individual feed breaker, and verify the appropriate voltage is being measured at the terminals of the corresponding cabinet or equipment. Turn breaker off and confirm that voltage has been removed.

Shop Test Voltage: _____ . Measured voltage anticipated to be the same as the shop test voltage. There may be some variation from the shop test Voltage. If Measured Voltage is +/- 2% re-test shop test voltage.

CCT#	Description	Measured Voltage	Verified	Comments
	Interior Lights (Electrical Room)			
	UPS-21601			
	CP-21601 Panel Receptacle			
	Receptacle (NG Heater Room)			
	Emergency Lights			
	SF-08168 Supply Fan (NG Heater Room)			
	SF-08169 Supply Fan (NG Heater Room)			
	Interior Lights (NG Heater Room)			
	CO-21604 Contactor Panel			
	Exterior Lights			
	Receptacle (Electrical Room)			
	CP-21601 Cabinet Fan			
	SF-08174 Supply Fan (Electrical Room)			
	SF-08174 Supply Fan (Electrical Room)			
	SDV-08071A			

5.2 Section Sign-Off

Comments/Notes:	
Test Section is: () Passed () Failed	Deficiencies:
Test Executed By (Initial & Date):	Test Witnessed By (Initial & Date):

6. Control Panel Power Distribution

Each panel should be completely de-energized prior to testing.

6.1 AC/DC Power Distribution Tests

Confirm AC power distribution wires comply with cabinet drawings. Measure with multimeter to verify no short circuits exist between line, neutral, and ground.

Confirm AC power distribution wires comply with cabinet drawings. Measure with multimeter to verify isolation between AC and DC power.

Panel	AC Power Distribution Voltage (120 VAC)	DC Power Distribution Voltage (24 VDC)	Verified	Comments
UPS-21601				
CP-21601				
CP-21602				
CP-21603				
CP-21604				

6.2 Section Sign-Off

Comments/Notes:	
Test Section is: <input type="checkbox"/> Passed <input type="checkbox"/> Failed	Deficiencies:
Test Executed By (Initial & Date):	Test Witnessed By (Initial & Date):

7. Control Panel Start-up

Ensure all breakers and fuses are open, then apply power to the control panel to begin testing.

7.1 Control Panel Power Tests

On each cabinet, first verify incoming supply voltage.

For Internal Power Distribution testing, close each fuse one at a time, and confirm that power has been applied to the correct equipment.

Panel	Incoming Power Supply Voltage	Internal Power Distribution	Comments
CP-21601			
CP-21602			
CP-21603			
CP-21604			

7.2 Section Sign-Off

Comments/Notes:	
Test Section is: () Passed () Failed	Deficiencies:
Test Executed By (Initial & Date):	Test Witnessed By (Initial & Date):

8. PLC Start-Up

8.1 Procedure

The PLC Technician will connect to the PLC to perform the following steps

Procedure	Verified
1. Set Ethernet network addresses on all Ethernet modules	
2. Download PLC program to primary processor	
3. Verify that Transmit and Receive Indicator Lights are flashes on each Ethernet Port, confirming that cabling is in place, and communicating	
4. Place PLC processor into Run mode.	
5. Verify there are no Errors or Faults on the RSlogix 5000 software or Processor	

8.2 Section Sign-Off

Comments/Notes:	
Test Section is: <input type="checkbox"/> Passed <input type="checkbox"/> Failed	Deficiencies:
Test Executed By (Initial & Date):	Test Witnessed By (Initial & Date):

9. PLC Inspection

The PLC Technician will record the following information

9.1 PLC Information

Model	Part Number	Serial Number	Firmware Version	Software Version
1769-L33ER			21.11	21.11
Panelview Plus 1000			7.0.55.13	7.0
1769-IQ16			1.1	
1769-OWB8			2.1	
1769sc-IF4IH			3.1	
1769sc-OF4IH			3.1	

9.2 PLC Performance Test

PLC Scan Time: Avg _____ms Max _____ms

	Total	Available	Percent Free
PLC Memory	1,048,576	1,034,608	98.6
HMI Memory			

Inputs/Outputs

	Total	Available	Percent
Discrete In	16	7	50%
Discrete Out	16	5	31%
Analog In	16	3	19%
Analog Out	4	3	75%

9.3 Section Sign-Off

Comments/Notes:	
Test Section is: () Passed () Failed	Deficiencies:
Test Executed By (Initial & Date):	Test Witnessed By (Initial & Date):

10. HMI Inspection

10.1 Procedure

The PanelView HMI will be powered up, and the following conditions verified.

Procedure	Verified
1. Start the PanelView	
2. Ensure that the overview display is used as Startup Display	
3. Verify HMI reads data from PLC, and write commands	
4. Verify all provided User Logins and Passwords have been configured	
5. Verify Navigation	
6. Verify Alarm Summary page displays all current and unacknowledged alarms	

User Accounts

Username	Default Password
Engineer	
Operator	
PM	

10.2 Section Sign-Off

Comments/Notes:	
Test Section is: () Passed () Failed	Deficiencies:
Test Executed By (Initial & Date):	Test Witnessed By (Initial & Date):

11. Discrete IO

11.1 Appendix Referenced

-Appendix A - Discrete IO List

11.2 Procedure

The Electrical Technician will change the state of each discrete input. The PLC Technician will confirm the signal is being received in accordance with Appendix A – Discrete IO List. This includes address, and normally open/normally closed status.

The PLC Technician will then change the state of each discrete output. The Electrical Technician will confirm the signal is being received in accordance with Appendix A – Discrete IO List.

Procedure	Verified
1. Verify each line in Appendix A - Discrete IO List – Discrete has been verified and signed off.	

11.3 Section Sign-Off

Comments/Notes:	
Test Section is: <input type="checkbox"/> Passed <input type="checkbox"/> Failed	Deficiencies:
Test Executed By (Initial & Date):	Test Witnessed By (Initial & Date):

12. Analog IO

12.1 Appendix Referenced

-Appendix B - Analog IO List

12.2 Procedure

The Electrical Technician will change the value of each Analog Input from 4mA, 12mA, and 20mA. The PLC Technician will verify the signal is being received in accordance with Appendix B - Analog IO List. This includes verifying that the correct value is being displayed on the HMI, as well as the Alarm and Trip setpoints

The PLC Technician will change the value of each Analog Output from 0%, 50%, and 100%. The Electrical Technician will verify that the signal is being received at the device in accordance with Appendix B - Analog IO List.

Procedure	Verified
1. Verify each line in Appendix B - Analog IO List has been verified and signed off.	

12.3 Section Sign-Off

Comments/Notes:	
Test Section is: <input type="checkbox"/> Passed <input type="checkbox"/> Failed	Deficiencies:
Test Executed By (Initial & Date):	Test Witnessed By (Initial & Date):

13. Data Transfer Points

13.1 Appendix Referenced

-Appendix C - Data Transfer Points Summary

13.2 Procedure

Confirm devices communicating with the PLC can read/write to data points as specified in the Appendix C - Data Transfer Points Summary document.

Procedure	Verified
1. Verify each IO point listed in Appendix C - Data Transfer Points Summary has been verified and signed off	

13.3 Section Sign-Off

Comments/Notes:	
Test Section is: <input type="checkbox"/> Passed <input type="checkbox"/> Failed	Deficiencies:
Test Executed By (Initial & Date):	Test Witnessed By (Initial & Date):

14. Function Test - Discrete Alarms

14.1 Appendix Referenced

-Appendix D - Function List

14.2 Procedure

Verify that Discrete Alarm functions as specified in the Appendix D - Function List.

Procedure	Verified
1. Verify each function in Appendix D - Function List – Section 22.1 – Discrete Alarms has been verified and signed off	

14.3 Section Sign-Off

Comments/Notes:	
Test Section is: <input type="checkbox"/> Passed <input type="checkbox"/> Failed	Deficiencies:
Test Executed By (Initial & Date):	Test Witnessed By (Initial & Date):

15. Function Test - Transmitters

15.1 Appendix Referenced

-Appendix D - Function List

15.2 Procedure

Verify that each transmitter functions as specified in the Appendix D - Function List.

Procedure	Verified
1. Verify each function in Appendix D - Function List – Section 22.2 – Transmitters has been verified and signed off	

15.3 Section Sign-Off

Comments/Notes:	
Test Section is: <input type="checkbox"/> Passed <input type="checkbox"/> Failed	Deficiencies:
Test Executed By (Initial & Date):	Test Witnessed By (Initial & Date):

16. Function Test – SIL Units

16.1 Appendix Referenced

-Appendix D - Function List

16.2 Procedure

Verify that each SIL Unit functions as specified in the Appendix D - Function List.

Procedure	Verified
1. Verify each function in Appendix D - Function List – Section 22.3 – SIL Units has been verified and signed off	

16.2 Section Sign-Off

Comments/Notes:	
Test Section is: <input type="checkbox"/> Passed <input type="checkbox"/> Failed	Deficiencies:
Test Executed By (Initial & Date):	Test Witnessed By (Initial & Date):

17. Function Test – Control Loop

17.1 Appendix Referenced

-Appendix D - Function List

17.2 Procedure

Verify that each heater functions as specified in the Appendix D - Function List.

Procedure	Verified
1. Verify each function in Appendix D - Function List – Section 22.4 – Control Loops has been verified and signed off	

17.3 Section Sign-Off

Comments/Notes:	
Test Section is: <input type="checkbox"/> Passed <input type="checkbox"/> Failed	Deficiencies:
Test Executed By (Initial & Date):	Test Witnessed By (Initial & Date):

18 Deficiency Log

Item	Section Ref	Description	Responsible Party	Resolved	Verified	Date Corrected
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

19 Appendix A - Discrete IO List

19.1 Discrete Inputs

Tag	Address	Description	HMI Screen	NO/NC	Verified
XI21601C1	R2:1.0	UPS-21601D1 AC Failure	Overview	NC	
XI21601D1	R2:1.1	UPS-21601D1 DC Low	Overview	NC	
XIB21601A1	R2:1.2	CP-21501 Common Alarm	Overview	NC	
XIS21602A1	R2:1.3	CP-21502 Common Alarm	Overview	NC	
XI21601A1	R2:1.4	HVAC Common Alarm	Overview	NC	
HZS-21601A/2A/3A	R2:1.5	Emergency Shutdown	Overview	NC	
XI21603A1	R2:1.6	Heater Common Alarm	Overview	NC	
XI21602C1	R2:1.7	Smoke Detector Alarm	Overview	NC	
XI21602D1	R2:1.8	Loss Of Power To Beacons + Horn	Overview	NC	

19.2 Discrete Outputs

Tag	Address	Description	NO/NC	Verified
XY8071A1	R2:2.0	Common Alarm	NC	
XY8071B1	R2:2.1	Skid Trip Alarm	NC	
XY21601A1	R2:2.2	HVAC Common Alarm	NC	
XY21601B1	R2:2.3	Building Temperature Alarm	NC	
XY21602A1	R2:2.4	LEL Common Alarm	NC	
XY21602B1	R2:2.5	Flame Common Alarm	NC	
SDV08071A	R2:2.6	Emergency Valve Open	NC	
XY21602A1	R2:2.7	Beacon/Horn Test	NC	
XY21602A2	R2:3.0	Silence Horn	NC	
XY21602A3	R2:3.1	Smoke Detector Reset	NC	
XY21602A4	R2:3.2	ESD Trip Reset	NC	

20 Appendix B - Analog IO List

20.1 Analog Inputs

Tag	Address	Description	HMI Screen	Eng Units	Eng Max	Eng Min	HH SP	H SP	SP	L SP	LL SP	Signal Verified
TT08071A1	R1:4.0	Outlet Gas Temperature	Process	deg C	100	-50		60	25	18		
FT08071A1	R1:4.1	Outlet Gas Flow	Process	Sm3/d	2000	0						
ZT08071A	R1:4.2	Shutdown Valve Position	Overview	%	100	0						
TT21601A	R1:4.3	Building Temperature	Process	deg C	50	-50				0		
TZT08071A	R1:5.0	Natural Gas Heater Temperature Transmitter	Process	deg C	100	-50	72.6					
TZT08071B	R1:5.1	Gas Outlet Temp. Transmitter	Process	deg C	100	-50					-10	
PZT08071A	R1:5.2	Heater H-08071 Gas Outlet Pressure	Process	Kpag	12,000	0	8370					
PZT08071B	R1:5.3	1st Stage Reduction Gas Pressure	Pressure Control Valves	Kpag	5515.8	0	3760					
PZT08071C	R1:6.0	2nd Stage Reduction Gas Pressure	Pressure Control Valves	Kpag	5515.8	0	1127					
PZT08071D	R1:6.1	Stream 2 PIT (Ignore)	Pressure Control Valves	Kpag	1034.2	0	563					
UZT21601A	R1:6.2	Natural Gas Heater Room Combustible Gas Detection	Overview	%	100	0	40	20				
YZT21601A	R1:6.3	Natural Gas Heater Room Fire Detection	Overview	mA	20	4	16					
UZT21601B	R1:7.0	Natural Gas Heater Room Combustible Gas Detection	Overview	%	100	0	40	20				

20.2 Analog Outputs

Tag	Address	Description	HMI Screen	Eng Units	4mA	12mA	20mA	Verified
H08071	R1:8.1	Natural Gas Heater	Process	%				

21 Appendix C - Data Transfer Points Summary

TAG	DESCRIPTION	AREA_NAME	Min Eng	Max Eng	Units	Modbus/Ethernet I/P address	COMMENTS	IP ADDRESS	SUBNET MASK	Verified
TZT-08071A	Natural Gas Heater Temp	CMT	-50	100	deg C	HMI_INPUT_REAL[0]		10.32.254.83	255.255.255.192	
PZT-08071A	Heater H-08071 Gas Outlet Pressure	CMT	0	12000	kPa	HMI_INPUT_REAL[1]		10.32.254.83	255.255.255.192	
PZT-08071B	Heater H-08071 Gas Outlet Pressure	CMT	0	5515.8	kPa	HMI_INPUT_REAL[2]		10.32.254.83	255.255.255.192	
PZT-08071C	Heater H-08071 Gas Outlet Pressure	CMT	0	5515.8	kPa	HMI_INPUT_REAL[3]		10.32.254.83	255.255.255.192	
PZT-08071D	Heater H-08071 Gas Outlet Pressure	CMT	0	1034.2	kPa	HMI_INPUT_REAL[4]		10.32.254.83	255.255.255.192	
TZT-08071B	Gas Outlet Temp	CMT	-50	100	deg C	HMI_INPUT_REAL[5]		10.32.254.83	255.255.255.192	
FT-08071A1	Outlet Gas Flow	CMT	0	2000	Sm3/d	HMI_INPUT_REAL[6]		10.32.254.83	255.255.255.192	
TT-08071A1	Gas Outlet Temp	CMT	-50	100	deg C	HMI_INPUT_REAL[7]		10.32.254.83	255.255.255.192	
ZT-08071A	Shutdown Valve Position	CMT	0	100	%	HMI_INPUT_REAL[8]		10.32.254.83	255.255.255.192	
TT-21601A	SHELTER TEMPERATURE	CMT	-50	50	deg C	HMI_INPUT_REAL[9]		10.32.254.83	255.255.255.192	
XZY-08071A	SIL PANEL TRIP	CMT				HMI_INPUT_BOOL[0].0	Common SIL Panel Trip, no individual inputs	10.32.254.83	255.255.255.192	
HZS-21601/2A	ESD STRING TRIP	CMT				HMI_INPUT_BOOL[0].1	Common ESD Trip, no individual inputs	10.32.254.83	255.255.255.192	
YZT-21601A	Natural Gas Heater Room FLAME	CMT				HMI_INPUT_BOOL[0].2		10.32.254.83	255.255.255.192	
UZT-21601A	Natural Gas Heater Room LEL	CMT				HMI_INPUT_BOOL[0].3		10.32.254.83	255.255.255.192	
UZT-21601B	Natural Gas Heater Room LEL	CMT				HMI_INPUT_BOOL[0].4		10.32.254.83	255.255.255.192	

22 Appendix D - Function List

22.1	Discrete Alarms			
	Cause	Tag	Effect	Effect Verified (✓)
22.1.1	UPS AC Failure	XI-21601C1	Notify (Alarm) to HMI	
22.1.2	UPS DC Low	XI-21601D1	Notify (Alarm) to HMI	
22.1.3	Common Alarm Input	XI-B-21601A1	Notify (Alarm) to HMI	
			Open Output R1:02:00 Common Alarm	
22.1.4	Common Alarm Input	XI-S-21601A1	Notify (Alarm) to HMI	
			Open Output R1:02:00 Common Alarm	
22.1.5	HVAC Alarm	XI-21601A1	Notify (Alarm) to HMI	
			Open Output R1:02:02 HVAC Alarm	
22.1.6	Skid ESD	ESD	Notify (Alarm) to HMI	
			Open Output R1:02:01 Skid Trip	
			Close SDV-08071A	
22.2	Transmitters			
22.2.1	TT-08071A1			
	Cause	Tag	Effect	Effect Verified (✓)
22.2.1.1	Temperature Transmitter Fail	TAX-08071A1	Notify (Alarm) to HMI	
22.2.1.2	Temperature Low Alarm	TAL-08071A1	Notify (Alarm) to HMI	
22.2.1.3	Temperature High Alarm	TAH-08071A1	Notify (Alarm) to HMI	
22.2.2	FT-08071A1			
	Cause	Tag	Effect	Effect Verified (✓)
22.2.2.2	Flow Totalizer	FQIT-08071A1	Display on HMI	
22.2.3	PZT-08071A			
	Cause	Tag	Effect	Effect Verified (✓)
22.2.3.1	Pressure Transmitter Fail	PAX-08071A1	Notify (Alarm) to HMI	
22.2.3.2	Pressure High High Alarm	PZH-08071A1	Notify (Alarm) to HMI	

22.2.4	PZT-08071B			
	Cause	Tag	Effect	Effect Verified (✓)
22.2.4.1	Pressure Transmitter Fail	PAX-08071B1	Notify (Alarm) to HMI	
22.2.4.2	Pressure High High Alarm	PZH-08071B1	Notify (Alarm) to HMI	
22.2.5	PZT-08071C			
	Cause	Tag	Effect	Effect Verified (✓)
22.2.5.1	Pressure Transmitter Fail	PAX-08071C1	Notify (Alarm) to HMI	
22.2.5.2	Pressure High High Alarm	PZH-08071C1	Notify (Alarm) to HMI	
22.2.6	PZT-08071D			
	Cause	Tag	Effect	Effect Verified (✓)
22.2.6.1	Pressure Transmitter Fail	PAX-08071D1	Notify (Alarm) to HMI	
22.2.6.2	Pressure High High Alarm	PZH-08071D1	Notify (Alarm) to HMI	
22.2.7	ZT-08071A			
	Cause	Tag	Effect	Effect Verified (✓)
22.2.7.1	Shutdown Valve Transmitter Fail	ZAX-08071A	Notify (Alarm) to HMI	
22.2.7.2	Shutdown Valve Closed Alarm	ZALL-08071A	Notify (Alarm) to HMI	
			Move TIC-08071A1 to Manual	
			Set TIC-08071A1 Manual Setpoint to 0	
22.2.8	TT-21601A			
	Cause	Tag	Effect	Effect Verified (✓)
22.2.8.1	Temperature Transmitter Fail	TAX-21601A	Notify (Alarm) to HMI	
22.2.8.2	Temperature Low Alarm	TAL-21601A	Notify (Alarm) to HMI	
			Open Output R1:02:02 Building Temperature Alarm	
22.2.9	TZT-08071A			
	Cause	Tag	Effect	Effect Verified (✓)
22.2.9.1	Temperature Transmitter Fail	TZX-08071A	Notify (Alarm) to HMI	

22.2.9.2	Temperature High Alarm	TZH-08071A	Notify (Alarm) to HMI	
22.2.10	TZT-08071B			
	Cause	Tag	Effect	Effect Verified (✓)
22.2.10.1	Temperature Transmitter Fail	TZX-08071B	Notify (Alarm) to HMI	
22.2.10.2	Temperature Low Alarm	TZL-08071B	Notify (Alarm) to HMI	
22.2.11	UZT-21601A			
	Cause	Tag	Effect	Effect Verified (✓)
22.2.11.1	LEL Transmitter Fail	UZX-21601A	Notify (Alarm) to HMI	
22.2.11.2	LEL High Alarm	UZH-21601A	Notify (Alarm) to HMI	
			Open Output R1:02:03 LEL Alarm	
22.2.12	UZT-21601B			
	Cause	Tag	Effect	Effect Verified (✓)
22.2.12.1	LEL Transmitter Fail	UZX-21601B	Notify (Alarm) to HMI	
22.2.12.2	LEL High Alarm	UZH-21601B	Notify (Alarm) to HMI	
			Open Output R1:02:03 LEL Alarm	
22.2.13	YZT-21601A			
	Cause	Tag	Effect	Effect Verified (✓)
22.2.13.1	Fire Transmitter Fail	YZX-21601A	Notify (Alarm) to HMI	
22.2.13.2	Fire High Alarm	YZH-21601A	Notify (Alarm) to HMI	
			Open Output R1:02:04 Fire Alarm	
22.3	SIL Units			
	Cause	Tag	Effect	Effect Verified (✓)
22.3.1	Gas Temperature High High	TZH08071A	Shut Down Inlet ESD Valve	
			Shut Down Heater H-08071	
			Activate R1:01:03 Common Alarm	
22.3.2	Gas Temperature Low Low	TZL08071B	Shut Down Inlet ESD Valve	
			Shut Down Heater H-08071	

			Activate R1:01:03 Common Alarm	
22.3.3	Gas Pressure High High	PZH08071A	Shut Down Inlet ESD Valve	
			Shut Down Heater H-08071	
			Activate R1:01:03 Common Alarm	
22.3.4	Gas Pressure High High	PZH08071B	Shut Down Inlet ESD Valve	
			Shut Down Heater H-08071	
			Activate R1:01:03 Common Alarm	
22.3.5	Gas Pressure High High	PZH08071C	Shut Down Inlet ESD Valve	
			Shut Down Heater H-08071	
			Activate R1:01:03 Common Alarm	
22.3.6	Gas Pressure High High	PZH08071D	Shut Down Inlet ESD Valve	
			Shut Down Heater H-08071	
			Activate R1:01:03 Common Alarm	
22.3.7	LEL 2oo2 Alarm	UZH21601A	Shut Down Inlet ESD Valve	
			Shut Down Heater H-08071	
			Activate R1:01:03 Common Alarm	
			Activate Fan C-08174	
22.3.8	Fire High High	YZH21601A	Shut Down Inlet ESD Valve	
			Shut Down Heater H-08071	
			Activate R1:01:03 Common Alarm	

22.4	Control Loops			
22.4.1	TIC-08071A1			
	Cause	Tag	Effect	Effect Verified (✓)
22.4.1.1	Control Loop AutoMan	TIC-08071A1	Prove Control Loop AutoMan Operation	
22.4.1.2	Control Loop In Auto		Prove Control Loop Auto Operation	
22.4.1.3	Control Loop In Manual		Prove Control Loop Manual Operation	
22.4.1.4	Control Loop Control	H-08071A	Output Matches Control Loop Command	

ProCoat Coatings Ltd.

Standard Surface Preparation & Painting Procedures

1. General

- 1.1 Abrasive blasting will only be performed when weather/ambient conditions permit, more specifically when the surface temperature is at a minimum of 3 degrees celsius above the dew point.
- 1.2 Painting will only be performed when the weather/ambient conditions permit as per the manufacturer products data sheets.
- 1.3 Non-conformities found through inspection will be brought up to acceptable levels as per the buyers need and/or manufacturers recommendations and will be performed at the earliest possible date.
- 1.4 Any deviation from the pre-approved scope of work as per the bid & quote process will only be accepted in writing and confirmed between a representative of ProCoat and the buyer.

2. Surface Preparation

- 2.1 The reference standards for surface preparation are SSPC-Vis 1.
- 2.2 Surface preparation will be brought to a level outlined in the bid & quote process.
- 2.3 Solvent cleaning is carried out in accordance with SSPC-1.
- 2.4 The type of abrasive used will be 12/50 Special Target.
- 2.5 Bulk sand abrasive is stored in a waterproof sand silo to prevent moisture contamination.
- 2.6 All compressors have water and oil traps to prevent abrasive blast contamination.
- 2.7 Spent abrasive is removed from the surface by brushing, vacuuming and/or dry compressed air.
- 2.8 Profiled surfaces will be primed the day of blasting to prevent any surface contaminants under the primer coat.

3. Painting

- 3.1 All paint in a coating system will be from one manufacturer unless pre-approved by the buyer.
- 3.2 All painting will be completed as per the manufacturer product data sheets.
- 3.3 All painting will be completed as directed by the bid & quote process.
- 3.4 Curing and recoat interval times vary as per manufacturer product data sheet recommendations.
- 3.5 All areas difficult to coat will be brushed prior to application to ensure required thickness levels.
- 3.6 All equipment adheres to manufacturer product data sheet recommendations.
- 3.7 All work performed will be free of runs, sags, drips, dry spray, debris and uniform in appearance.

4. Inspection

- 4.1 Surface preparation will be subject to a visual inspection and measurement of the profile using Testex Press-O-Film X Coarse tape and a spring micrometer.
- 4.2 All Dry Film Thickness tests will be performed using an Exacto Electro-Physik coating thickness gauge.
- 4.3 Ambient conditions will be measured during surface preparation and application of primer and any subsequent coatings using an Omega digital sling psychrometer thermo hydrometer and Raytek laser temperature gauge.
- 4.4 All internal coatings will be checked using a 67.5 volt holiday detector.
- 4.5 All quality control reports will be made available 2 business days upon completion of the work performed.

natpro

NDE Request

Date: MAY 19/15

Prepared by: Rick St. Louis

403 993 6633

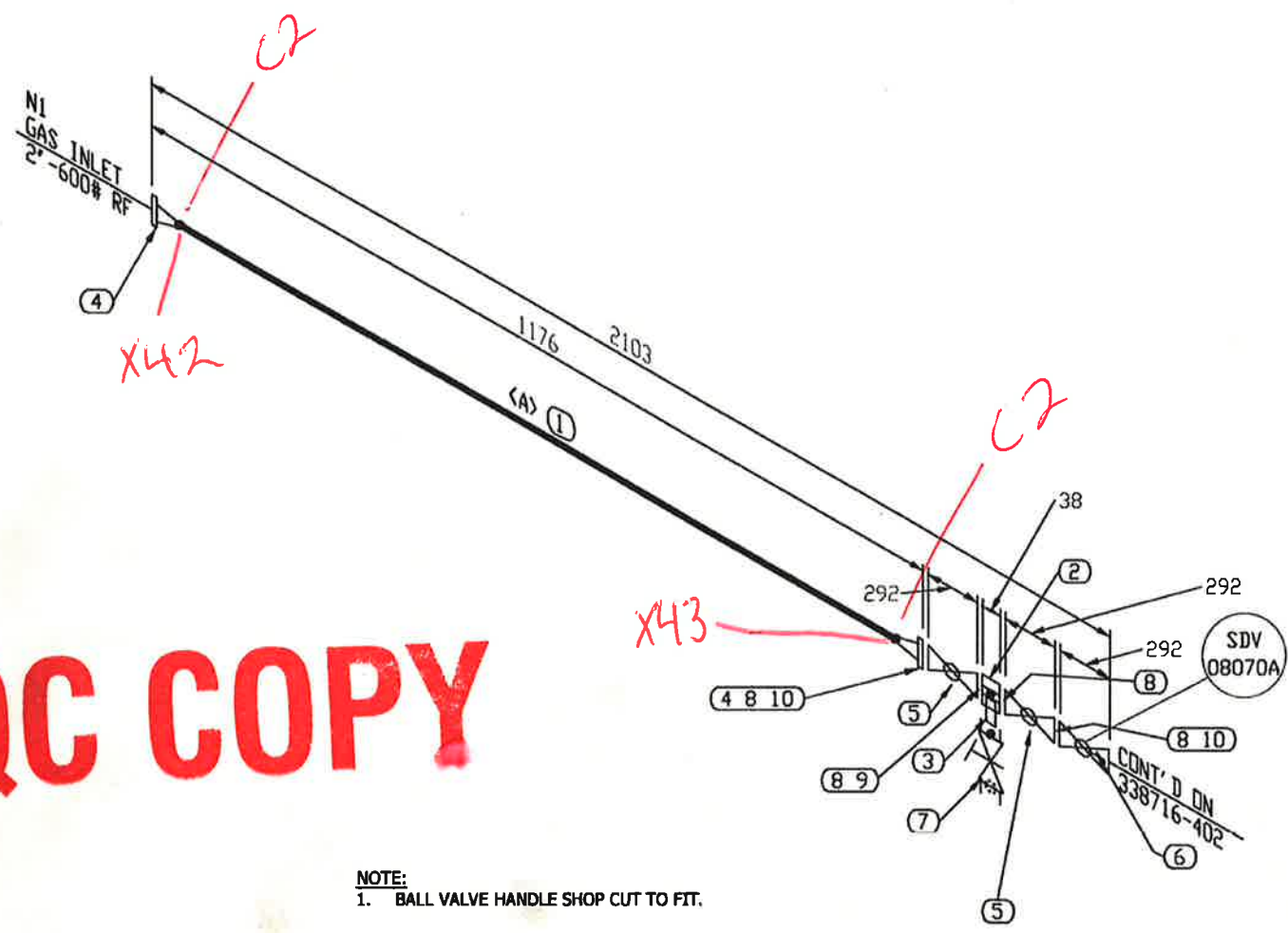
Office 403 724 4366

Job #	Joint #	WID	Size	SCH	Code	Comments
338716	X-57	L1	2"	XH	B31.3N	SPOOLS TAGGED WITH WHITE RIBBON.
↑	X-58	L1	↑	↑	↑	
	X-59	L1				
	X-60	A				EAST END OF SHOR
	X-61	A				
	X-62	A				SHOOTING WINDOW!
	X-63	C2				8PM - to 5AM.
	X-64	A				
	X-65	A				PO# 3869974.
	X-66	C2				
	X-67	C2				
	X-68	C2				
	X-69	A				
	X-70	A				
	X-71	C2				
	X-72	A				
	X-73	C2				
	X-74	C2				
	X-75	C2				
	X-76	C2				
	X-77	C2				
	X-78	C2				
	X-79	C2				
	X-80	C2				
↓	X-81	C2	↓	↓	↓	
338716	X-82	C2	2"	XH	B31.3N	

100% RT

X# Job# WID Pipe Size

X-85 } ENVIRO BOX
X-86 } 468?



QC COPY

NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1011 MM	
FITTINGS				
2	2	BLEED RING, REF. 338716-100 ITEM #34	1	
3	3/4	NIPPLE, SCH 160, ASTM A333-6 PBE (4' LG)	1	
FLANGES				
4	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL 1	2	
VALVES / IN-LINE ITEMS				
5	2	BALL VALVE, FLG, REF. 338716-100 ITEM #21	2	
6	2	BALL VALVE, FLG, REF. 338716-100 ITEM #1	1	
7	3/4	GATE VALVE, SW/NPT, REF. 338716-100 ITEM #27	1	

ERECTOR MATERIALS				
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
8	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	4	
BOLTS				
9	2X6	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
10	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	16	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	1011	2

25w

- GENERAL NOTES
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX
 - NO FCAW ALLOWED BY SHELL.

ISSUED FOR CONSTRUCTION
15/04/15
natpro
SIGNATURE

1	2	3	4	5	6	7
WP#: NPE-1(REV2),NPE-4	WP#: NPE-1(REV2),NPE-4	WP#: NPE-1(REV2),NPE-4	WP#: NPE-1(REV2),NPE-4	WP#: NPE-1(REV2),NPE-4	WP#: NPE-1(REV2),NPE-4	WP#: NPE-1(REV2),NPE-4
RFWN	TYP. BUTT WELD	RFSO	RFSW	LAP JOINT	OLET	SW FITTING

PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP/DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

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natpro

PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
JOB#: 338716 QUOTE: CGY2014-85 POC: 4512-109-130

DATE: JUL 04/14
DATE: JUL 04/14
DATE: JUL 04/14

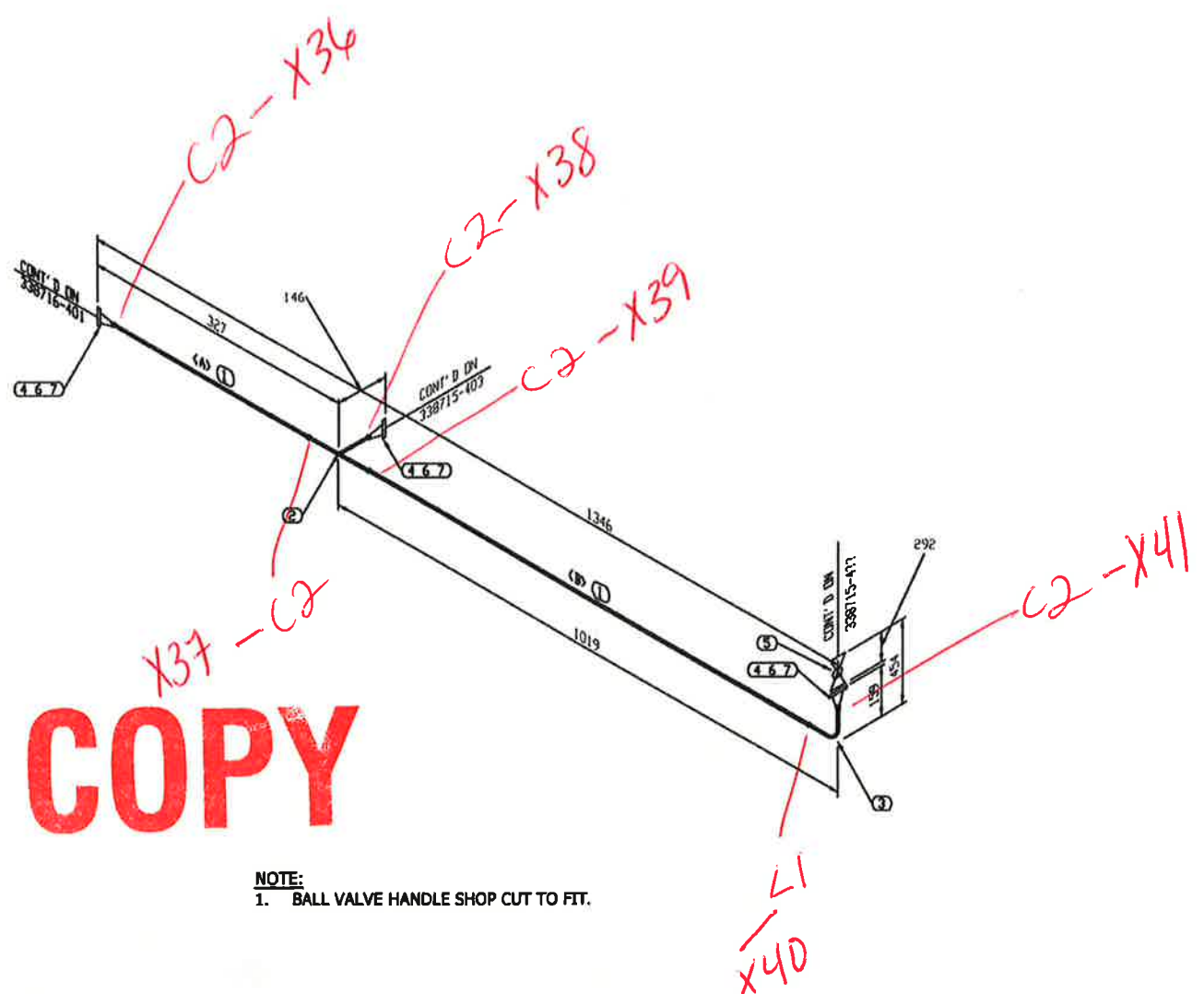
338716-401-Rev1
PAGE: 1 OF 1

S-08070 GAS INLET
SPOOL DETAIL

10090 RT



QC COPY



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1051 MM	
FITTINGS				
2	2X2	TEE, SCH XS, ASTM A420-WPL-6	1	
3	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	1	
FLANGES				
4	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL 1	3	
VALVES / IN-LINE ITEMS				
5	2	BALL VALVE, FLG, REF. 338716-100 ITEM #21	1	

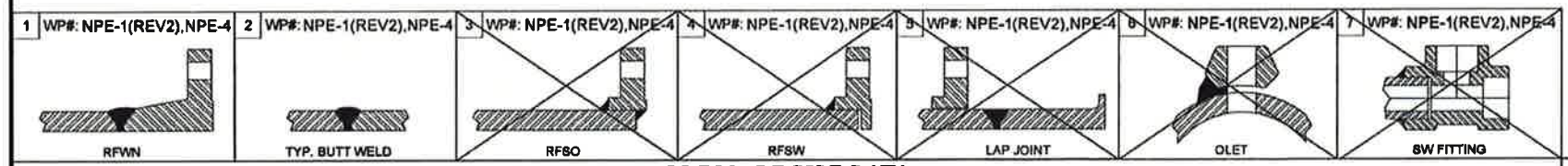
ERECTOR MATERIALS				
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
6	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	3	
BOLTS				
7	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, V/2 NUTS: A194-2H	24	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	178	2
	873	2

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE: Y/M/D
 SIGNATURE: [Signature]
natpro

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

NOTE:
 1. BALL VALVE HANDLE SHOP CUT TO FIT.



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP/DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/11
D	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 08/11
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 28/10

**S-08070 GAS INLET
 SPOOL DETAIL**

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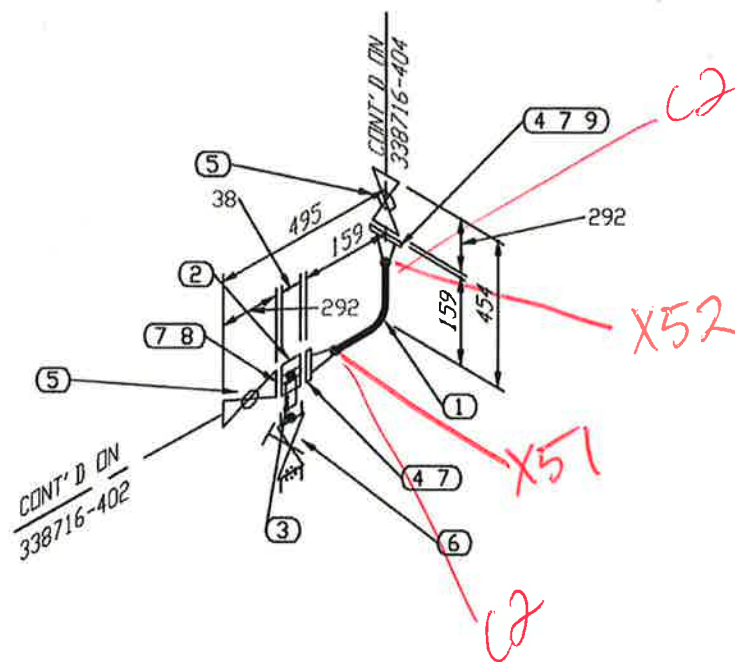
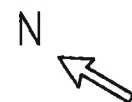
natpro

PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 BLS#: 338716 QUOTE CGY2014-85 PO# 4512-109-130

DATE: JUL 04/14
 DATE: JUL 04/14
 DATE: JUL 04/14

1 OF 1

100% RT



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
FITTINGS				
1	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	1	
2	2	BLEED RING, REF. 338716-100 ITEM #34	1	
3	3/4	NIPPLE, SCH 160, ASTM A333-6 PBE (4' LG)	1	
FLANGES				
4	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL 1	2	
VALVES / IN-LINE ITEMS				
5	2	BALL VALVE, FLG, REF. 338716-100 ITEM #21	2	
6	3/4	GATE VALVE, SW/NPT, REF. 338716-100 ITEM #27	1	

ERECTION MATERIALS

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
7	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	3	
BOLTS				
8	2X6	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
9	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

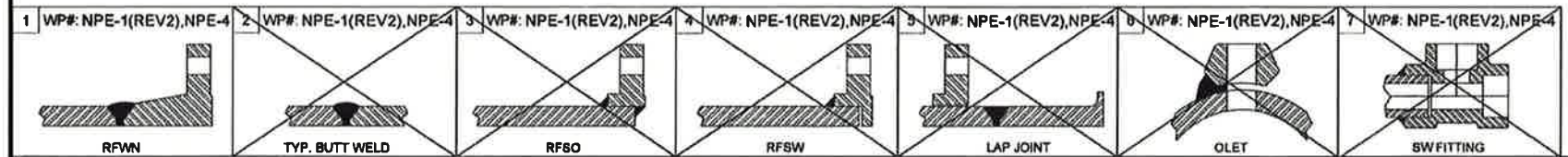
25W

QC COPY

NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

ISSUED FOR CONSTRUCTION
15/04/15
DATE:YYMMDD
SIGNATURE: [Signature]
natpro



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	OWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 14/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 09/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

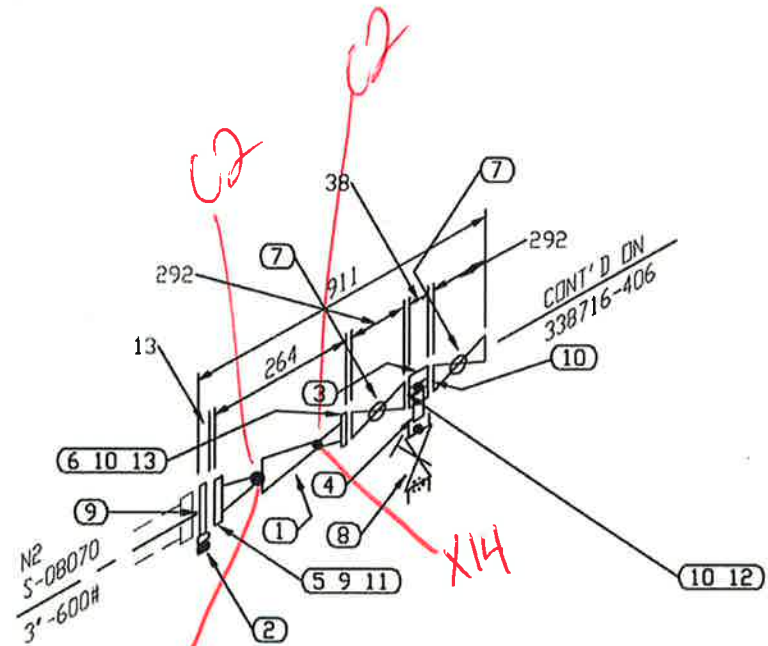
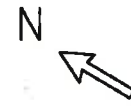
S-08070 GAS INLET SPOOL DETAIL

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natpro

PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
BLS#: 338716 QUOTE: CGY2014-85 POF: 4512-109-130

DRW: GG DATE: JUL 04/14 DWG#: 338716-403-Rev1
CHK: ET DATE: JUL 04/14
APP: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A



QC COPY

NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
FITTINGS				
1	3X2	RED CONC, SCH STD/XS, ASTM A420-WPL-6	1	
2	3	SPECTACLE BLIND, REF. 338716-100 ITEM #29	1	
3	2	BLEED RING, REF. 338716-100 ITEM #34	1	
4	3/4	NIPPLE, SCH 160, ASTM A333-6 PBE (4' LG)	1	
FLANGES				
5	3	FLG RFWN, 600LB, SCH STD, ASTM A350-LF2-CL 1	1	
6	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL 1	1	
VALVES / IN-LINE ITEMS				
7	2	BALL VALVE, FLG, REF. 338716-100 ITEM #21	2	
8	3/4	GATE VALVE, SW/NPT, REF. 338716-100 ITEM #27	1	

ERECTION MATERIALS

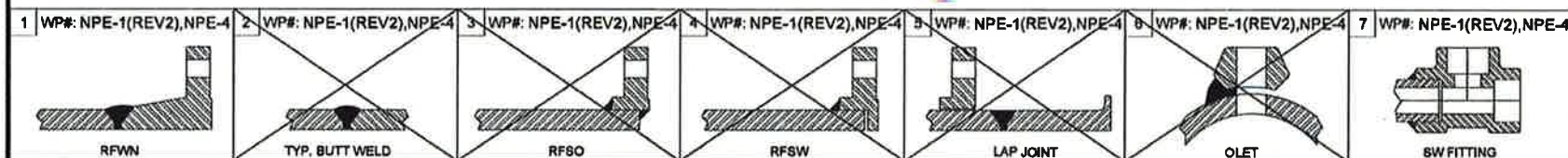
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
9	3	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS DR SS OUTER RING	2	
10	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS DR SS OUTER RING	3	
BOLTS				
11	3X5 3/4	3/4" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
12	2X6	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
13	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

GENERAL NOTES

- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCAW ALLOWED BY SHELL.

ISSUED FOR CONSTRUCTION

15/04/15
DATE: Y/M/WD
SIGNATURE: [Handwritten Signature]



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

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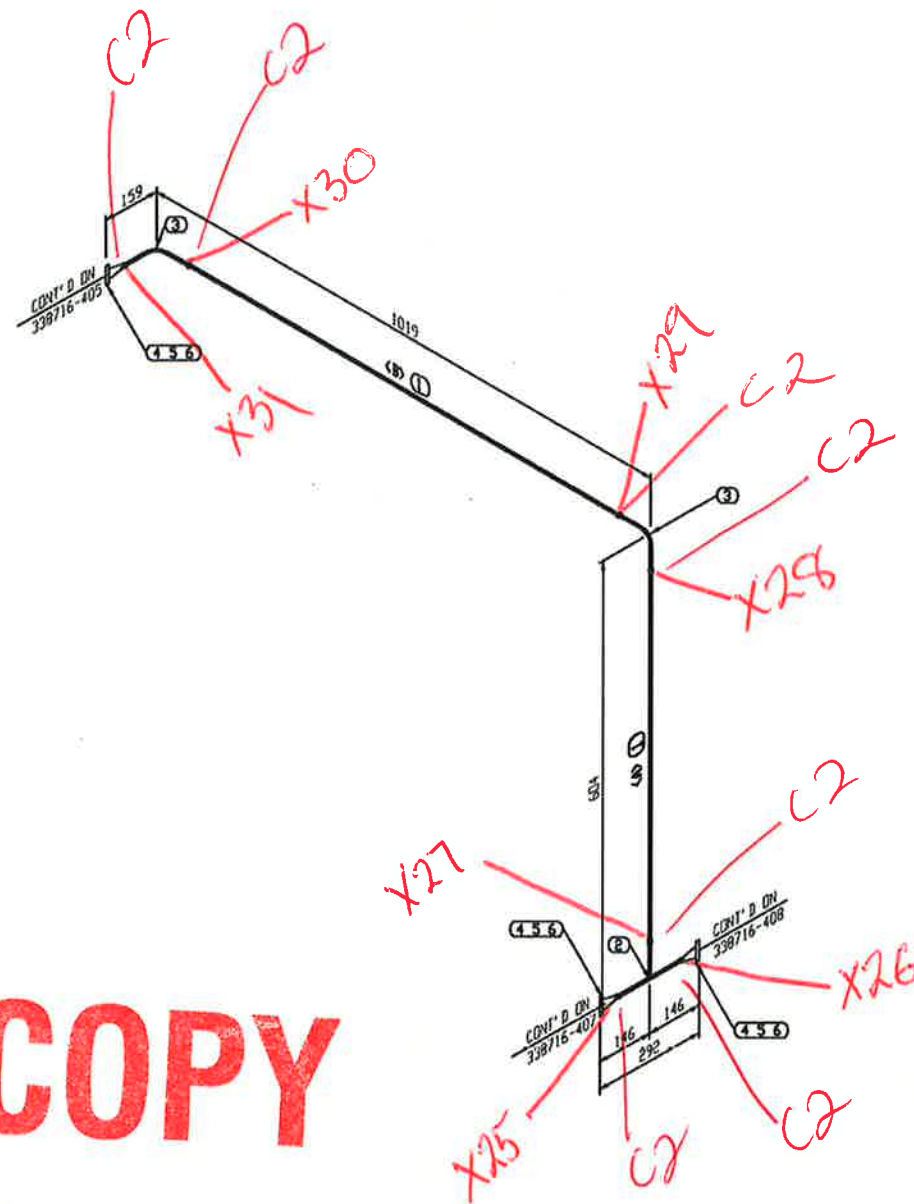


PROJECT NAME: CARMON CREEK PROJECT	
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING	
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2	
TAG: 0735A-08030	
BL# 338716	QUOTE: CGY2014-85
PO# 4512-109-130	
DRW: GG	DATE: JUL 04/14
DRW: ET	DATE: JUL 04/14
APP: COG	DATE: JUL 04/14
DWD #: 338716-405-Rev1	
PAGE: 1 OF 1	CAD: N/A

S-08070 GAS INLET SPOOL DETAIL

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 14/16
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 09/16
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 28/16

100% RT



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BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1319 MM	
FITTINGS				
2	2X2	TEE, SCH XS, ASTM A420-WPL-6	1	
3	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	2	
FLANGES				
4	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL. 1	3	

ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	3	
BOLTS				
6	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	24	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	458	2
	861	2

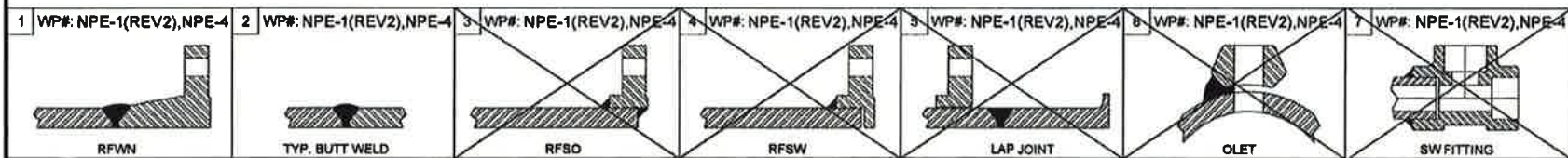
GENERAL NOTES

- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCAW ALLOWED BY SHELL.

ISSUED FOR CONSTRUCTION

15/04/15
DATE:YY/MM/DD

ASD
SIGNATURE



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP/DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

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PROJECT NAME: CARMON CREEK PROJECT

CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING

LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

TAG: 0735A-08030

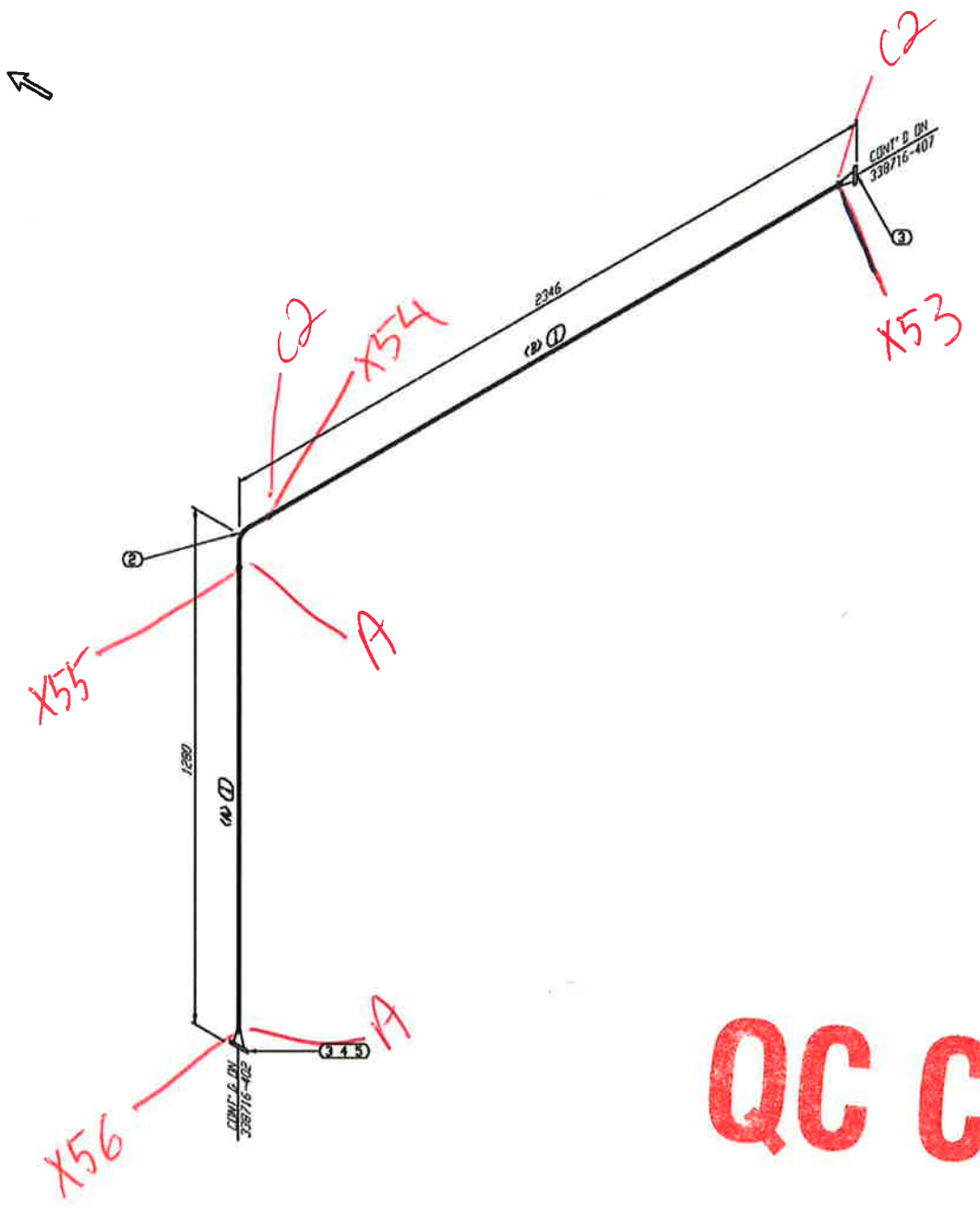
BLP: 338716 QUOTE: CGY2014-85 POR: 4512-109-130

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 28/15

S-08070 GAS INLET SPOOL DETAIL

OWNR: GG	DATE: JUL 04/14	DRW#:	
CHK: ET	DATE: JUL 04/14	338716-406-Rev1	
APP: COG	DATE: JUL 04/14	PAGE: 1 OF 1	CRD: N/A

100% RT



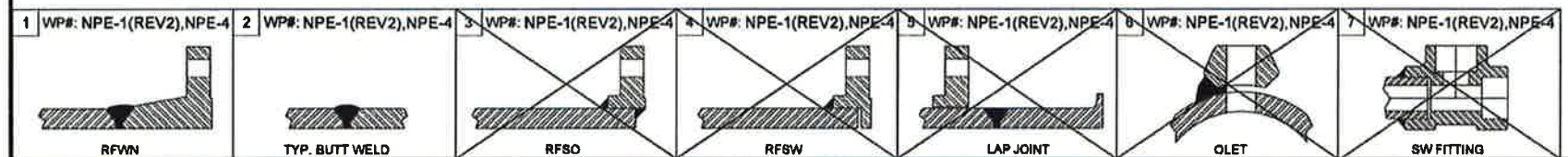
QC COPY

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	3302 MM	
FITTINGS				
2	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	1	
FLANGES				
3	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL. 1	2	
ERECTION MATERIALS				
GASKETS				
4	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS DR SS OUTER RING	1	
BOLTS				
5	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, V/2 NUTS: A194-2H	8	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	1117	2
	2185	2

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE YEAR/MONTH



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	OWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

S-08070 GAS INLET SPOOL DETAIL

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.

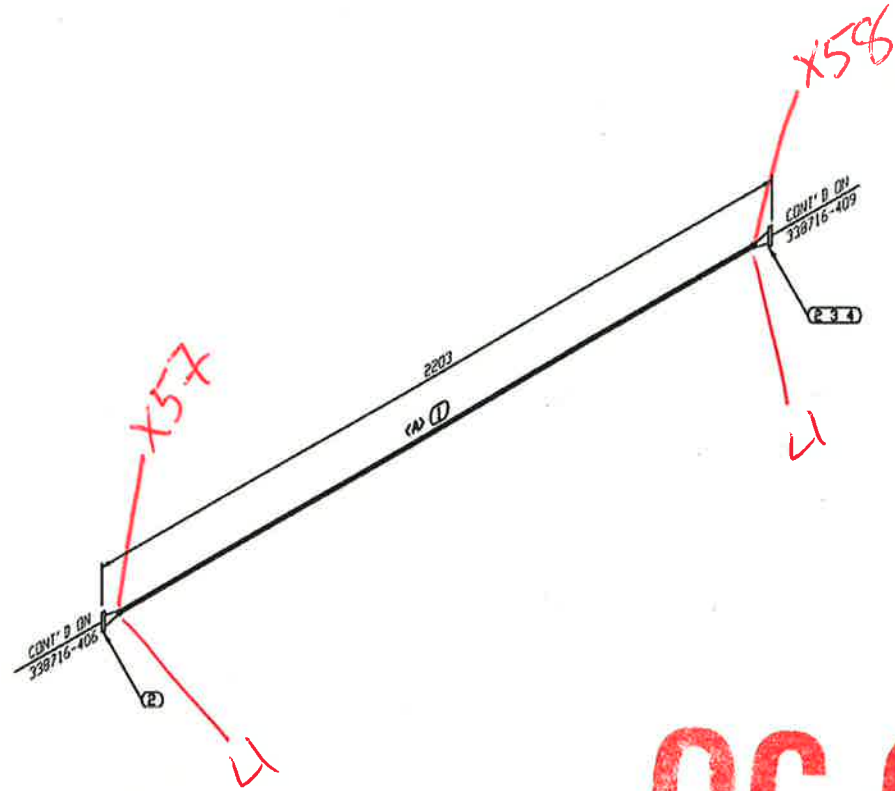
natpro

PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 BL# 338716 QUOTE: CGY2014-85 FOR 4512-109-130

DATE: JUL 04/14
 DATE: JUL 04/14
 DATE: JUL 04/14

1 OF 1

100% RT



QC COPY

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	2037 MM	
FLANGES				
2	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL. 1	2	

ERECTION MATERIALS

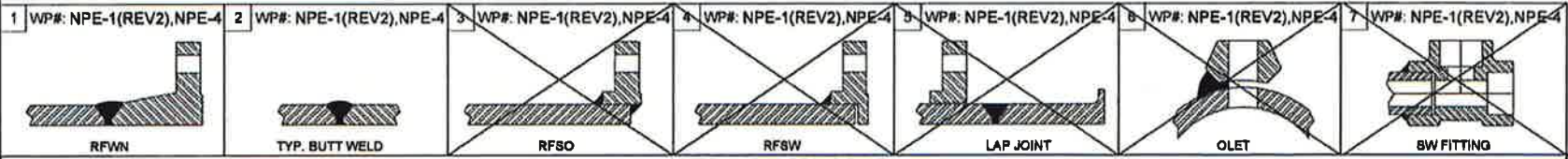
BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
3	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
4	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	2037	2

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE: YY/MM/DD
 natpro



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

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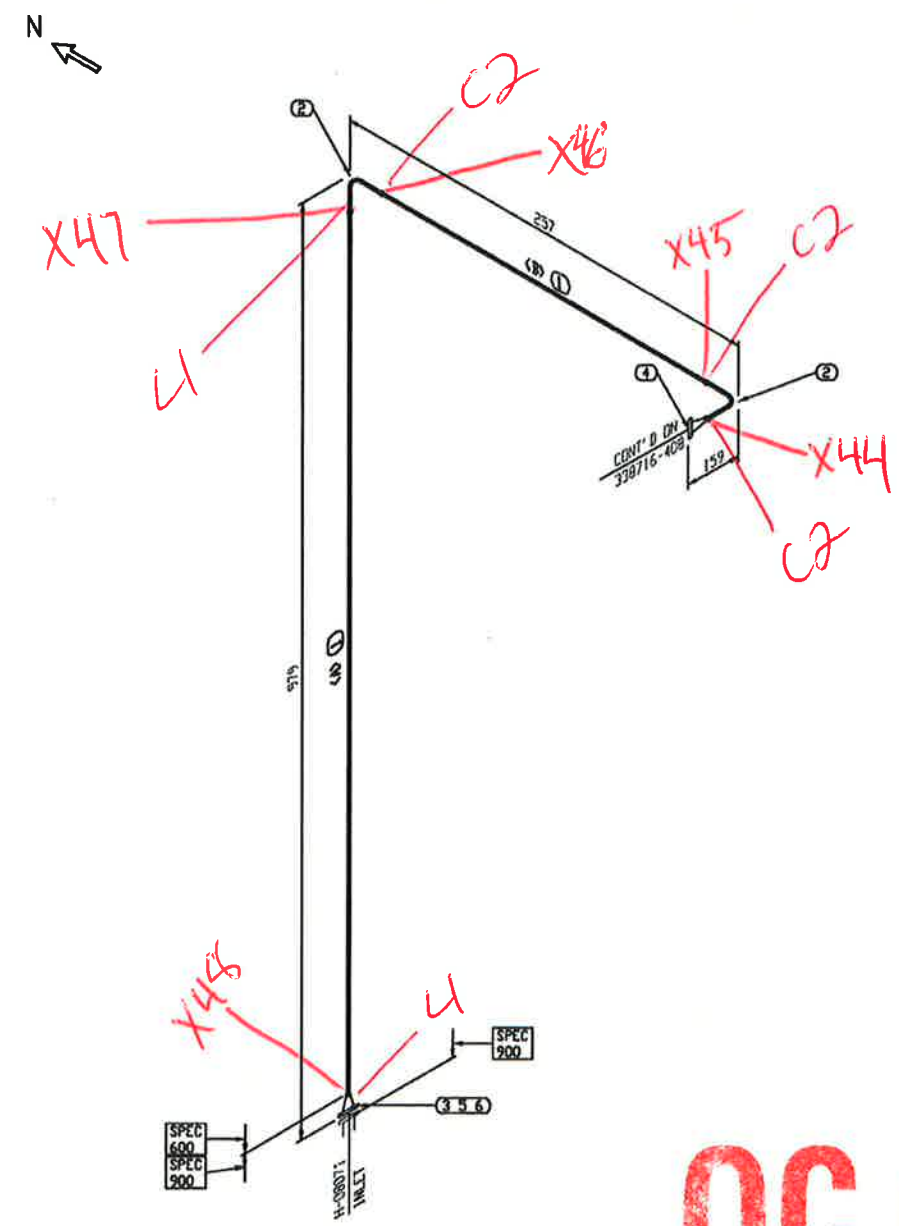
PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 BLG#: 338716 QUOTE: CGY2014-85 POF: 4512-109-130

DATE: JUL 04/14
 DATE: JUL 04/14
 DATE: JUL 04/14

338716-408-Rev0
 PAGE: 1 OF 1

**GAS TO H-08071
 SPOOL DETAIL**

100% RT



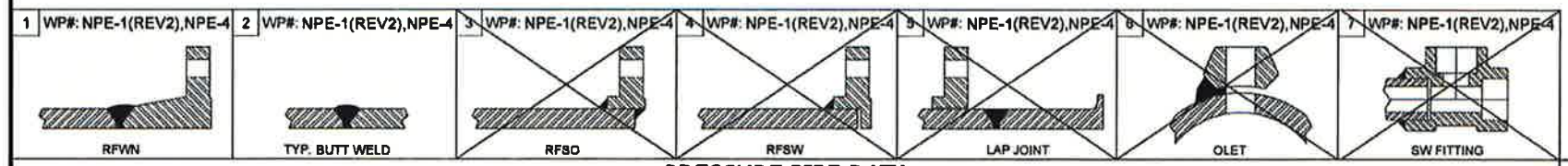
QC COPY

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	888 MM	
FITTINGS				
2	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	2	
FLANGES				
3	2	FLG RFWN, 1500LB, SCH XS, ASTM A350-LF2-CL.1	1	
4	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL.1	1	
ERECTION MATERIALS				
GASKETS				
5	2	GASKET, 1500LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
6	2X5 3/4	7/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	789	2
	99	2

- GENERAL NOTES**
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 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE:YY/MM/DD
 SIGNATURE: [Signature]
 natpro



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI-RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

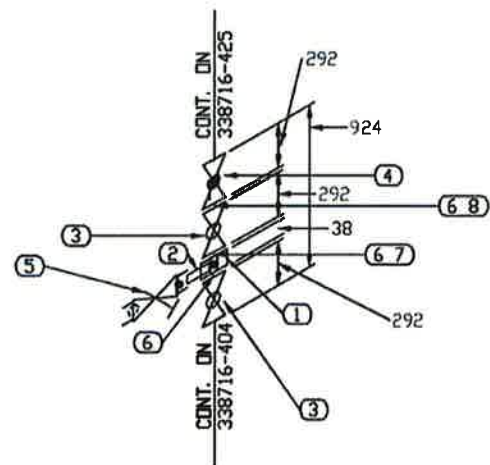
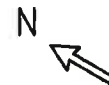
DESCRIPTION	DWN	CHK	APP	DATE
1 CHANGED NOTES	LK	AA	AA	APR 13/15
2 ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
3 ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 BL#P: 338716 QUOTE: CGY2014-85 POP: 4512-109-130
 DWN: GG DATE: JUL 04/14 DNG: 338716-409-Rev1
 DWT: ET DATE: JUL 04/14
 APP: COG DATE: JUL 04/14 PAGE: 1 OF 1 CND: N/A

GAS TO H-08071
 SPOOL DETAIL



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
------	------	-------------	-----	-----

FITTINGS				
1	2	BLEED RING, REF. 338716-100 ITEM #34	1	
2	3/4	NIPPLE, SCH 160, ASTM A333-6 PBE (4' LG)	1	
VALVES / IN-LINE ITEMS				
3	2	BALL VALVE, FLG, REF. 338716-100 ITEM #21	2	
4	2	GLOBE VALVE, FLG, REF. 338716-100 ITEM #36	1	
5	3/4	GATE VALVE, SW/NPT, REF. 338716-100 ITEM #27	1	

ERECTION MATERIALS

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
------	------	-------------	-----	-----

GASKETS				
6	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	3	
BOLTS				
7	2X6	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
8	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

2 SW

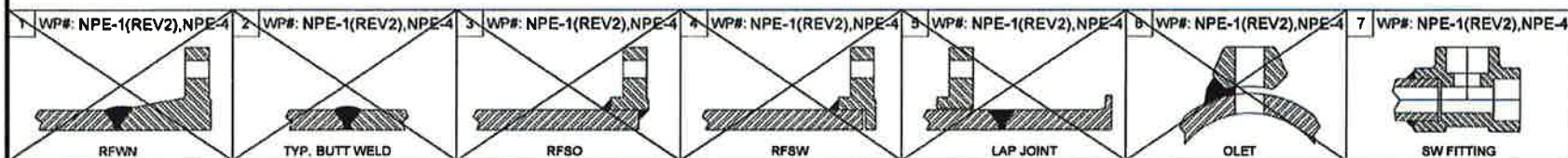
2 SW

QC COPY

NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY, FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

ISSUED FOR CONSTRUCTION
15/04/15
DATE: YY/MM/DD
natpro



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10% MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

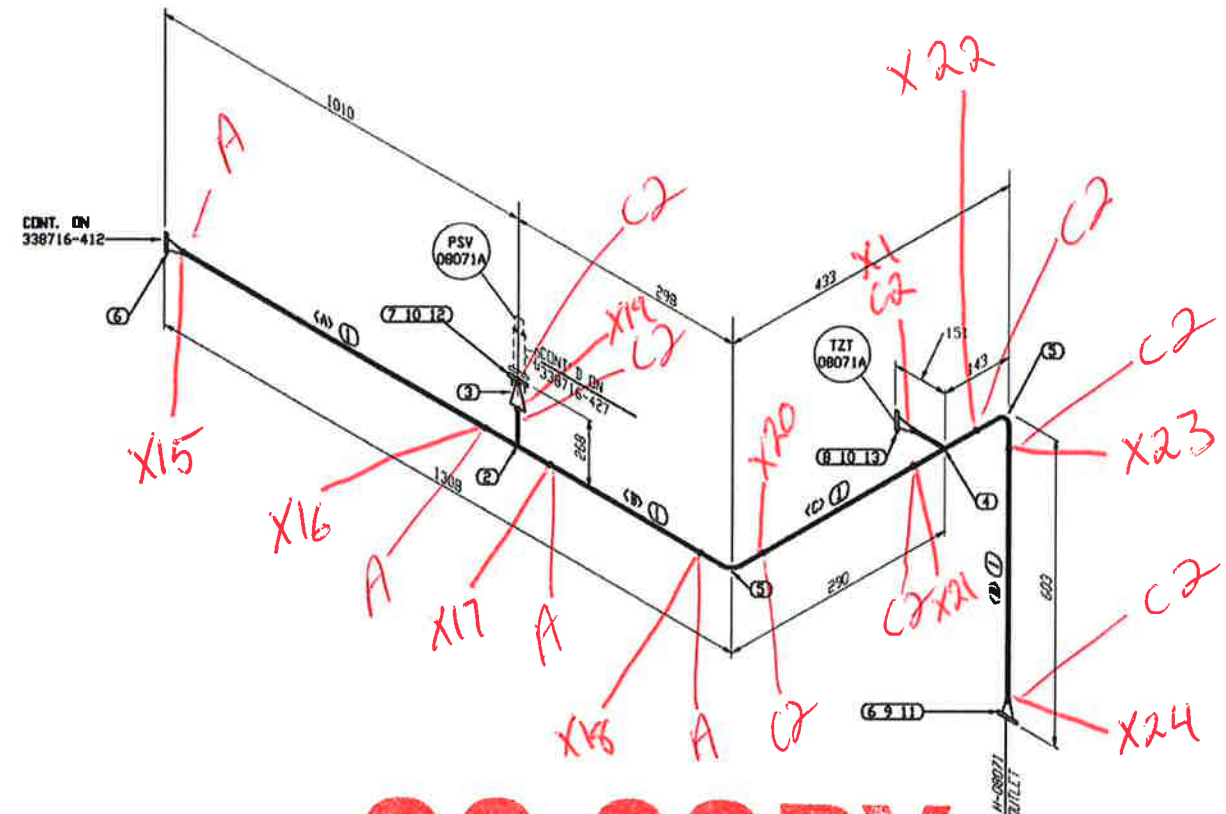
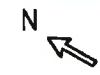
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PROJECT NAME: CARMON CREEK PROJECT	CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2	TAG: 0735A-08030
SLIP#: 338716	QUOTE: CGY2014-85
PO# 4512-109-130	
DWG# GG	DATE: JUL 04/14
CHK# ET	DATE: JUL 04/14
APP# COG	DATE: JUL 04/14
DWG#	338716-410-Rev1
PH#	1 OF 1
CAD#	N/A

SPOOL DETAIL

100% RT



QC COPY

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1543 MM	
FITTINGS				
2	2X2	TEE, SCH XS, ASTM A420-WPL-6	1	
3	2X1 1/2	SWAGE CONC, SCH XS, ASTM A420-WPL-6 BLE	1	
4	2X1 1/2	TEE RED, SCH XS, ASTM A420-WPL-6	1	
5	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	2	
FLANGES				
6	2	FLG RFWN, 1500LB, SCH XS, ASTM A350-LF2-CL. 1	2	
7	1 1/2	FLG RFSW, 1500LB, SCH XS, ASTM A350-LF2-CL. 1	1	
8	1 1/2	FLG RFWN, 1500LB, SCH XS, ASTM A350-LF2-CL. 1	1	

12 BW
1 SW

ERECTION MATERIALS

BILL OF MATERIAL

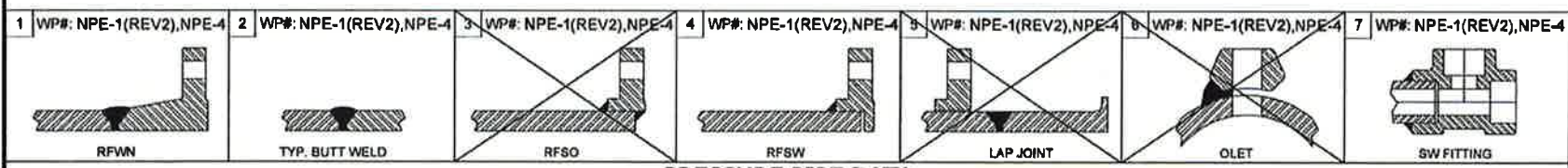
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
9	2	GASKET, 1500LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
10	1 1/2	GASKET, 1500LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	2	
BOLTS				
11	2X5 3/4	7/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
12	1 1/2X6 1/4	1" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	
13	1 1/2X5 1/2	1" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	832	2
	153	2
<C>	145	2
<D>	413	2

ISSUED FOR CONSTRUCTION

15/04/15
DATE:YY/MM/DD SIGNATURE



SPECIFICATION: SHELL C20W CLASS 900	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 3330 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 2035 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

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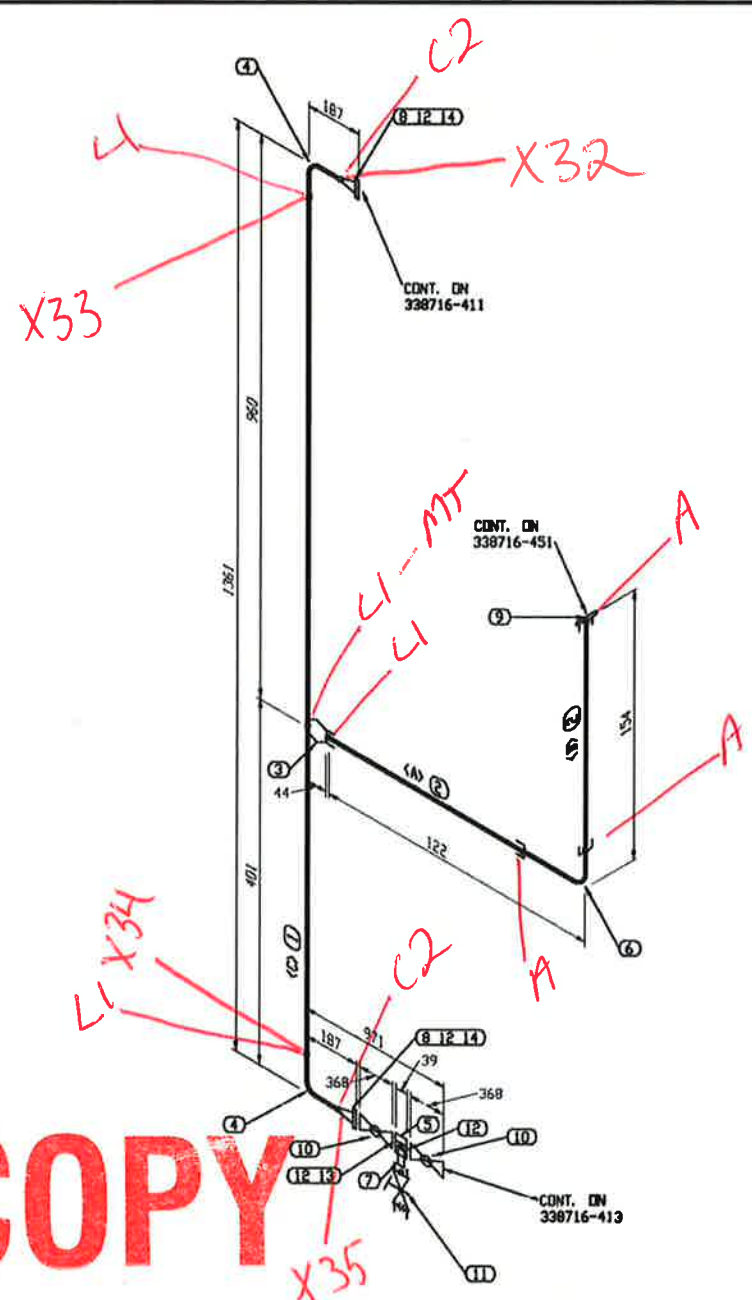
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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 BLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
 DATE: APR 06/15
 DATE: APR 09/15
 DATE: APR 09/15
 PAGE: 1 OF 1
 CND: N/A

H-08071 OUTLET
SPOOL DETAIL

100% RT

QC COPY



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1202 MM	
2	3/4	PIPE, SMLS, SCH XS, ASTM A333-6	203 MM	
FITTINGS				
3	2X3/4	OLET, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
4	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	2	
5	2	BLEED RING, REF. 338716-100 ITEM #35	1	
6	3/4	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
7	3/4	NIPPLE, SCH 160, ASTM A333-6 PBE (6" LG)	1	
FLANGES				
8	2	FLG RFSW, 1500LB, SCH XS, ASTM A350-LF2-CL. 1	2	
9	3/4	FLG RFSW, 1500LB, SCH XS, ASTM A350-LF2-CL. 1	1	
VALVES / IN-LINE ITEMS				
10	2	BALL VALVE, FLG, REF. 338716-100 ITEM #22	2	
11	3/4	GATE VALVE, SW/NPT, REF. 338716-100 ITEM #27A	1	

LI BW
1 olet
6 SW

ERECTOR MATERIALS				
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
12	2	GASKET, 1500LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	4	
BOLTS				
13	2X7 1/2	7/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
14	2X5 3/4	7/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	16	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	101	3/4
	102	3/4
<C>	1202	2

6 SW
1 olet

ISSUED FOR CONSTRUCTION
15/04/15
DATE: YY/MM/DD
SIGNATURE
natpro

NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

1	2	3	4	5	6	7
WP#: NPE-1(REV2),NPE-4	WP#: NPE-1(REV2),NPE-4	WP#: NPE-1(REV2),NPE-4	WP#: NPE-1(REV2),NPE-4	WP#: NPE-1(REV2),NPE-4	WP#: NPE-1(REV2),NPE-4	WP#: NPE-1(REV2),NPE-4
RFWN	TYP. BUTT WELD	RFSO	RFSW	LAP JOINT	OLET	6W FITTING

PRESSURE PIPE DATA

SPECIFICATION: SHELL C20W CLASS 900	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 3330 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 2035 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO PCAW ALLOWED BY SHELL.

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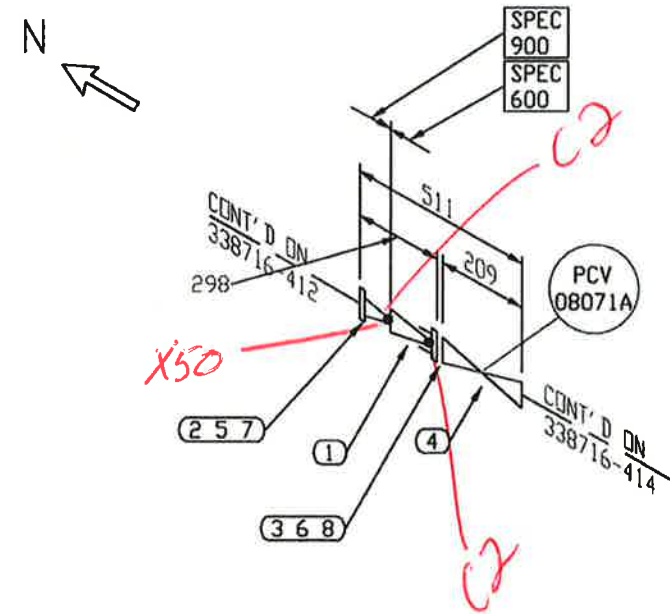
PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
BL# 338716 QUOTE CGY2014-85 PO# 4512-109-130

DATE: APR 06/15
DATE: APR 09/15
DATE: APR 09/15

338716-412-Rev0
PAGE: 1 OF 1
CARE: N/A

GAS OUTLET SPOOL DETAIL

100% RT



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
FITTINGS				
1	2X1	SWAGE CONC, SCH XS, ASTM A420-WPL-6 BLE PSE	1	
FLANGES				
2	2	FLG RFWN, 1500LB, SCH XS, ASTM A350-LF2-CL. 1	1	
3	1	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	1	
INSTRUMENTS				
4	1	CONTROL VALVE, FLG, REF. 338716-100 ITEM #9	1	

1 Bw
1 Sw

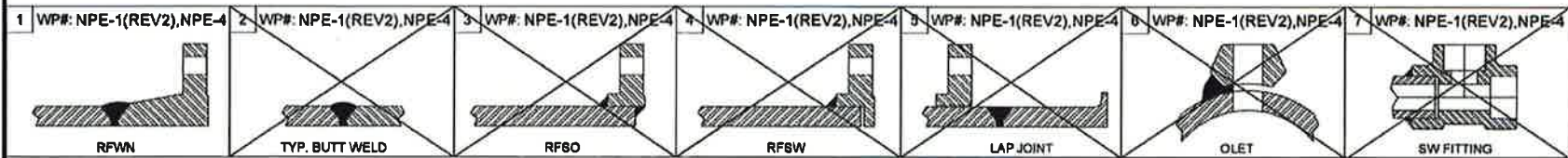
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	2	GASKET, 1500LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
6	1	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
7	2X5 3/4	7/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
8	1X3 3/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

1 Sw

QC COPY

- GENERAL NOTES**
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 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

ISSUED FOR CONSTRUCTION
15/04/15
DATE: YYMMDD
188
SIGNATURE
matjones



PRESSURE PIPE DATA		
SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10% MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CJ M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

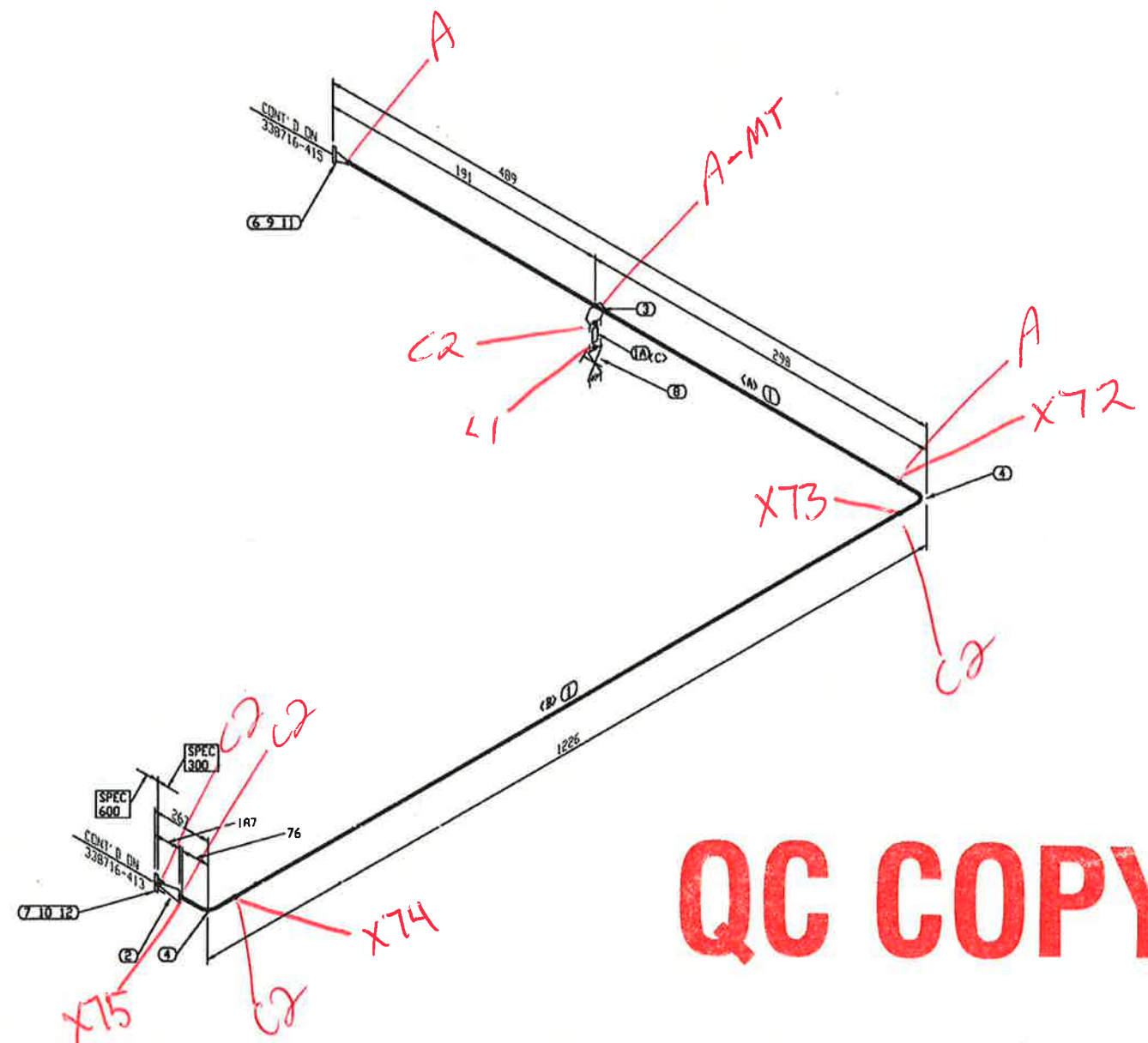
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PROJECT NAME: CARMON CREEK PROJECT	
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING	
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2	
TAG: 0735A-08030	SLBP: 338716 QUOTE: CGY2014-85 PO# 4512-109-130
OWNR: GG DATE: JUL 04/14	DRW: ET DATE: JUL 04/14
APP: COG DATE: JUL 04/14	PHYS: 1 OF 1 CAD: N/A

GAS OUTLET SPOOL DETAIL

15% RT



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1404 MM	
1A	3/4	PIPE, SMLS, SCH XS, ASTM A333-6	102 MM	
FITTINGS				
2	2X1	SWAGE CONC, SCH XS, ASTM A420-WPL-6 BLE PSE	1	
3	2X3/4	OLET, SW, 3000LB, ASTM A350-LF2-CL 1	1	
4	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	2	
5	-	REMOVED	-	
FLANGES				
6	2	FLG RFWN, 300LB, SCH XS, ASTM A350-LF2-CL 1	1	
7	1	FLG RFSV, 600LB, SCH XS, ASTM A350-LF2-CL 1	1	
VALVES / IN-LINE ITEMS				
8	3/4	GATE VALVE, SW/NPT, REF. 338716-100 ITEM #27	1	

5 BW
2 SW
1 olet

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
9	2	GASKET, 300LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS DR SS OUTER RING	1	
10	1	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS DR SS OUTER RING	1	
BOLTS				
11	2X3 1/2	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
12	1X3 3/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	337	2
	1067	2
<C>	102	3/4

3 SW
1 olet

ISSUED FOR CONSTRUCTION

15/04/15
DATE:YY/MM/DD

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- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.



PROJECT NAME: CARMON CREEK PROJECT

CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING

LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

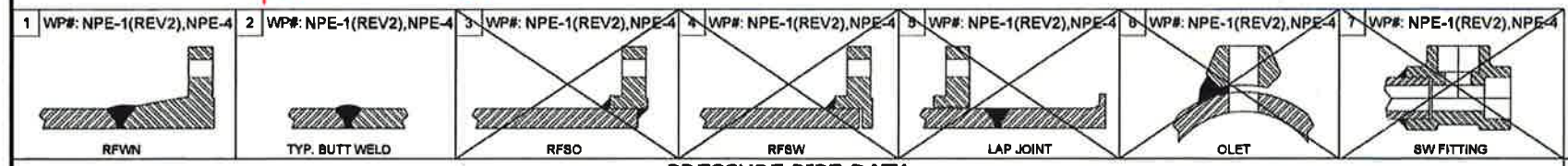
TAD: 0735A-08030

DLB#: 338716 QUOTE: CGY2014-85 POP: 4512-109-130

DWG#: GG DATE: JUL 04/14 DWS#: 338716-414-Rev1

DWG#: ET DATE: JUL 04/14

APP#: COG DATE: JUL 04/14 PAGE: 1 OF 1 GRD: N/A



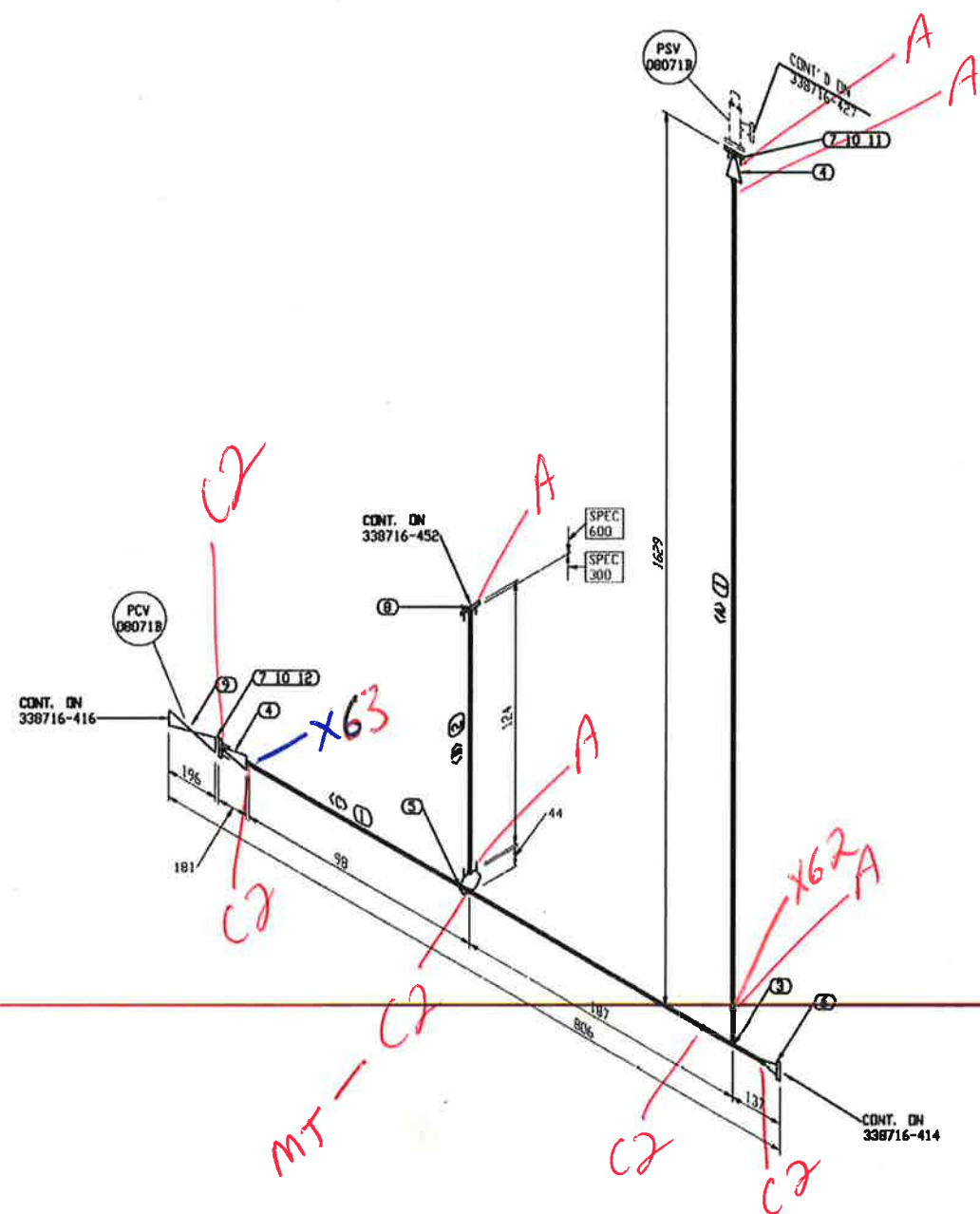
PRESSURE PIPE DATA

SPECIFICATION: SHELL E20W CLASS 300	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 1110 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 680 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	OWN	CHK	APP	DATE
1	ADDED 1A, REMOVED 4B, CHANGED NOTES	LK	AA	AA	APR 13/11
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/11
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 28/11

**GAS OULET
SPOOL DETAIL**

1590 RT



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1597 MM	
2	3/4	PIPE, SMLS, SCH XS, ASTM A333-6	102 MM	
FITTINGS				
3	2X2	TEE, SCH XS, ASTM A420-WPL-6	1	
4	2X1	SWAGE CONC, SCH XS, ASTM A420-WPL-6 BLE	2	
5	2X3/4	OLET, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
FLANGES				
6	2	FLG RFWN, 300LB, SCH XS, ASTM A350-LF2-CL. 1	1	
7	1	FLG RFSV, 300LB, SCH XS, ASTM A350-LF2-CL. 1	2	
8	3/4	FLG RFSV, 600LB, SCH XS, ASTM A350-LF2-CL. 1	1	
INSTRUMENTS				
9	1	CONTROL VALVE, FLG, REF. 338716-100 ITEM #10	1	

5 BW
2 SW
1 o/et

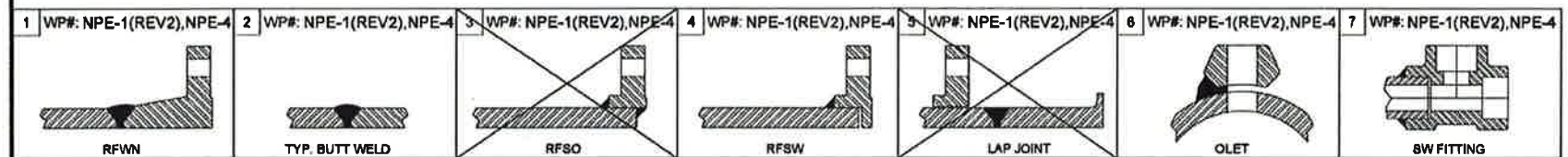
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
10	1	GASKET, 300LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	2	
BOLTS				
11	1X3 3/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	
12	1X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	1378	2
	102	3/4
<C>	219	2

4 SW
1 o/et

QC COPY

ISSUED FOR CONSTRUCTION
15/04/15
DATE YVAM/DJ
SIGNATURE
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PRESSURE PIPE DATA

SPECIFICATION: SHELL E20W CLASS 300	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 1110 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 680 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

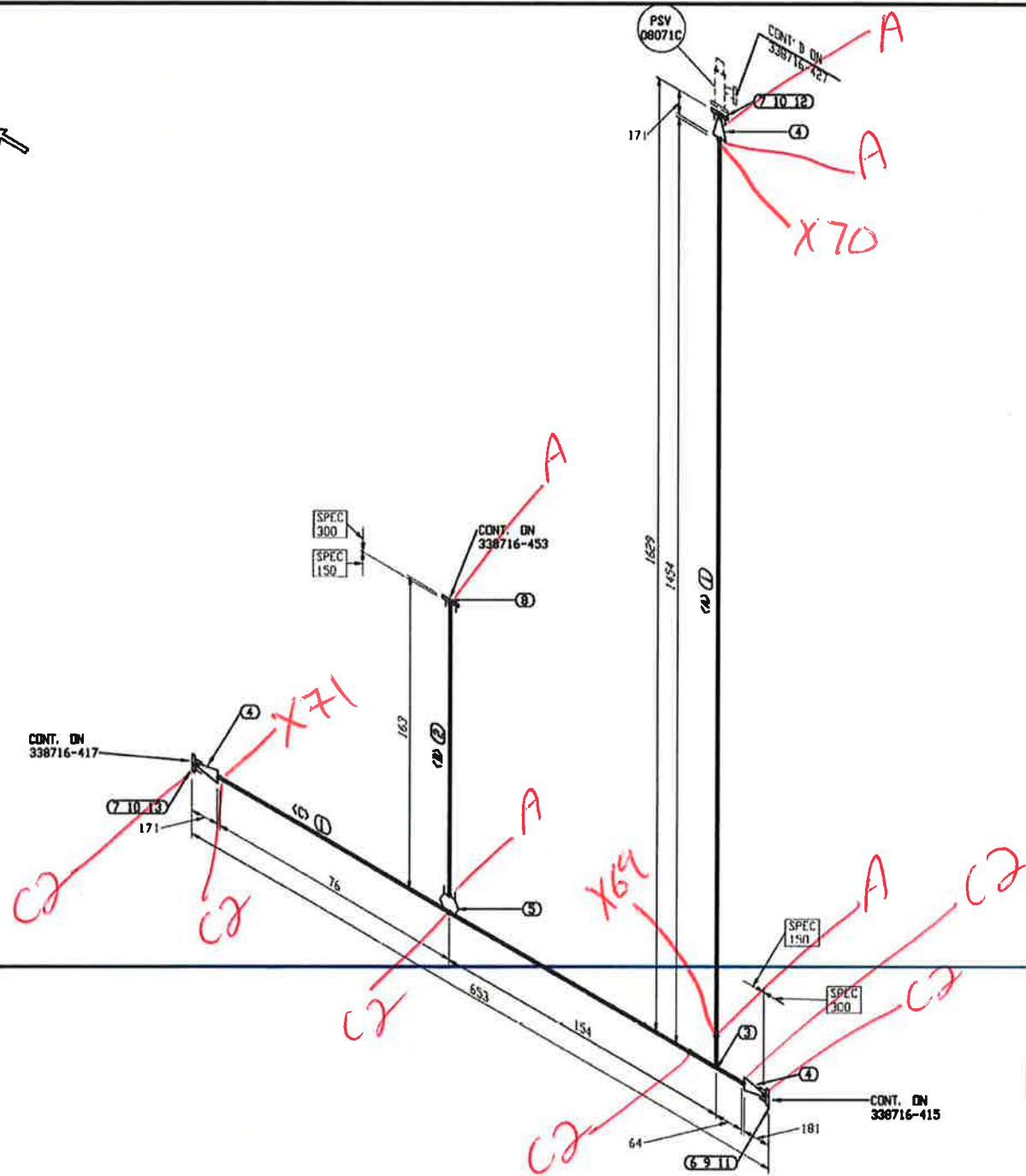
ISSUED FOR CONSTRUCTION	LK	AA	AA	APR 08/15
DESCRIPTION	DWN	CHK	APP	DATE
GAS OUTLET SPOOL DETAIL				

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PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
BL# 338716 QUOTE CGY2014-85 POF 4512-109-130

DWG# LK DATE APR 06/15 DRG# 338716-415-Rev0
CHK# AA DATE APR 09/15
APP# AA DATE APR 09/15 PAGE 1 OF 1 CND N/A



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1550 MM	
2	3/4	PIPE, SMLS, SCH XS, ASTM A333-6	102 MM	
FITTINGS				
3	2X2	TEE, SCH XS, ASTM A420-WPL-6	1	
4	2X1	SWAGE CONC, SCH XS, ASTM A420-WPL-6 BLE PSE	3	
5	2X3/4	OLET, SW, 300LB, ASTM A350-LF2-CL. 1	1	
FLANGES				
6	1	FLG RFSW, 300LB, SCH XS, ASTM A350-LF2-CL. 1	1	
7	1	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL. 1	2	
8	3/4	FLG RFSW, 300LB, SCH XS, ASTM A350-LF2-CL. 1	1	

5 BW
3 SW
1 olet

ERECTION MATERIALS				
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
9	1	GASKET, 300LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
10	1	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	2	
BOLTS				
11	1X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	
12	1X3 1/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	
13	1X2 3/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	1387	2
	102	3/4
<C>	163	2

5 SW
1 olet

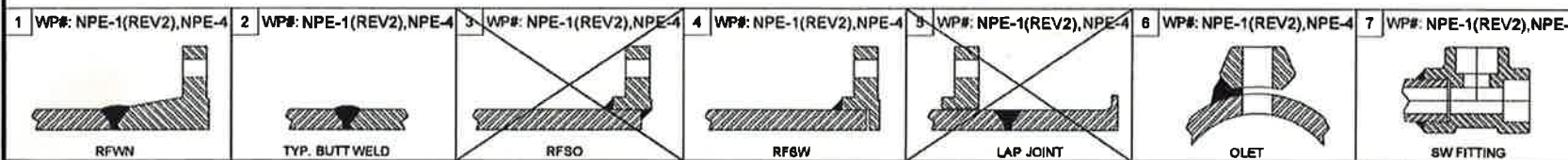
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ISSUED FOR CONSTRUCTION

15/04/15
DATE: YY/MM/DD

[Signature]
SIGNATURE

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PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT	
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING	
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2	
TAG: 0735A-08030	BLR#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
DATE: LK APR 06/15	DATE: AA APR 09/15
DATE: AA APR 09/15	DATE: AA APR 09/15
DATE: AA APR 09/15	DATE: AA APR 09/15
DATE: AA APR 09/15	DATE: AA APR 09/15

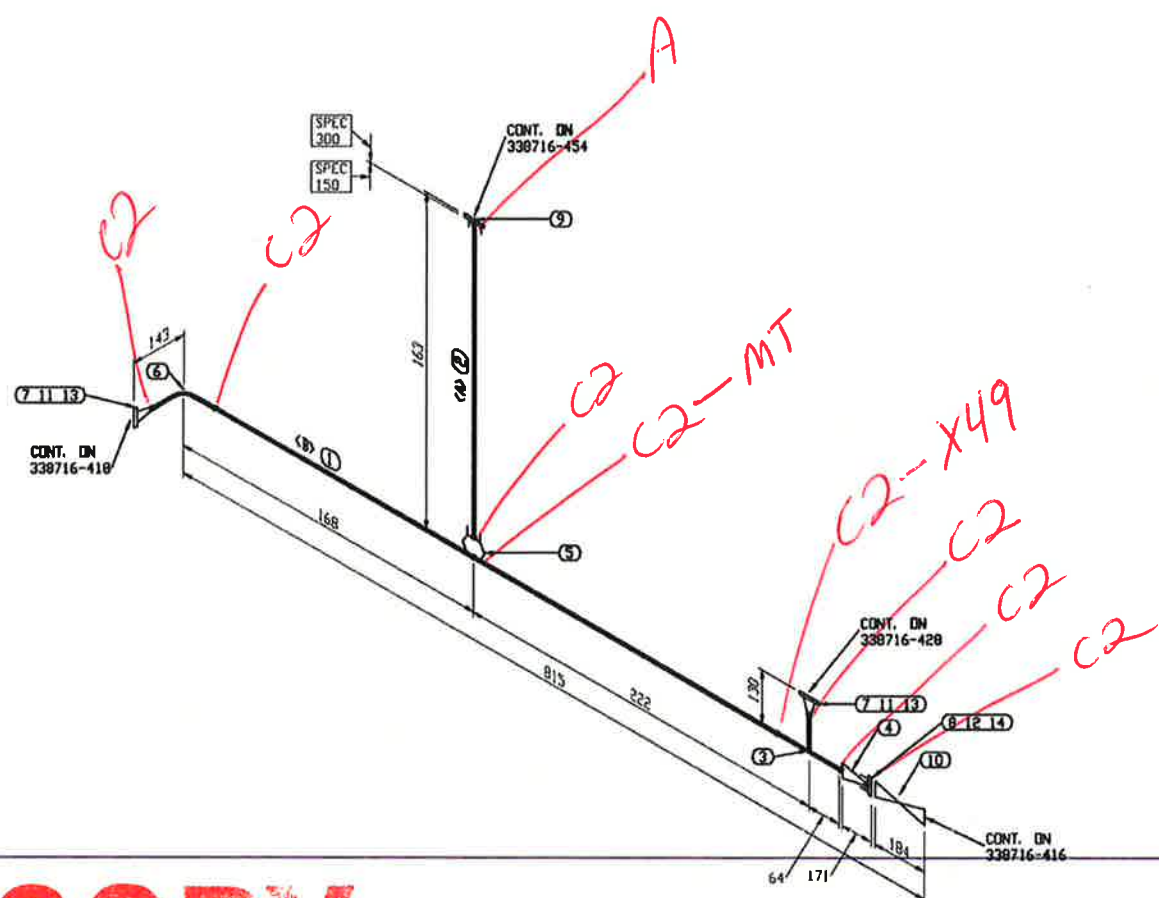
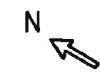
GAS OUTLET SPOOL DETAIL

338716-416-Rev0

1 OF 1

N/A

1590 RT



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	243 MM	
2	3/4	PIPE, SMLS, SCH XS, ASTM A333-6	102 MM	
FITTINGS				
3	2X2	TEE, SCH XS, ASTM A420-WPL-6	1	
4	2X1	SWAGE CONC, SCH XS, ASTM A420-WPL-6 BLE PSE	1	
5	2X3/4	OLET, SV, 3000LB, ASTM A350-LF2-CL. 1	1	
6	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	1	
FLANGES				
7	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL. 1	2	
8	1	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL. 1	1	
9	3/4	FLG RFSW, 300LB, SCH XS, ASTM A350-LF2-CL. 1	1	
INSTRUMENTS				
10	1	CONTROL VALVE, FLG, REF. 338716-100 ITEM #11	1	

5 BW
3 SW
1 olet

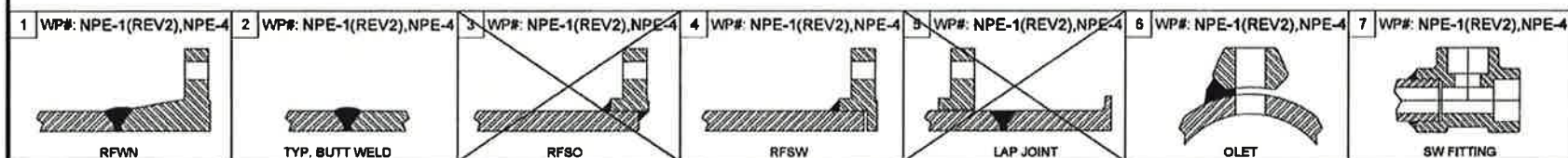
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
11	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	2	
12	1	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
BOLTS				
13	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
14	1X2 3/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	102	3/4
	243	2

3 SW
1 olet

ISSUED FOR CONSTRUCTION
15/04/15
DATE: YY/MM/DD
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PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP/DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

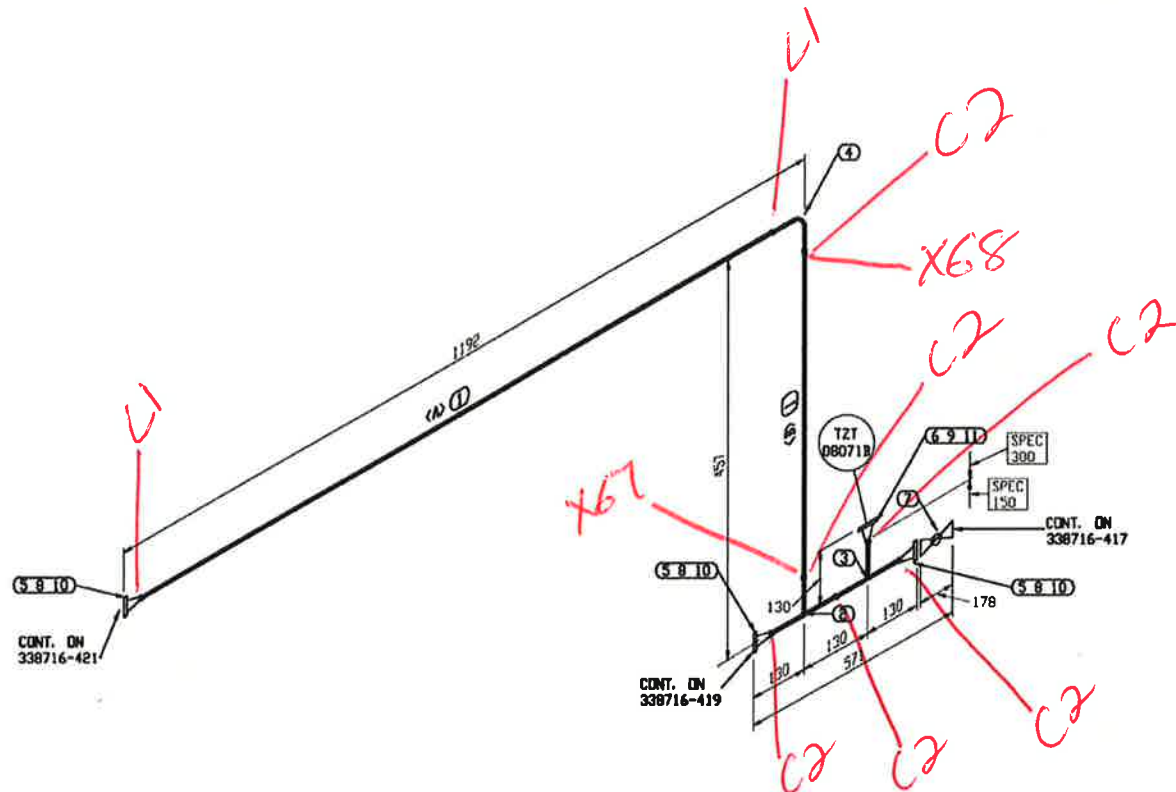
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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 BLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
 DATE: APR 06/15
 DATE: APR 09/15
 DATE: APR 09/15
 338716-417 -Rev0
 PAGE: 1 OF 1

GAS OUTLET SPOOL DETAIL

15% RT



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1357 MM	
FITTINGS				
2	2X2	TEE, SCH XS, ASTM A420-WPL-6	1	
3	2X1 1/2	TEE RED, SCH XS, ASTM A420-WPL-6	1	
4	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	1	
FLANGES				
5	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL.1	3	
6	1 1/2	FLG RFWN, 300LB, SCH XS, ASTM A350-LF2-CL.1	1	
VALVES / IN-LINE ITEMS				
7	2	BALL VALVE, FLG, REF. 338716-100 ITEM #20	1	

S B W

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
8	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	3	
9	1 1/2	GASKET, 300LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
10	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	12	
11	1 1/2X3 3/4	3/4" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	1045	2
	312	2

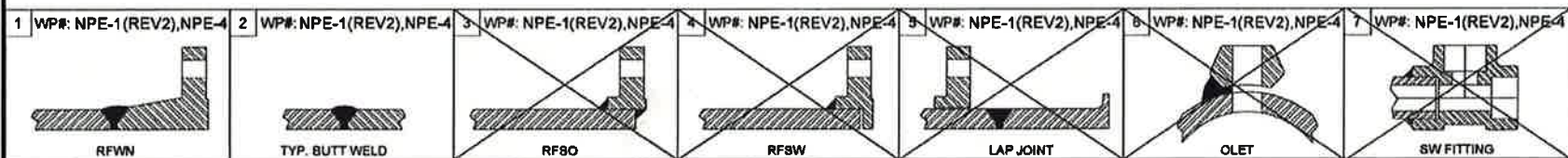
ISSUED FOR CONSTRUCTION

15/04/15, [Signature]
DATE: YYY/M/DD SIGNATURE



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NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.



PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

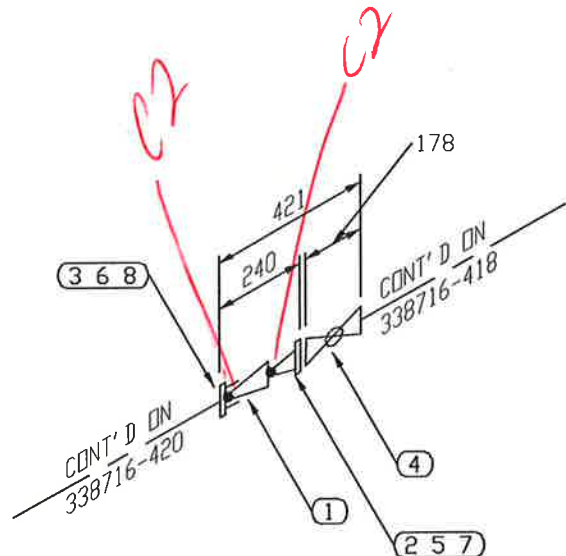
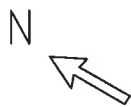
- GENERAL NOTES
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT	CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2	TAG: 0735A-08030
BL# 338716	QUOTE CGY2014-85
DATE: LK APR 06/15	DATE: AA APR 09/15
DATE: AA APR 09/15	DATE: AA APR 09/15
NO: 338716-418-Rev0	PAGE: 1 OF 1
PO# 4512-109-130	CAD: N/A

GAS OUTLET SPOOL DETAIL



QC COPY

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
<u>FITTINGS</u>				
△ 1	2X1/2	SWAGE CONC, SCH XS, ASTM A420-WPL-6 BLE PSE	1	
<u>FLANGES</u>				
2	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL. 1	1	
3	1/2	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL. 1	1	
<u>VALVES / IN-LINE ITEMS</u>				
4	2	BALL VALVE, FLG, REF. 338716-100 ITEM #20	1	

ERECTION MATERIALS

BILL OF MATERIAL

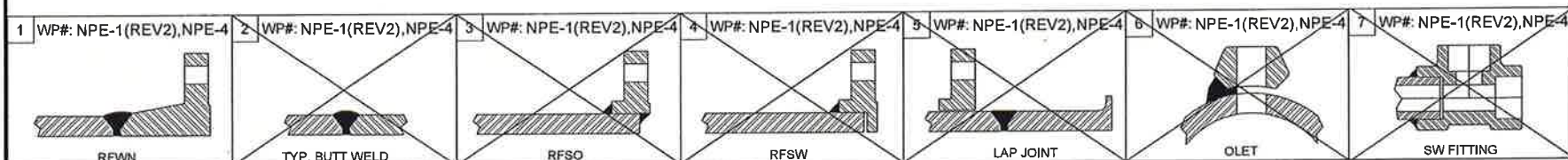
MARK	SIZE	DESCRIPTION	QTY	HT#
<u>GASKETS</u>				
5	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
6	1/2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
<u>BOLTS</u>				
7	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	
8	1/2X2 1/2	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

ISSUED FOR CONSTRUCTION

15/04/13
DATE:YY/MM/DD
SIGNATURE
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PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	DWN	CHK	APP	DATE
2	CHANGED SWAGE SIZE OF ITEM #1	LK	AA	AA	APR 30/15
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

GAS OUTLET SPOOL DETAIL

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.

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PROJECT NAME: CARMON CREEK PROJECT

CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING

LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

TAG: 0735A-08030

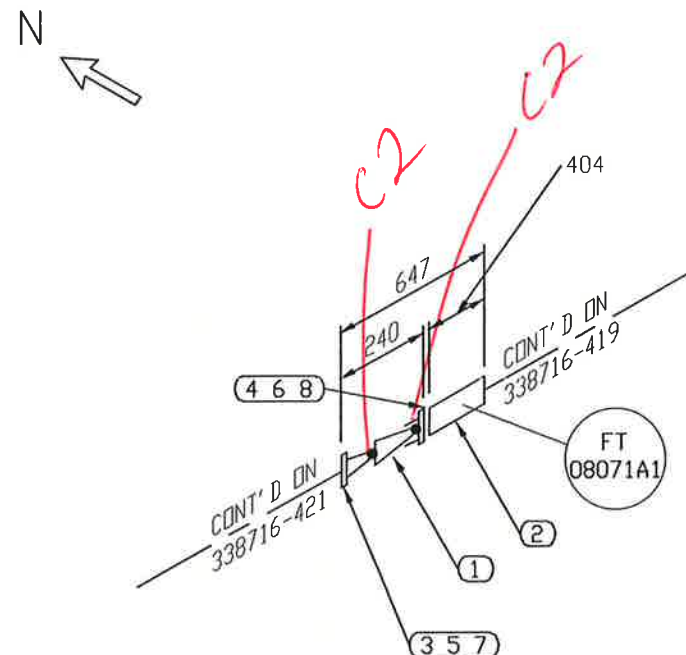
SLS# 338716 QUOTE: CGY2014-85 PO# 4512-109-130

DWN BY: GG DATE: JUL 04/14 DWG #: 338716-419-Rev2

CHK BY: ET DATE: JUL 04/14

APP BY: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A

Spl. Revised 01-MAY-15



QC COPY

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
FITTINGS				
△ 1	2X1/2	SWAGE CONC, SCH XS, ASTM A420-WPL-6 BLE PSE	1	
2	1/2	FLOW METER, FLG, REF. 338716-100 ITEM #16	1	
FLANGES				
3	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL.1	1	
4	1/2	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL.1	1	

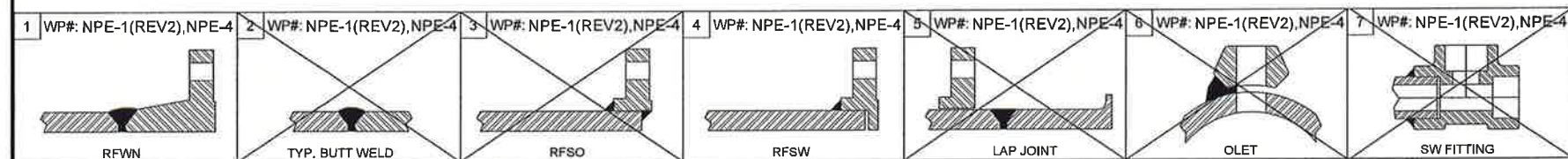
ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
6	1/2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
BOLTS				
7	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	
8	1/2X2 1/2	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

GENERAL NOTES

1. ALL DIMENSIONS ARE IN mm U.N.O.
2. FABRICATION TOLERANCE +/- 3mm U.N.O.
3. CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
4. ROOT GAP TO BE 1.6mm MAX.
5. NO FCAW ALLOWED BY SHELL.

CONSTRUCTION
15/04/30
SIGNATURE
pro



PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	DWN	CHK	APP	DATE
2	CHANGED SWAGE SIZE OF ITEM #1	LK	AA	AA	APR 30/15
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

GAS OUTLET SPOOL DETAIL

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PROJECT NAME: CARMON CREEK PROJECT

CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING

LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

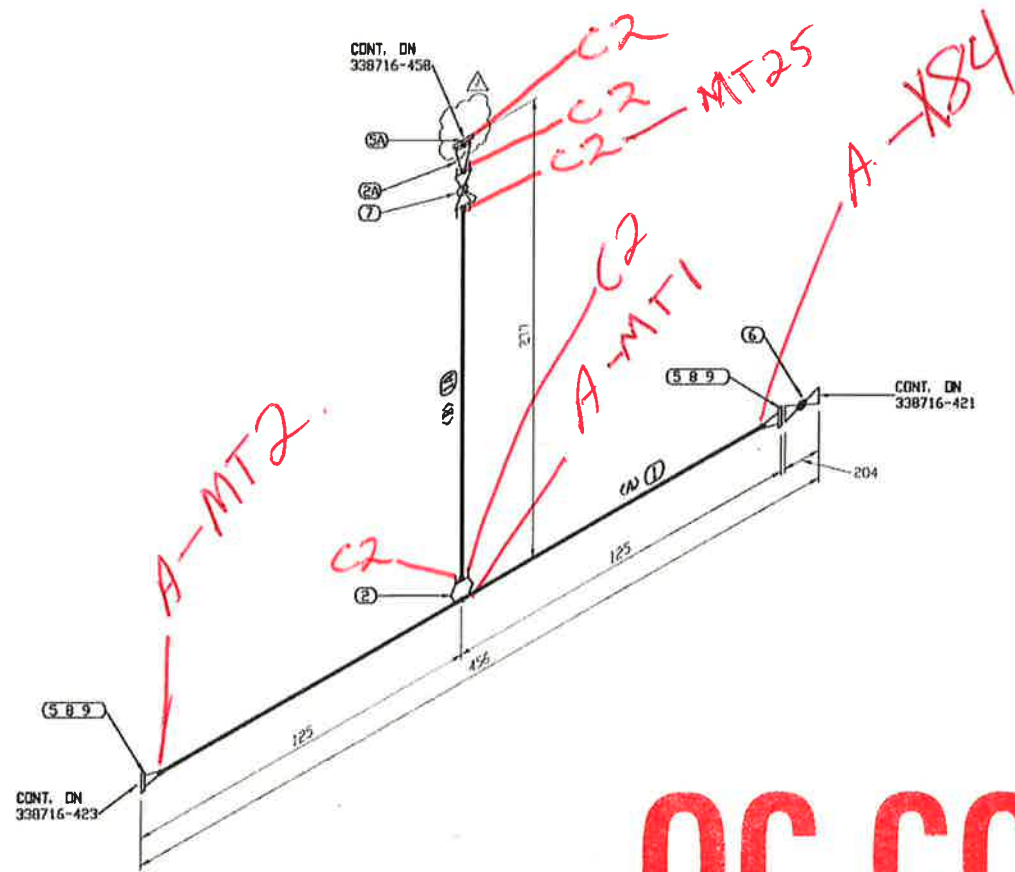
TAG: 0735A-08030

SLS#: 338716 QUOTE: CGY2014-85 POP: 4512-109-130

DWN BY: GG DATE: JUL 04/14 DWG #: 338716-420-Rev2

CHK BY: ET DATE: JUL 04/14

APP BY: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A



QC COPY

NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	116 MM	
1A	1/2	PIPE, SMLS, SCH XS, ASTM A333-6	76 MM	
FITTINGS				
2	2X1/2	OLET, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
2A	1X1/2	SWAGE CONDC, SCH XS, ASTM A420-WPL-6 PBE	1	
3	-	REMOVED	-	
4	-	REMOVED	-	
FLANGES				
5	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL. 1	2	
5A	1	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL. 1	1	

MARK	SIZE	DESCRIPTION	QTY	HT#
VALVES / IN-LINE ITEMS				
6	2	GLOBE VALVE, FLG, REF. 338716-100 ITEM #15A	1	
7	1/2	BALL VALVE, SW, REF. 338716-100 ITEM #25A	1	

MARK	SIZE	DESCRIPTION	QTY	HT#
ERECTION MATERIALS				
GASKETS				
8	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	2	
BOLTS				
9	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	116	2
	76	1/2

ISSUED FOR CONSTRUCTION
2015/06/16
DATE:YYMM/DD
natpro

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PROJECT NAME:	CARMON CREEK PROJECT
CUSTOMER:	SHELL CANADA c/o JACOBS ENGINEERING
LOCATION:	CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG:	0735A-08030
SLSB:	338716
DATE:	JUL 04/14
DATE:	JUL 04/14
DATE:	JUL 04/14

1	WP#: NPE-1(REV2),NPE-4	2	WP#: NPE-1(REV2),NPE-4	3	WP#: NPE-1(REV2),NPE-4	4	WP#: NPE-1(REV2),NPE-4	5	WP#: NPE-1(REV2),NPE-4	6	WP#: NPE-1(REV2),NPE-4	7	WP#: NPE-1(REV2),NPE-4
PRESSURE PIPE DATA													

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

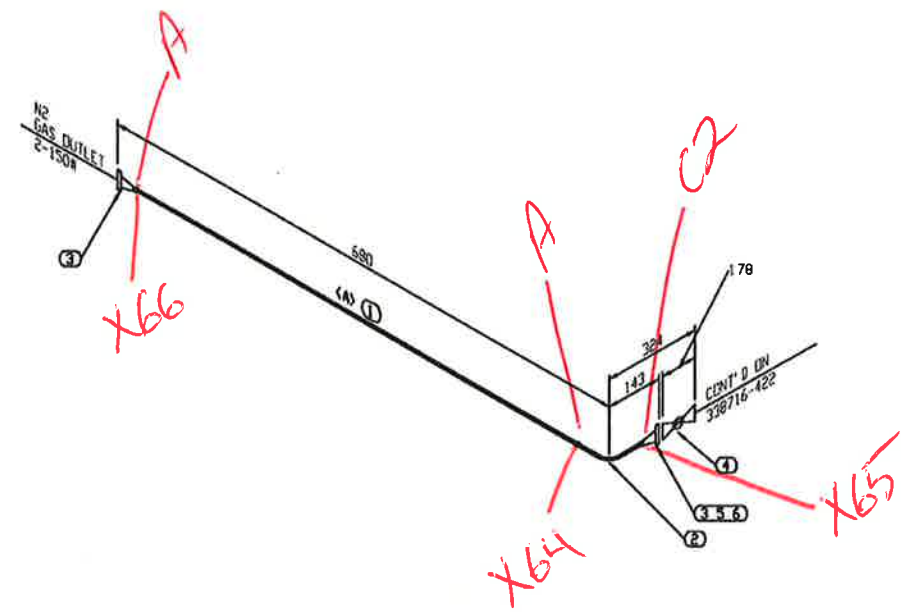
- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

REV	DESCRIPTION	DWN	CHK	APP	DATE
2	CHANGED UNION TO FLANGE & RELATED ITEMS	LK	AA	AA	JUN 02/15
1	ADDED ITEM 1A & 2A; REMOVED ITEM #3 & 4; CHANGED NOTES	LK	AA	AA	APR 08/10
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/10
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 28/15

GAS OUTLET SPOOL DETAIL

revised 19-JUN-15

1590



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	534 MM	
FITTINGS				
2	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	1	
FLANGES				
3	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL. 1	2	3Bw
VALVES / IN-LINE ITEMS				
4	2	BALL VALVE, FLG, REF. 338716-100 ITEM #20	1	

ERECTOR MATERIALS				
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
BOLTS				
6	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

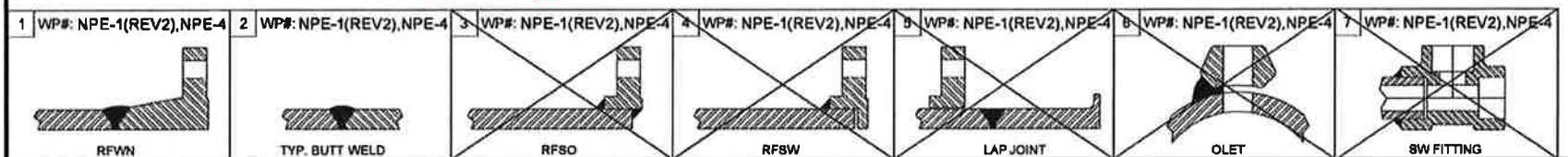
CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	534	2

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE: YY/MM/DD
 natpro

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NOTE:
 1. BALL VALVE HANDLE SHOP CUT TO FIT.

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX
 - NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA		
SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP/DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	OW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	OW	ET	PM	JAN 26/15

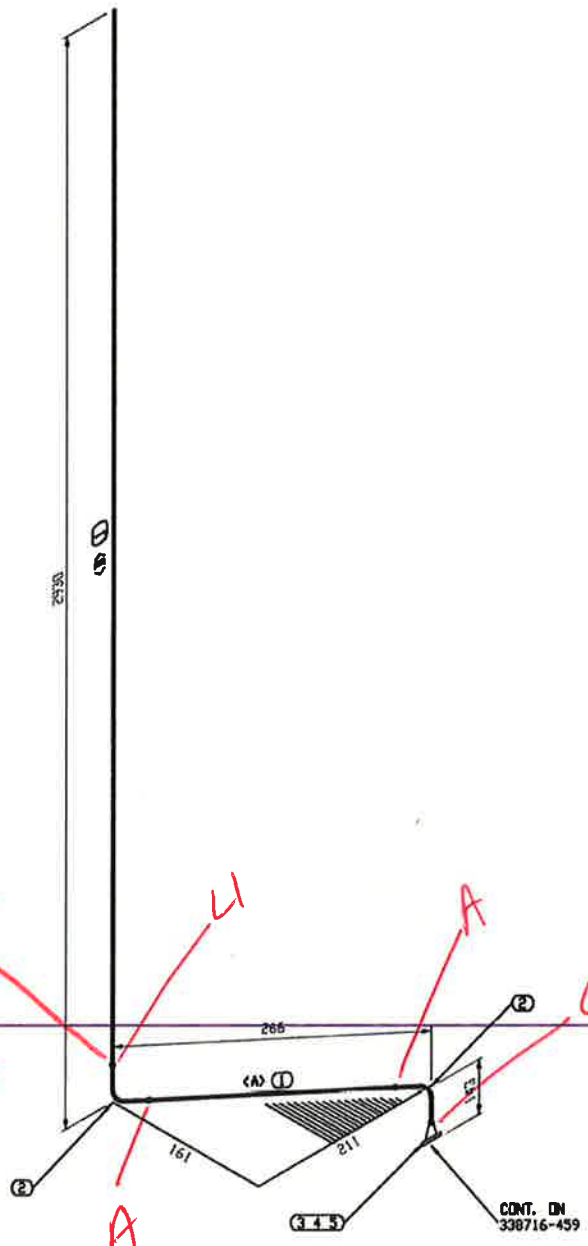
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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLB#: 338716 QUOTE: CGY2014-85 POK: 4512-109-130

DRW: GG DATE: JUL 04/14 DNO: 338716-423-Rev1
 CHK: ET DATE: JUL 04/14
 APP: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A

1590 RT



QC COPY

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	2958 MM	
FITTINGS				
2	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	2	
FLANGES				
3	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL. 1	1	4 BW

ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
4	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
BOLTS				
5	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	107	2
	2851	2

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE: MM/DD
 [Signature]

1	WP#: NPE-1(REV2),NPE-4	2	WP#: NPE-1(REV2),NPE-4	3	WP#: NPE-1(REV2),NPE-4	4	WP#: NPE-1(REV2),NPE-4	5	WP#: NPE-1(REV2),NPE-4	6	WP#: NPE-1(REV2),NPE-4	7	WP#: NPE-1(REV2),NPE-4
RFWN		TYP. BUTT WELD		RFSO		RFSW		LAP JOINT		OLET		SW FITTING	

PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

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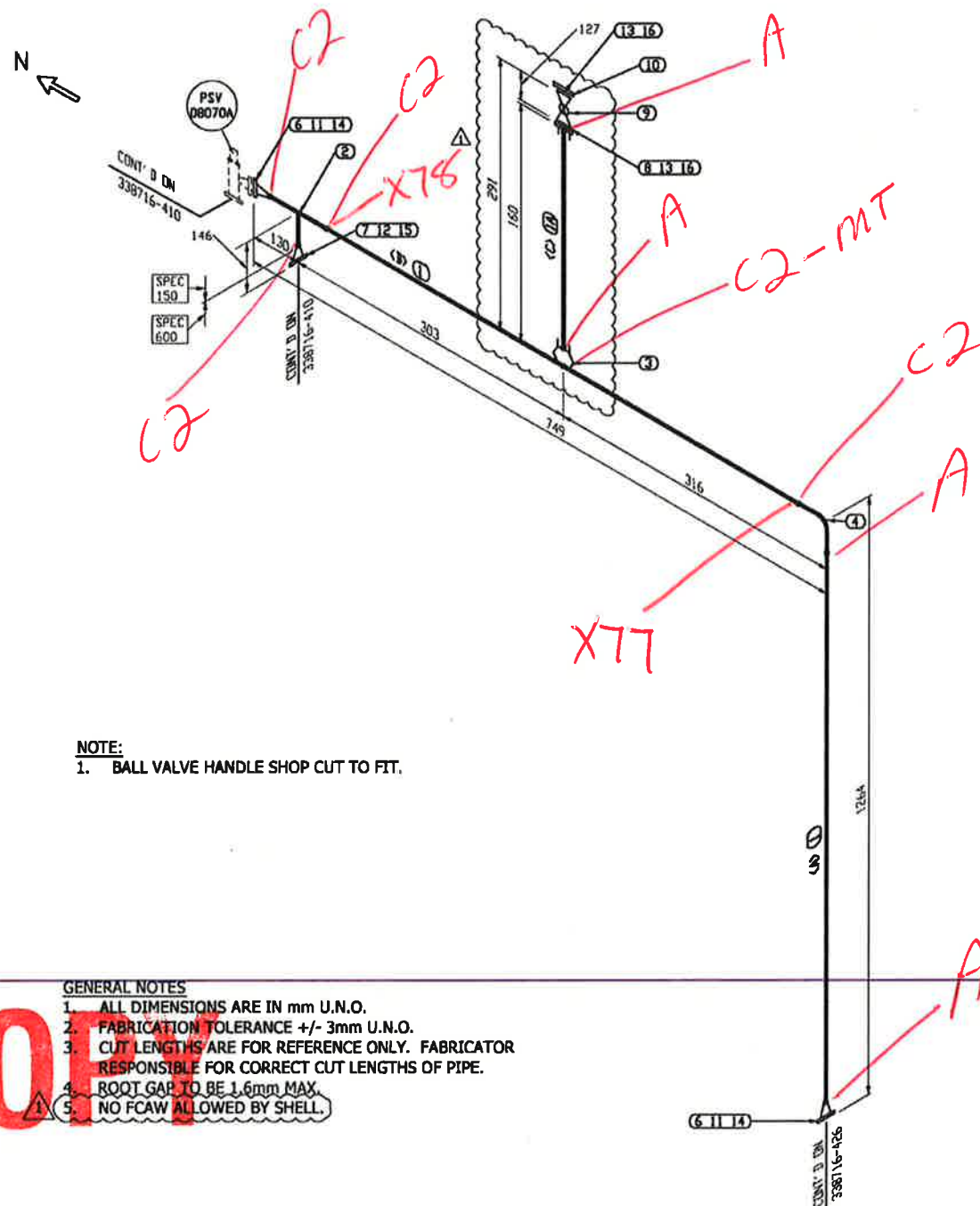


PROJECT NAME: CARMON CREEK PROJECT			
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING			
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2			
TAG: D735A-08030			
BLSE: 338716	QUOTE: CGY2014-85	PO#: 4512-109-130	
DRW: LK	DATE: APR 06/15	DWG #: 338716-424-Rev0	
CRK: AA	DATE: APR 09/15		
APP: AA	DATE: APR 09/15	PAGE: 1 OF 1	CAD: N/A

DESCRIPTION	DWN	CHK	APP	DATE
ISSUED FOR CONSTRUCTION	LK	AA	AA	APR 09/15

V-08069 VENT OUTLET SPOOL DETAIL

15% RT



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1592 MM	
1A	1	PIPE, SMLS, SCH XS, ASTM A333-6	101 MM	
FITTINGS				
2	2X2	TEE, SCH XS, ASTM A420-WPL-6	1	
3	2X1	OLET, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
4	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	1	
5	-	REMOVED	-	
FLANGES				
6	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL. 1	2	
7	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL. 1	1	
8	1	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL. 1	1	
VALVES / IN-LINE ITEMS				
9	1	BALL VALVE, FLG, REF. 338716-100 ITEM #25	1	
10	1	FLG BLIND, RF, 150LB, ASTM A350-LF2-CL. 1	1	

6 Bw
2 SW
1 olet

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
11	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	2	
12	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
13	1	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	2	
BOLTS				
14	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, V/2 NUTS: A194-2H	8	
15	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, V/2 NUTS: A194-2H	8	
16	1X2 3/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, V/2 NUTS: A194-2H	8	

ISSUED FOR CONSTRUCTION
15/04/15
DATE REVISIONED
180

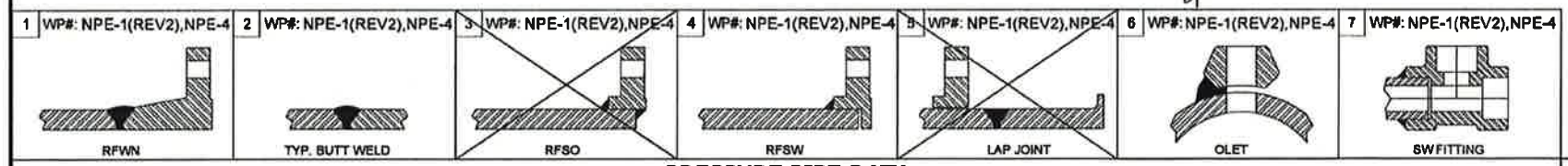
CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	1118	2
	474	2
<C>	101	1

2 SW
1 olet

QC COPIES

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 BL#P: 338716 QUOTE: CGY2014-85 POF: 4512-109-130

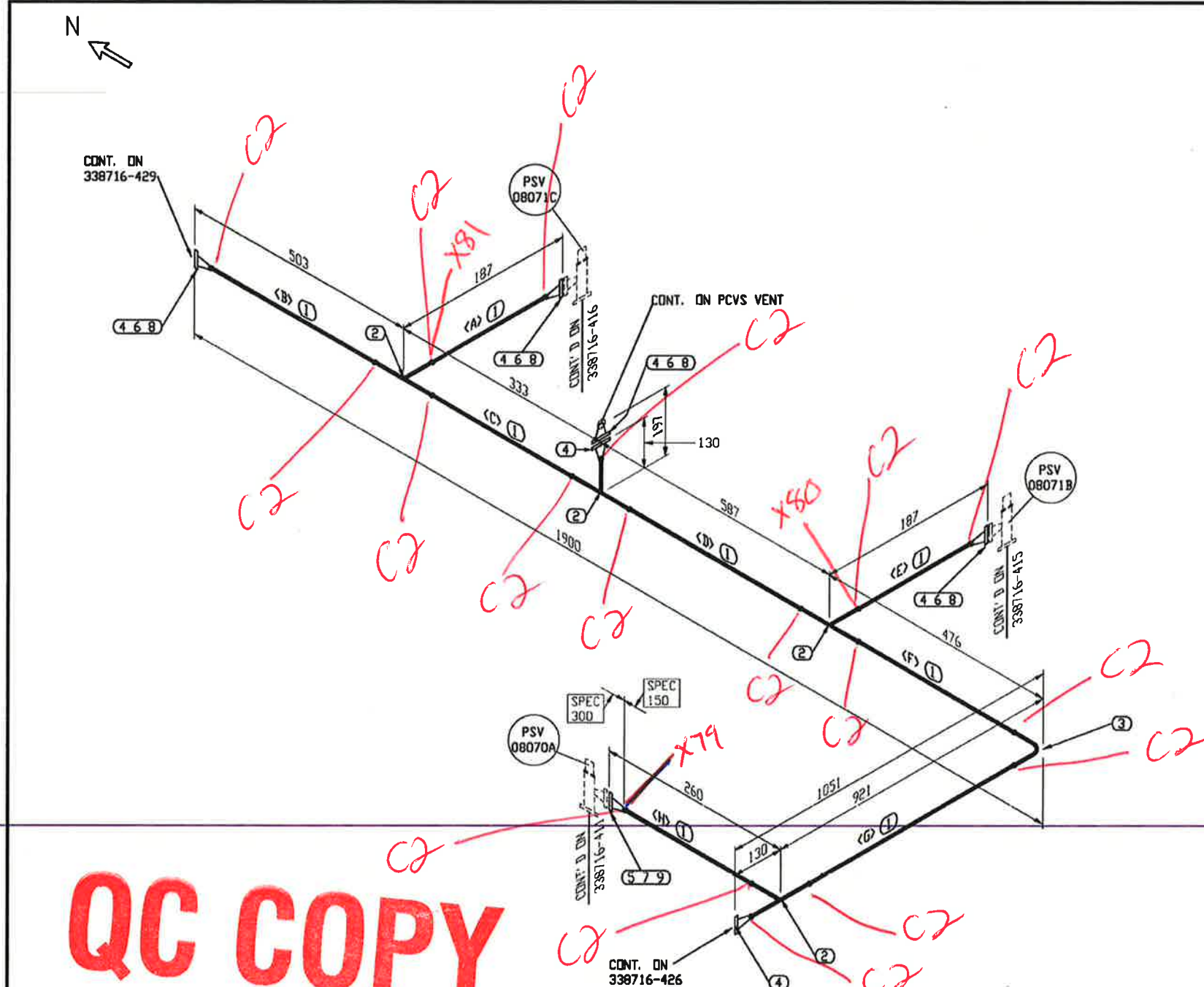
DATE: JUL 04/14
 DATE: JUL 04/14
 DATE: JUL 04/14

338716-425-Rev1
 PAGE 1 OF 1

REV	DESCRIPTION	OWN	CHK	APP	DATE
1	ADDED ITEM #14; REMOVED ITEM #5; CHANGED NOTES	LK	AA	AA	APR 09/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 28/15

PSV OUTLET SPOOL DETAIL

15% RT



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	2357 MM	
FITTINGS				
2	2X2	TEE, SCH XS, ASTM A420-WPL-6	4	
3	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	1	
FLANGES				
4	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL 1	6	
5	2	FLG RFWN, 300LB, SCH XS, ASTM A350-LF2-CL 1	1	183w

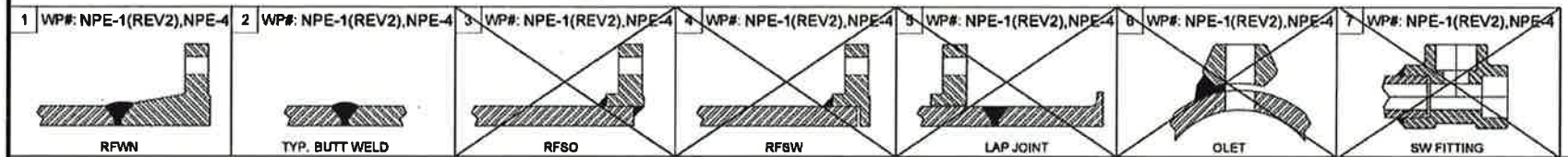
ERECTOR MATERIALS				
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
6	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	4	
7	2	GASKET, 300LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
8	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	16	
9	2X3 1/2	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	53	2
	370	2
<C>	200	2
<D>	454	2
<E>	53	2
<F>	331	2
<G>	776	2
<H>	120	2

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE: 15/04/15
 natpro

QC COPY

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA		
SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

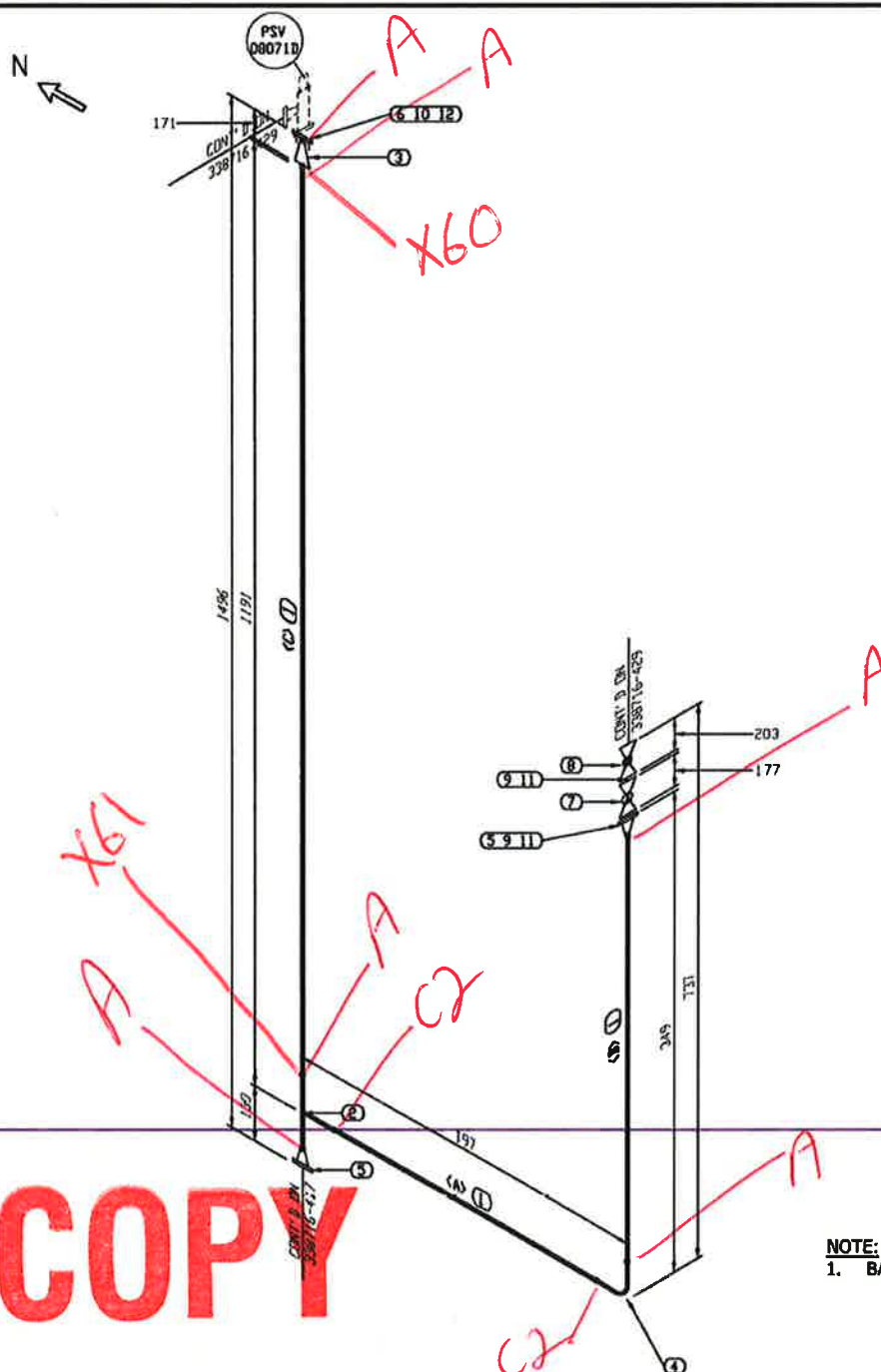
DATE: JUL 04/14
 DATE: JUL 04/14
 DATE: JUL 04/14

338716-427-Rev1
 PAGE: 1 OF 1

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/10
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 28/15

PSV OUTLET SPOOL DETAIL

1590 RT



QC COPY

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1377 MM	
FITTINGS				
2	2X2	TEE, SCH XS, ASTM A420-WPL-6	1	
3	2X1	SWAGE CONC. SCH XS, ASTM A420-WPL-6 BLE	1	
4	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	1	
FLANGES				
5	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL. 1	2	
6	1	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL. 1	1	
VALVES / IN-LINE ITEMS				
7	2	BALL VALVE, FLG, REF. 338716-100 ITEM #20	1	
8	2	GLOBE VALVE, FLG, REF. 338716-100 ITEM #15A	1	

7 Bw
1 Sw

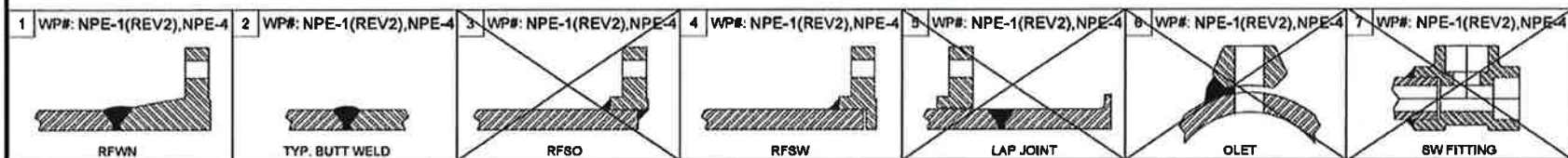
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
9	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	2	
10	1	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
BOLTS				
11	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
12	1X2 3/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	50	2
	203	2
<C>	1124	2

ISSUED FOR CONSTRUCTION
15/04/15
DATE: YY/MM/DD
180
1 Sw

NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

- GENERAL NOTES
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA		
SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CJ M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

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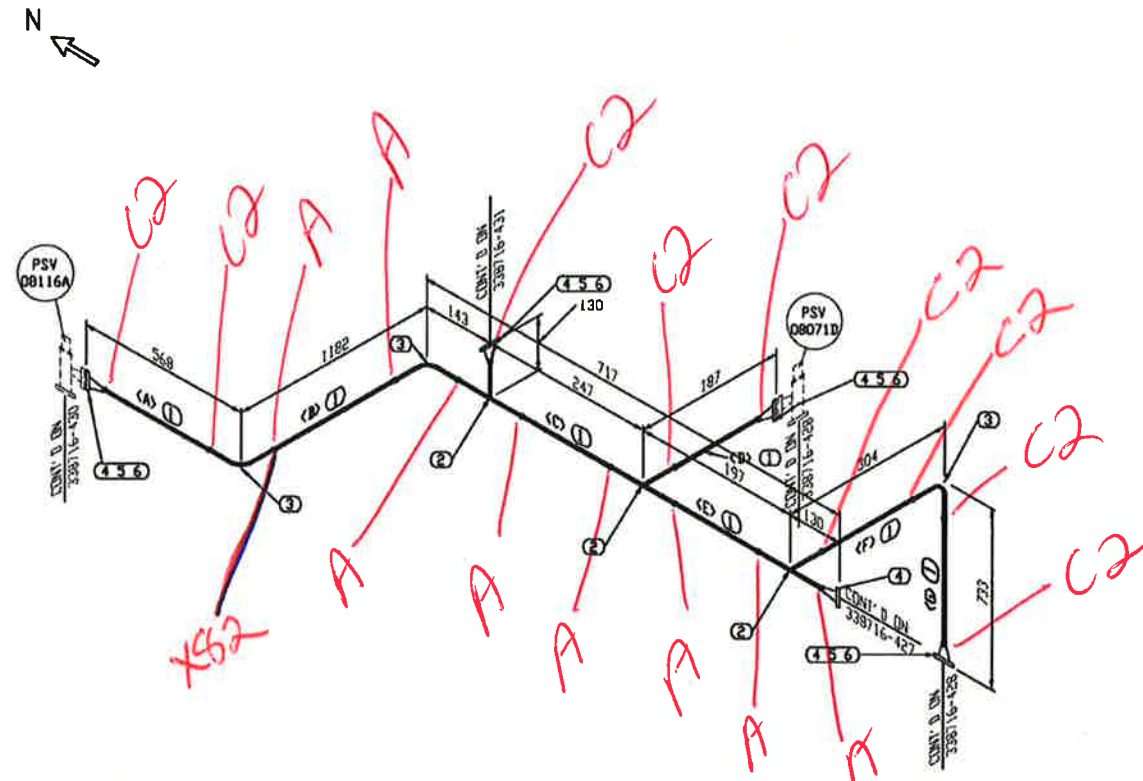
PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLIP: 338716 QUOTE: CGY2014-85 PO# 4512-109-130

DATE: JUL 04/14
 DATE: JUL 04/14
 DATE: JUL 04/14

338716-428-Rev1
 1 OF 1
 N/A

SPOOL DETAIL

1590 RT



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	2420 MM	
FITTINGS				
2	2X2	TEE, SCH XS, ASTM A420-WPL-6	3	
3	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	3	
FLANGES				
4	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL. 1	5	18 BW

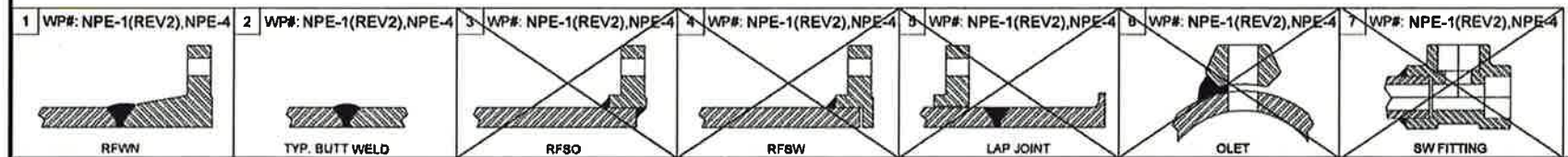
ERECTOR MATERIALS				
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	4	
BOLTS				
6	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	16	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	421	2
	1023	2
<C>	114	2
<D>	53	2
<E>	64	2
<F>	158	2
<G>	587	2

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE/TIME/INITIALS
 SIGNATURE
 natpro

QC COPY

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (8W)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	OWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 28/15

PSV OUTLET
SPOOL DETAIL

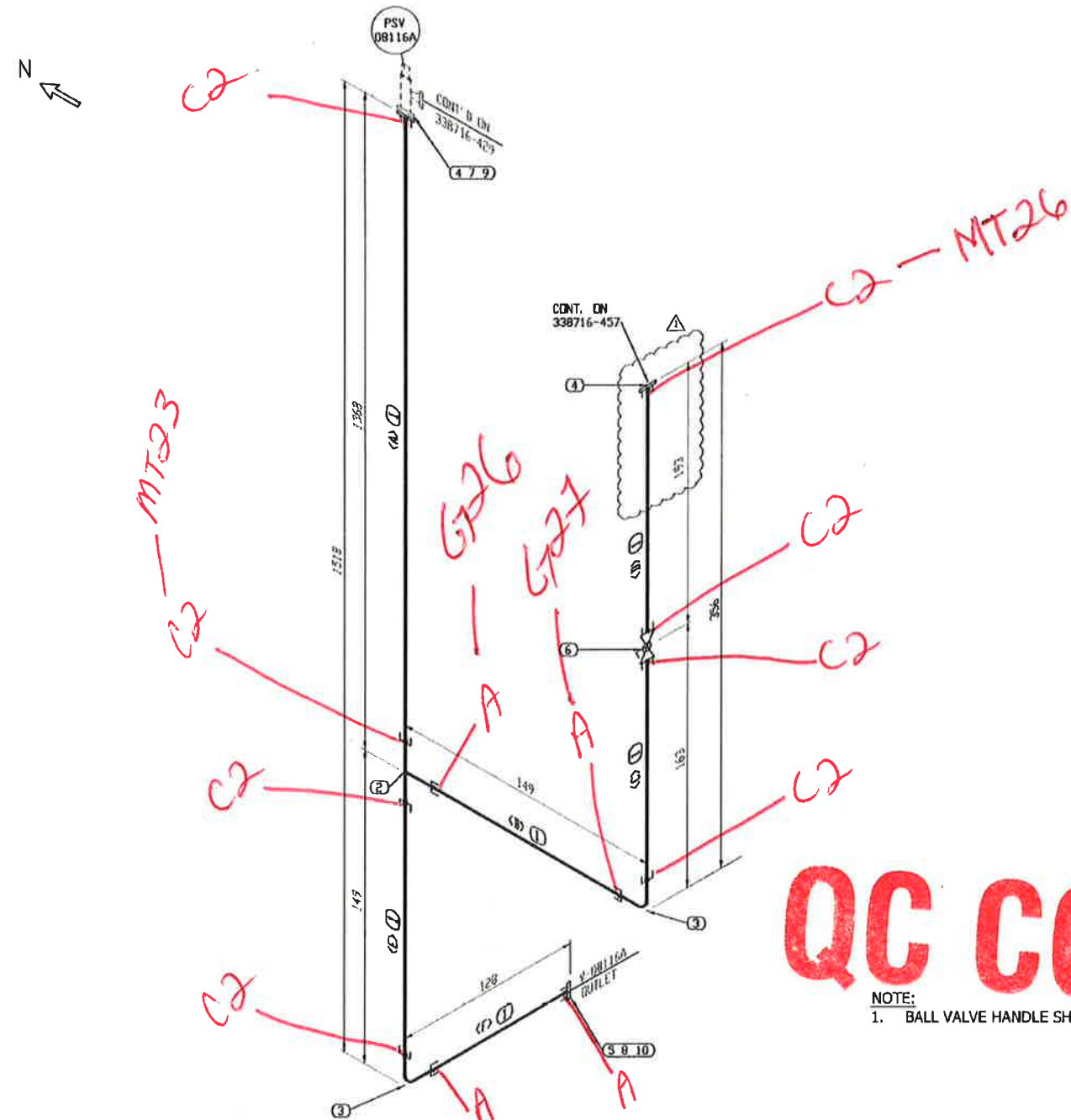
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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 BLR#: 338716 QUOTE CGY2014-85 POP 4512-109-130

DWG#: GG DATE: JUL 04/14
 DWG#: ET DATE: JUL 04/14
 APP#: COG DATE: JUL 04/14

DWG#: 338716-429-Rev1
 PAGE: 1 OF 1 CAD: N/A



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
△ 1	1	PIPE, SMLS, SCH XS, ASTM A333-6	1880 MM	
FITTINGS				
2	1X1	TEE, SW, 300LB, ASTM A350-LF2-CL.1	1	
3	1	90 ELL, SW, 300LB, ASTM A350-LF2-CL.1	2	
FLANGES				
△ 4	1	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL.1	2	
5	1	FLG RFSW, 300LB, SCH XS, ASTM A350-LF2-CL.1	1	
VALVES / IN-LINE ITEMS				
6	1	BALL VALVE, SW, REF. 338716-100 ITEM #24	1	

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
7	1	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
8	1	GASKET, 300LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
9	1X3 1/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	
10	1X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	1338	1
	101	1
<C>	102	1
△ <D>	149	1
<E>	102	1
<F>	88	1

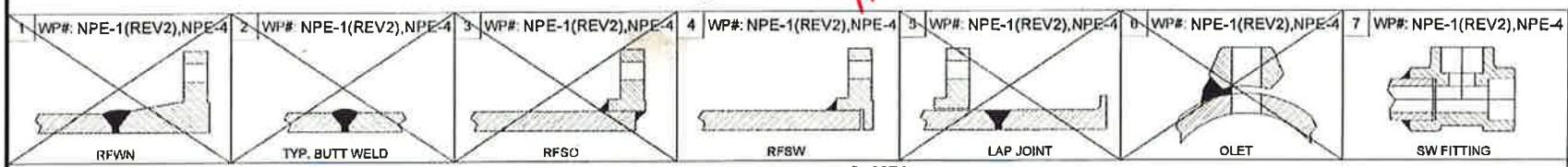
QC COPY

NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

ISSUED FOR CONSTRUCTION

2015/06/16 / *MS*
DATE:YY/MM/DD SIGNATURE

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PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

V-08116A OUTLET SPOOL DETAIL

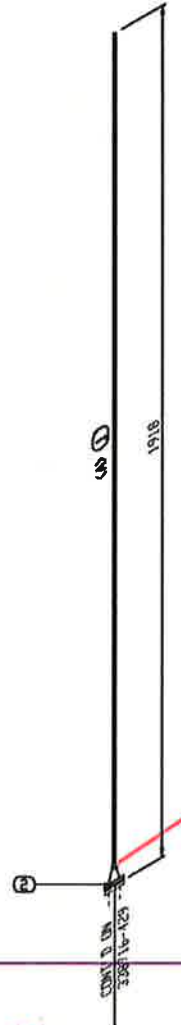
1	CHANGED UNION TO FLANGE & RELATED ITEMS	LK	AA	AA	JUN 02/15
0	ISSUED FOR CONSTRUCTION	LK	AA	AA	APR 09/15
	DESCRIPTION	DWN	CHK	APP	DATE

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 GLOB#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
 DWN BY: LK DATE: APR 06/15 DWG #: 338716-430-Rev1
 CHW BY: AA DATE: APR 09/15
 APP BY: AA DATE: APR 09/15 PAGE: 1 OF 1 CAD: N/A

15% RT



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1852 MM	
FLANGES				
2	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL. 1	1	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	1852	2

1 BW

QC COPY

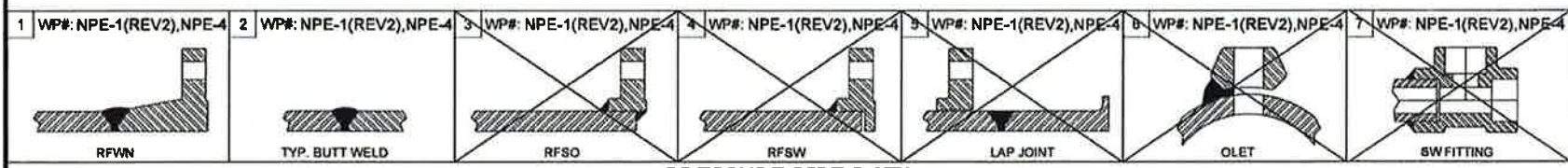
ISSUED FOR CONSTRUCTION

15/04/15
DATE: YY/MM/DD

AA
SIGNATURE

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- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

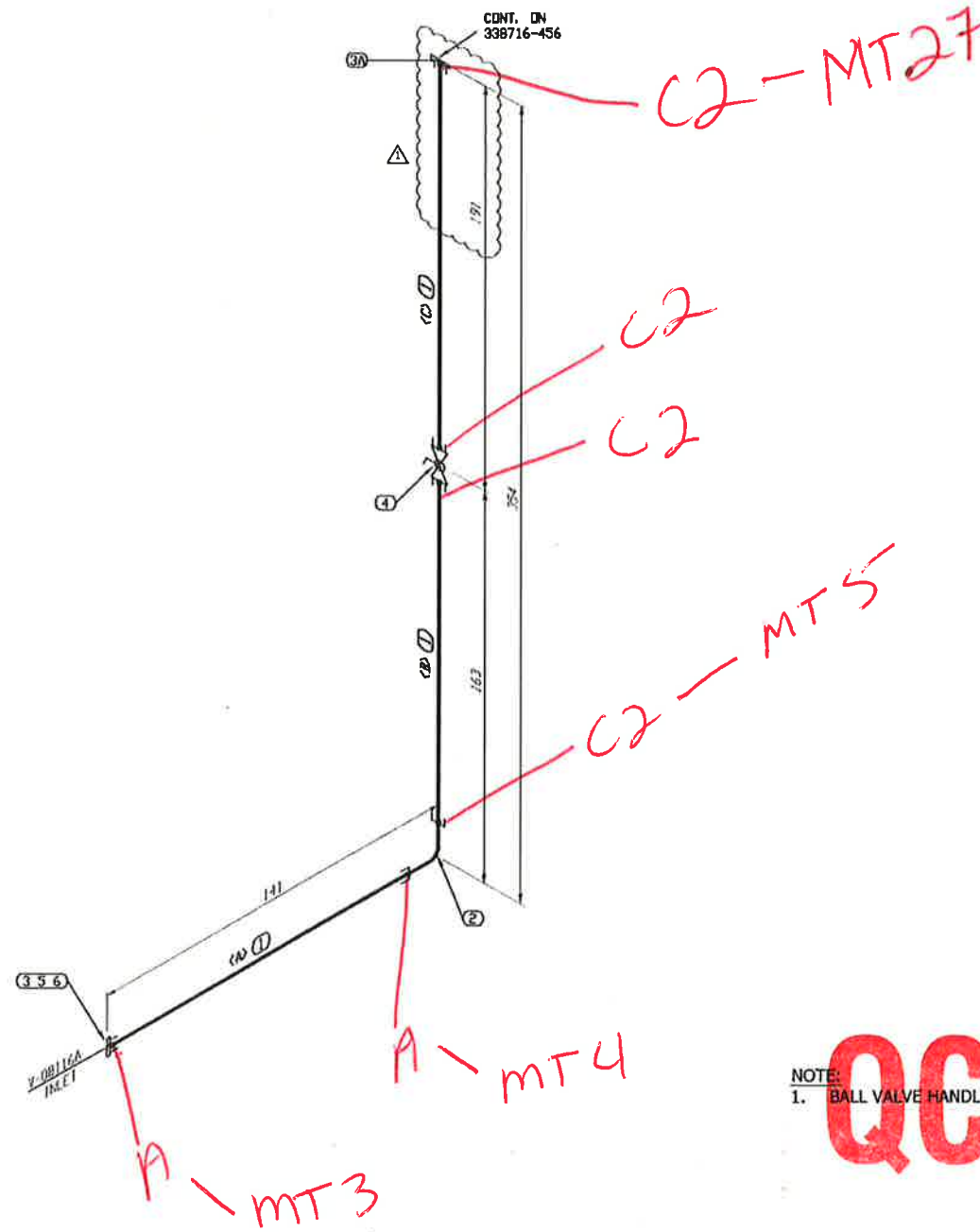
REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/16
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

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PROJECT NAME: CARMON CREEK PROJECT	CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2	TAG: 0735A-08030
BLSP: 338716	QUOTE: CGY2014-85
POF: 4512-109-130	
DRW BY: GG	DATE: JUL 04/14
DRW BY: ET	DATE: JUL 04/14
APP BY: COG	DATE: JUL 04/14
DWG NO: 338716-431-Rev1	
PAGE: 1 OF 1	CAD: N/A

PSV OUTLET SPOOL DETAIL



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
△ 1	1	PIPE, SMLS, SCH XS, ASTM A333-6	350 MM	
FITTINGS				
2	1	90 ELL, SW, 300LB, ASTM A350-LF2-CL.1	1	
FLANGES				
3	1	FLG RFSW, 300LB, SCH XS, ASTM A350-LF2-CL.1	1	
△ 3A	1	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL.1	1	
VALVES / IN-LINE ITEMS				
4	1	BALL VALVE, SW, REF. 338716-100 ITEM #24	1	

ERECTOR MATERIALS				
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	1	GASKET, 300LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS DR SS OUTER RING	1	
BOLTS				
6	1X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

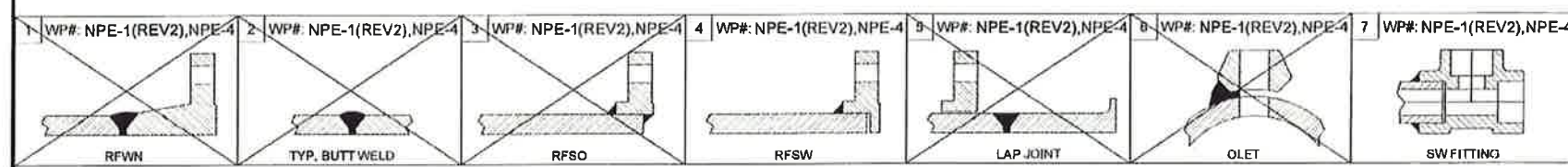
CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	102	1
	101	1
△ <C>	147	1

NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

QC COPY

ISSUED FOR CONSTRUCTION

15/06/16, [Signature]
DATE:YY/MM/DD SIGNATURE
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PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

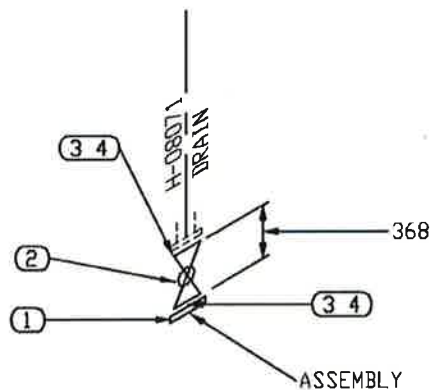
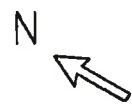
- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 POW: 4512-109-130
 DATE: APR 06/15
 DATE: APR 09/15
 DATE: APR 09/15
 DWG#: 338716-432-Rev1
 PAGE: 1 OF 1
 CAC: N/A

V-08116A INLET
SPOOL DETAIL



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
------	------	-------------	-----	-----

VALVES / IN-LINE ITEMS

1	2	FLG BLIND, RF, 1500LB, ASTM A350-LF2-CL. 1	1	
2	2	BALL VALVE, FLG, REF. 338716-100 ITEM #22	1	

ERECTION MATERIALS

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
------	------	-------------	-----	-----

GASKETS

3	2	GASKET, 1500LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	2	
---	---	---	---	--

BOLTS

4	2X5 3/4	7/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	16	
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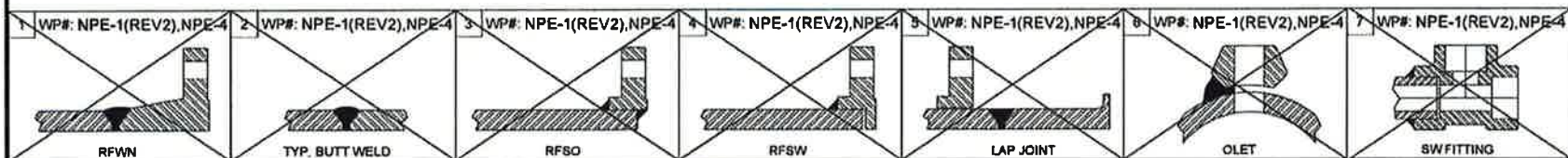
N/A

ISSUED FOR CONSTRUCTION
15/04/15
DAILY YWMMVUP
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NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL C20W CLASS 900	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 3330 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 2035 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CJ M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/16
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

**H-08071 DRAIN
SPOOL DETAIL**

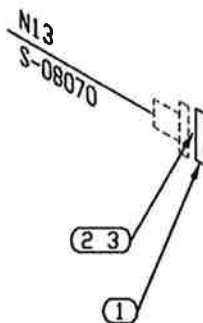
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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE CGY2014-85 PO# 4512-109-130

DRW: GG	DATE: JUL 04/14	DWG #:	338716-433-Rev1
CHK: ET	DATE: JUL 04/14		
APP: COG	DATE: JUL 04/14	PAGE: 1 OF 1	

CAD: N/A



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
------	------	-------------	-----	-----

VALVES / IN-LINE ITEMS

1	3	FLG BLIND, RF, 600LB, ASTM A350-LF2-CL. 1	1	
---	---	---	---	--

ERECTION MATERIALS

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
------	------	-------------	-----	-----

GASKETS

2	3	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
---	---	--	---	--

BOLTS

3	3X5	3/4" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
---	-----	--	---	--

N/A

ISSUED FOR CONSTRUCTION

15/04/15
DATE: YY/MM/DD

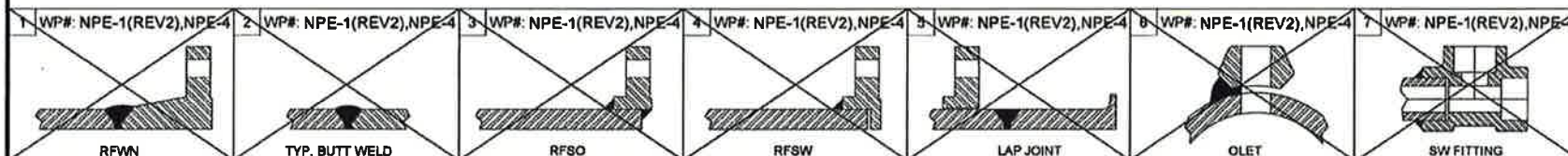
[Signature]
SIGNATURE



QC COPY

GENERAL NOTES

- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA

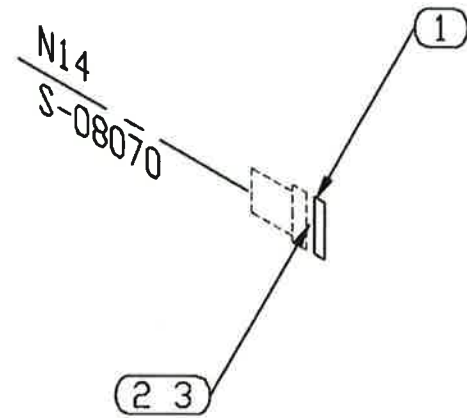
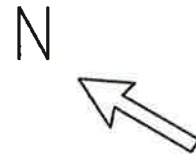
SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP/DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

SPOOL DETAIL

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.

PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 BLS#: 338716 QUOTE: CGY2014-85 POF: 4512-109-130
 DWN: GG DATE: JUL 04/14 DWO: 338716-434A-Rev1
 CHK: ET DATE: JUL 04/14
 APP: COG DATE: JUL 04/14 PAGE: 1 OF 1 CND: N/A



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
------	------	-------------	-----	-----

VALVES / IN-LINE ITEMS

1	2	FLG BLIND, RF, 600LB, ASTM A350-LF2-CL.1	1	
---	---	--	---	--

ERECTION MATERIALS

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
------	------	-------------	-----	-----

GASKETS

2	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
---	---	--	---	--

BOLTS

3	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, 1/2 NUTS: A194-2H	8	
---	---------	--	---	--

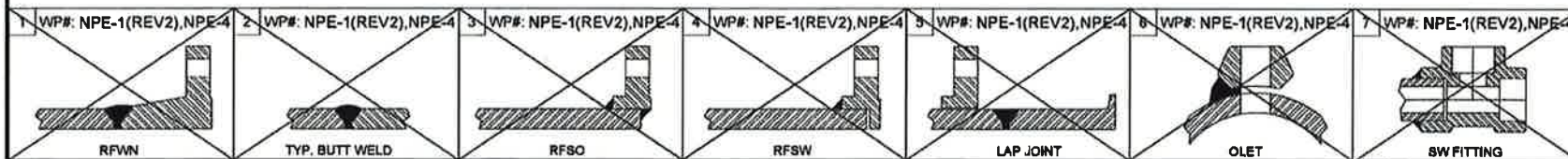
N/A

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE:YY/MM/DD
 [Signature]

QC COPY

GENERAL NOTES

- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP/DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 09/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 28/15
REV	DESCRIPTION	DWN	CHK	APP	DATE

SPOOL DETAIL

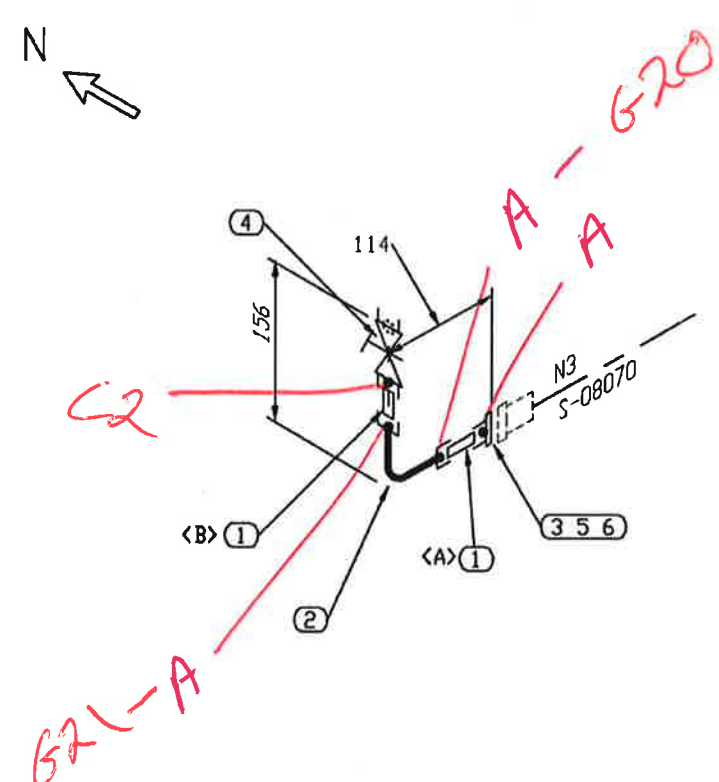
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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 BLS#: 338716 QUOTE: CGY2014-85 POP: 4512-109-130

ISSUED BY: GG DATE: JUL 04/14 DWO # 338716-434B-Rev1
 CHECKED BY: ET DATE: JUL 04/14
 APPROVED BY: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A

1090 MT + 1090 RT GAP



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
△ 1	1/2	PIPE, SMLS, SCH XS, ASTM A333-6	152 MM	
FITTINGS				
2	1/2	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
FLANGES				
△ 3	1/2	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	1	
VALVES / IN-LINE ITEMS				
4	1/2	GATE VALVE, SW/NPT, REF. 338716-100 ITEM #32	1	

4 SW

ERECTION MATERIALS

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	1/2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
6	1/2X3 1/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	76	1/2
	76	1/2

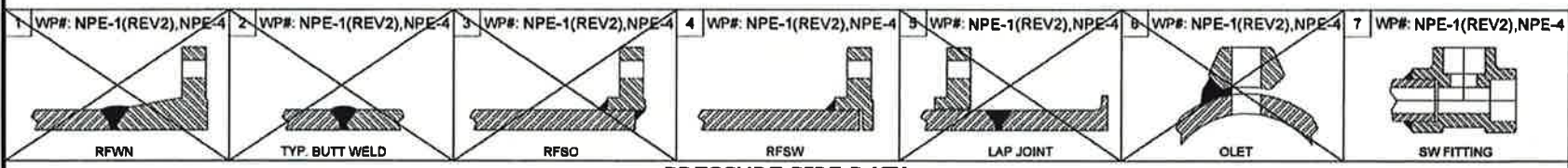
4 SW

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE YY/MM/DD
 SIGNATURE

QC COPY

GENERAL NOTES

- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX
- NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

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PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
SLB#: 338716 QUOTE: CGY2014-85 PO# 4512-109-130
OWN: GG DATE: JUL 04/14
DRW: ET DATE: JUL 04/14
APP: COG DATE: JUL 04/14
338716-435-Rev1
PAGE: 1 OF 1 CAD: N/A

SPOOL DETAIL

10% MT + 10% RT GAP

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
△ 1	1	PIPE, SMLS, SCH XS, ASTM A333-6	310 MM	
FITTINGS				
△ 2	-	REMOVED	-	
3	1	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
FLANGES				
△ 4	-	REMOVED	-	
△ 5	1	FLG RFSV, 600LB, SCH XS, ASTM A350-LF2-CL. 1	2	

6 SW

MARK	SIZE	DESCRIPTION	QTY	HT#
VALVES / IN-LINE ITEMS				
6	1	GATE VALVE, SW, REF. 338716-100 ITEM #23	1	
INSTRUMENTS				
7	1	CHOKER VALVE, FLG, REF. 338716-100 ITEM #2	1	

ERECTOR MATERIALS

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
8	1	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	2	
BOLTS				
9	1X3 3/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH

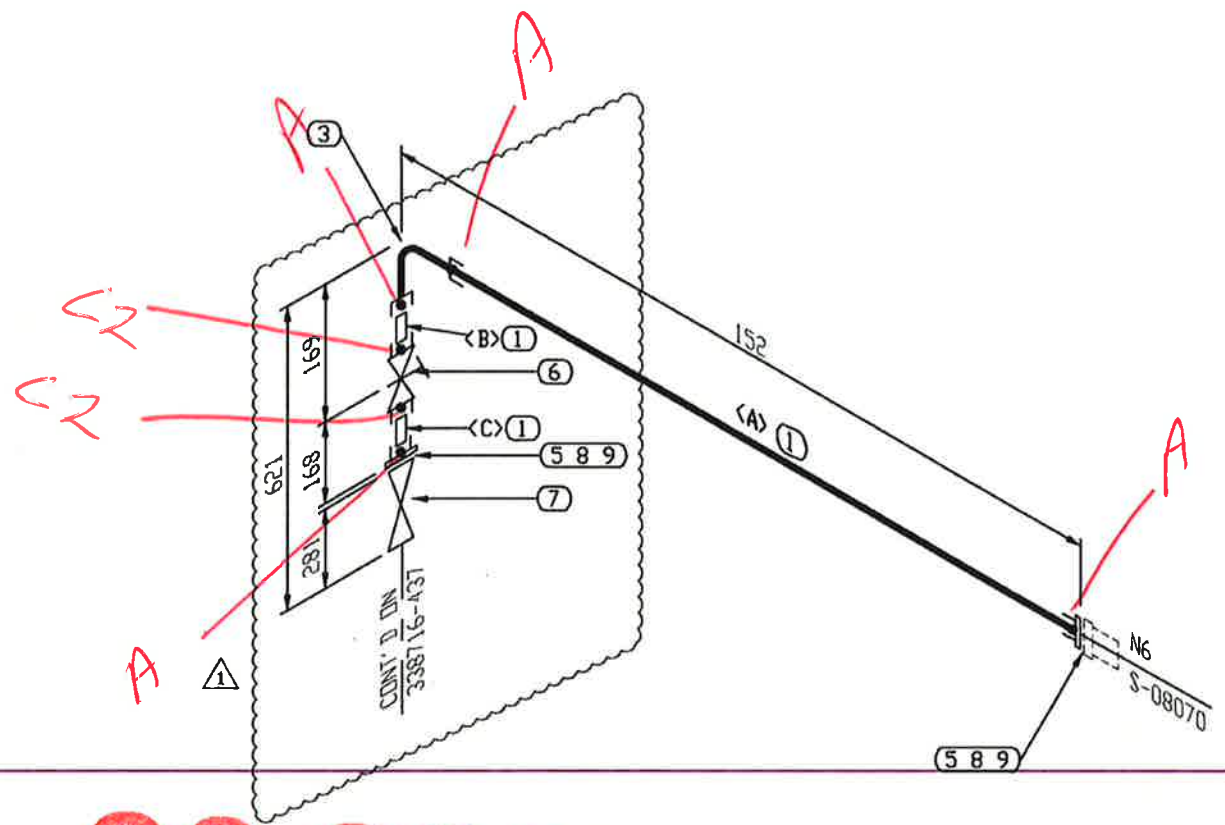
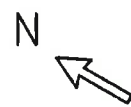
PIECE NUM	LENGTH (MM)	SIZE (INCH)
(A)	106	1
(B)	102	1
(C)	102	1

6 SW

ISSUED FOR CONSTRUCTION

15/04/15

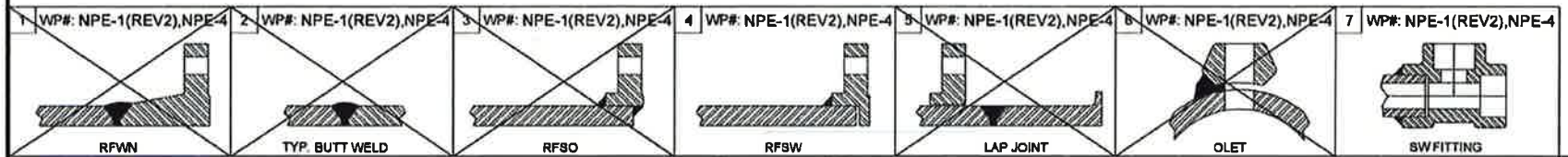
DATE Y/M/D
SIGNATURE
natpro



QC COPY

GENERAL NOTES

- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

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PROJECT NAME: CARMON CREEK PROJECT

CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING

LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

TAG: 0735A-08030

SLB#: 338716 QUOTE: CGY2014-85 POP: 4512-109-130

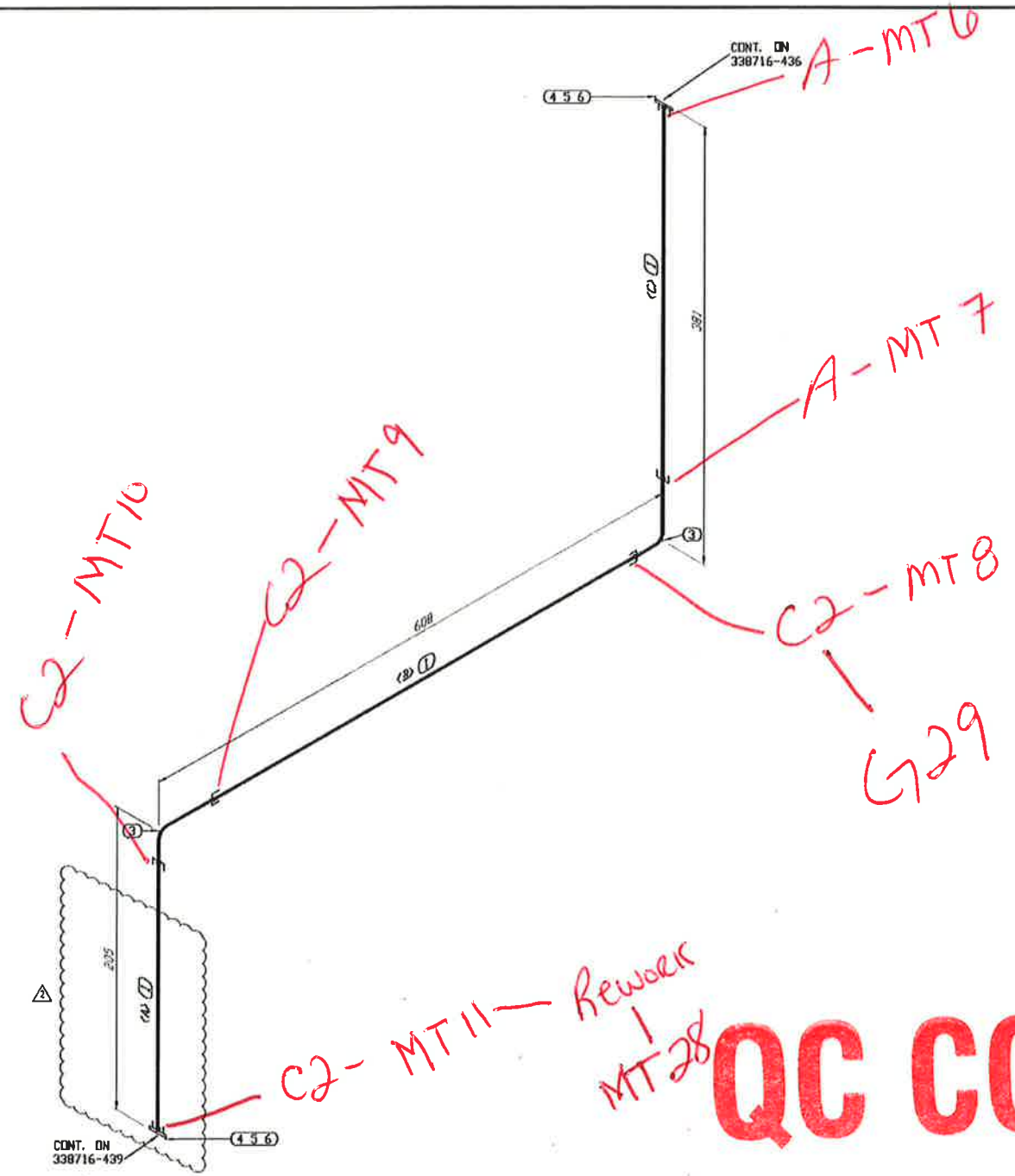
DRW#: GG DATE: JUL 04/14 DWD#: 338716-436-Rev1

CRK#: ET DATE: JUL 04/14

APP#: COG DATE: JUL 04/14 PAGES: 1 OF 1 CDR: N/A

SPOOL DETAIL

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED QTY OF #1 & 5 AND NOTES; REMOVED #2 & 4	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 09/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
△ 1	1	PIPE, SMLS, SCH XS, ASTM A333-6	1054 MM	
FITTINGS				
△ 2		REMOVED		
3	1	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	2	
FLANGES				
△ 4	1	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	2	

ERECTOR MATERIALS				
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
△ 5	1	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	2	
BOLTS				
△ 6	1X3 3/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
△ <A>	159	1
	560	1
<C>	335	1

ISSUED FOR CONSTRUCTION

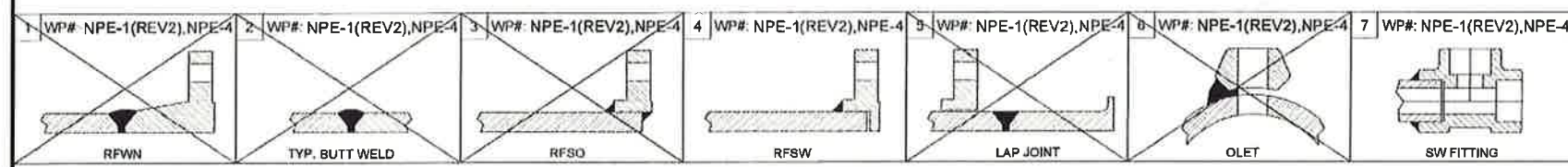
15/06/16

DATE: YY/MM/DD

SIGNATURE

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PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

REV	DESCRIPTION	DWN	CHK	APP	DATE
2	CHANGED UNION TO FLANGE & RELATED ITEMS	LK	AA	AA	JUN 02/16
1	CHANGED QTY OF #1 & NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 28/15

SPOOL DETAIL

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PROJECT NAME: CARMON CREEK PROJECT

CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING

LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

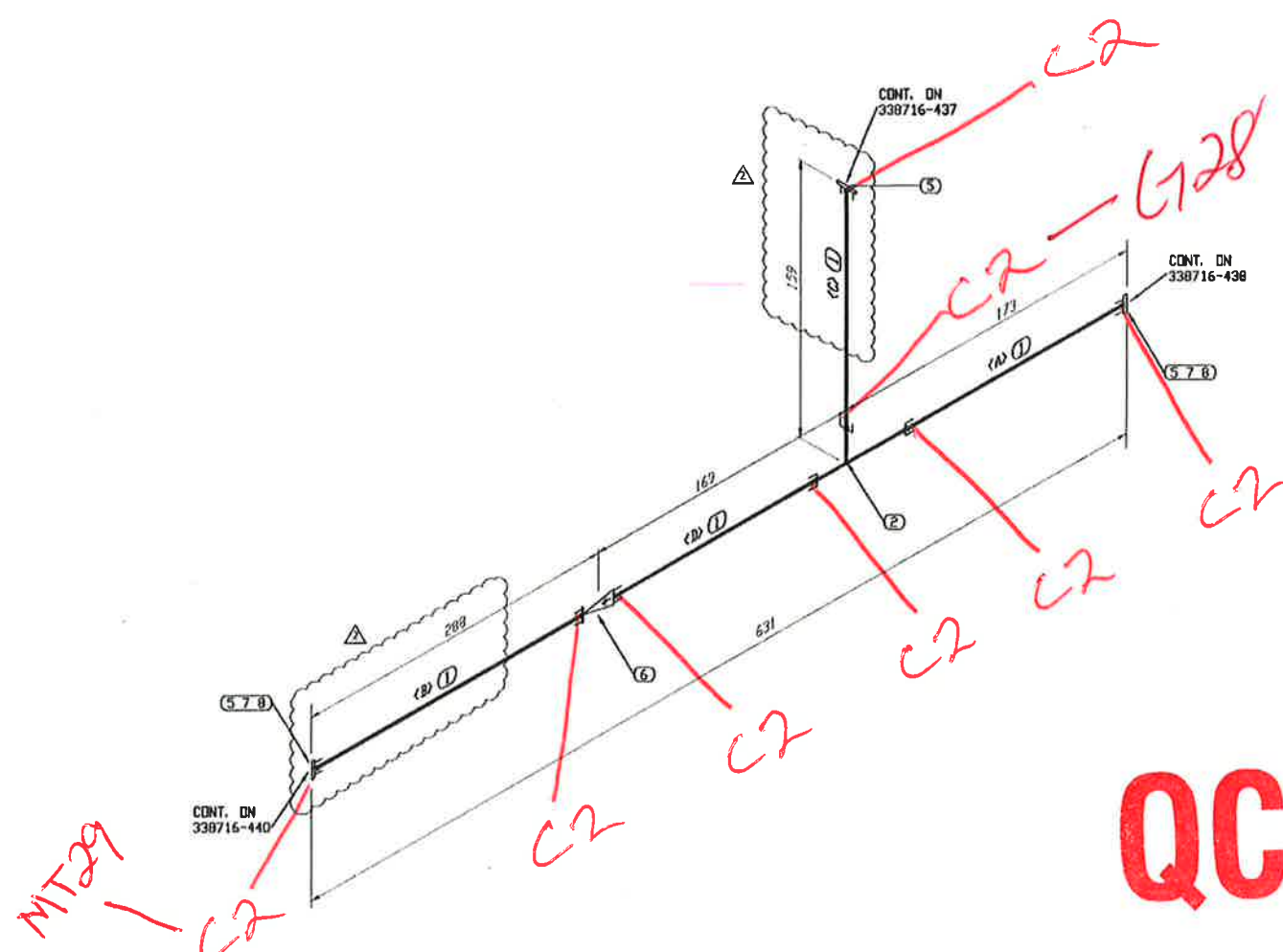
TAG: 0735A-08030

SLS#: 338716 QUOTE: CGY2014-85 POC: 4512-109-130

OWNR: GG DATE: JUL 04/14 UNK# 338716-437-Rev2

CHKR: ET DATE: JUL 04/14

APPR: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
△ 1	1	PIPE, SMLS, SCH XS, ASTM A333-6	565 MM	
FITTINGS				
2	1X1	TEE, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
3	-	REMOVED	-	
△ 4	-	REMOVED	-	
FLANGES				
△ 5	1	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	3	
VALVES / IN-LINE ITEMS				
6	1	CHECK VALVE, SW, REF. 338716-100 ITEM #28	1	

ERECTION MATERIALS

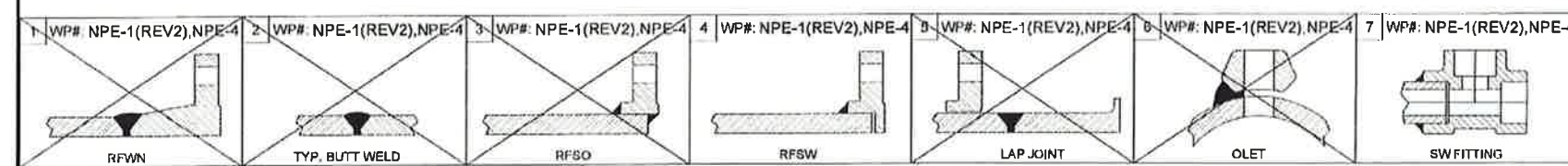
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
△ 7	1	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	2	
BOLTS				
△ 8	1X3 3/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	127	1
△ 	223	1
<C>	113	1
<D>	102	1

QC COPY

ISSUED FOR CONSTRUCTION
 15/06/16
 DATE:YY/MM/DD
 SIGNATURE
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PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

GENERAL NOTES

- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCAW ALLOWED BY SHELL.

REV	DESCRIPTION	BY	CHK	APP	DATE
2	CHANGED UNION TO FLANGE & RELATED ITEMS	LK	AA	AA	JUN 02/15
1	ADDED 1<C> & 1<D>, REMOVED #3, CHANGED QTY OF #1 & NOTE	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

SPOOL DETAIL

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATPRO PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NP.

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PROJECT NAME: CARMON CREEK PROJECT

CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING

LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

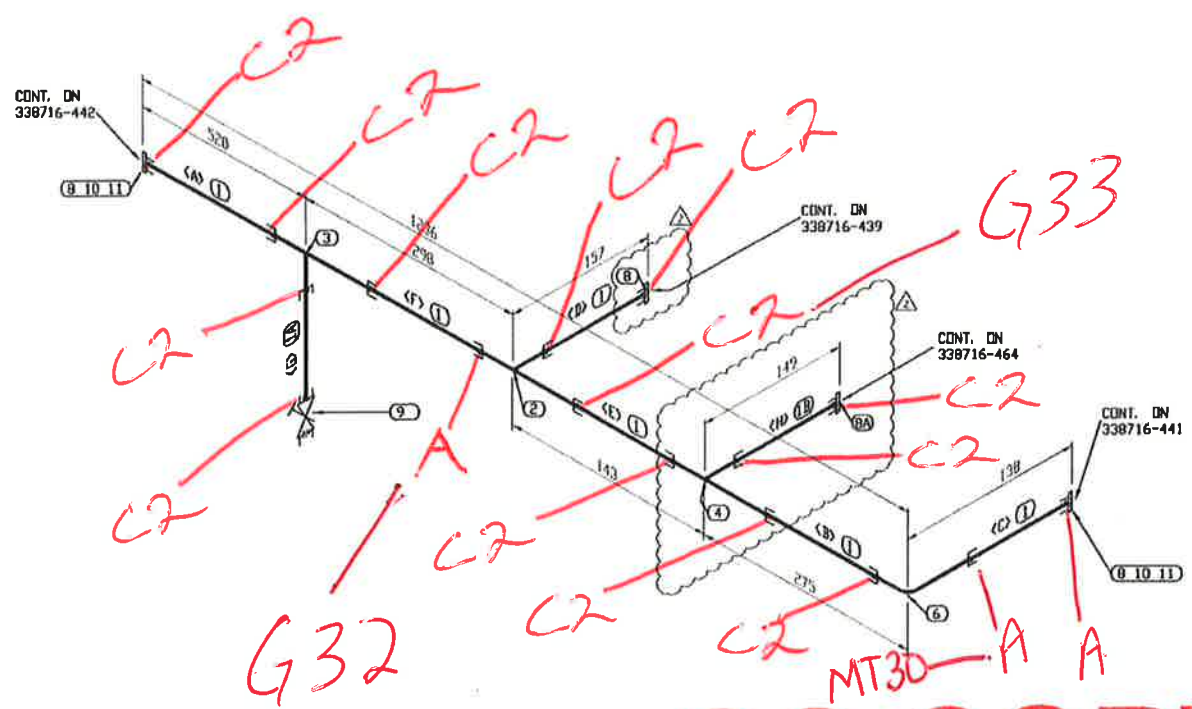
TAG: 0735A-08030

BLS#: 338716 QUOTE: CGY2014-85 PO# 4512-109-130

DWG#: GG DATE: JUL 04/14 DWG#: 338716-439-Rev2

CHK BY: ET DATE: JUL 04/14

APP BY: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A



QC COPY

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
△ 1	1	PIPE, SMLS, SCH XS, ASTM A333-6	1251 MM	
1A	3/4	PIPE, SMLS, SCH XS, ASTM A333-6	76 MM	
△ 1B	1/2	PIPE, SMLS, SCH XS, ASTM A333-6	102 MM	
FITTINGS				
2	1X1	TEE, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
3	1X3/4	TEE RED, SW X SW X SW, 3000LB, ASTM A350-LF2-CL. 1	1	
△ 4	1X1/2	TEE RED, SW X SW X SW, 3000LB, ASTM A350-LF2-CL. 1	1	
5	-	REMOVED	-	
6	1	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
7	-	REMOVED	-	
FLANGES				
△ 8	1	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	3	
△ 8A	1/2	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	1	
VALVES / IN-LINE ITEMS				
9	3/4	GATE VALVE, SW/NPT, REF. 338716-100 ITEM #27	1	

ERECTION MATERIALS

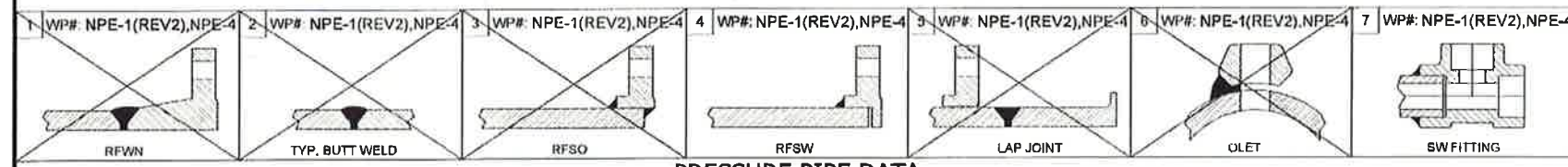
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
10	1	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	2	
BOLTS				
11	1X3 3/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	475	1
△ 	227	1
<C>	92	1
<D>	111	1
△ <E>	96	1
<F>	251	1
<G>	76	3/4
△ <H>	102	1/2

ISSUED FOR CONSTRUCTION

15/06/16
DATE:YY/MM/DD
SIGNATURE
natpro



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX, AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

GENERAL NOTES

- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCAW ALLOWED BY SHELL.

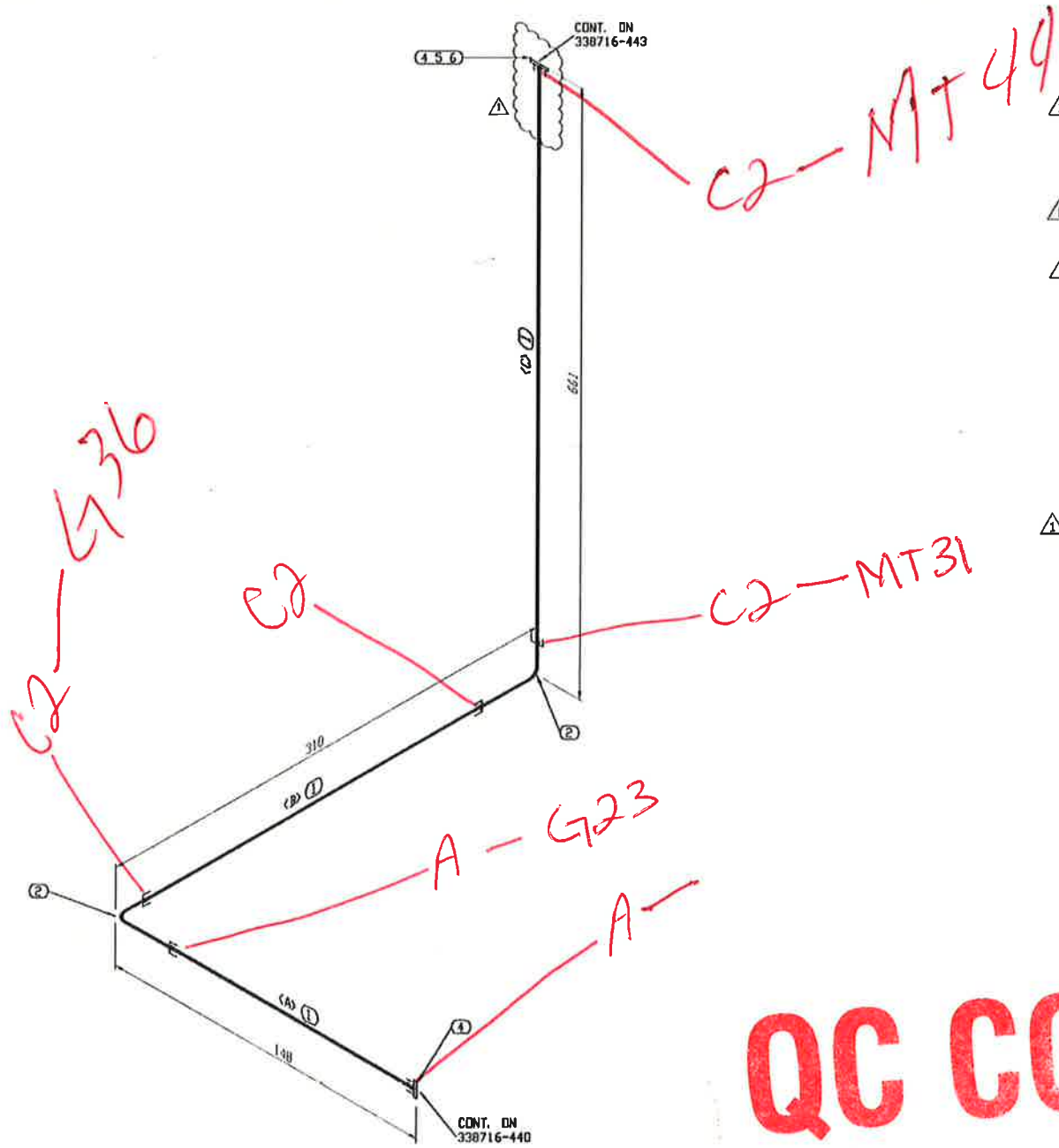
REV	DESCRIPTION	OWN	CHK	APP	DATE
2	CHANGED UNION TO FLANGE, TUBING TO PIPE & RELATED ITEMS	LK	AA	AA	JUN 02/15
1	ADDED 1<D>, <E>, <F> & 1A<G>, REMOVED #5&7; CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 28/15

DRAIN OUTLET SPOOL DETAIL

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE CGY2014-85 I/O# 4512-109-130
 OWNER: GG DATE: JUL 04/14
 DRAWN: ET DATE: JUL 04/14
 CHECKED: COG DATE: JUL 04/14
 TITLE: 338716-440-Rev2
 PAGE: 1 OF 1
 CAD: N/A



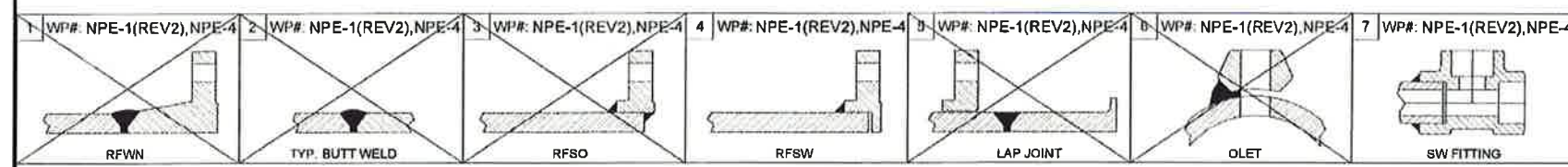
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
△ 1	1	PIPE, SMLS, SCH XS, ASTM A333-6	979 MM	
FITTINGS				
2	1	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	2	
△ 3	-	REMOVED	-	
FLANGES				
△ 4	1	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	2	

ERECTION MATERIALS				
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	1	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
△ 6	1X3 3/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	102	1
	262	1
△ <C>	615	1

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ISSUED FOR CONSTRUCTION
 15/06/16
 DATE: YYMMDD
 SIGNATURE
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PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

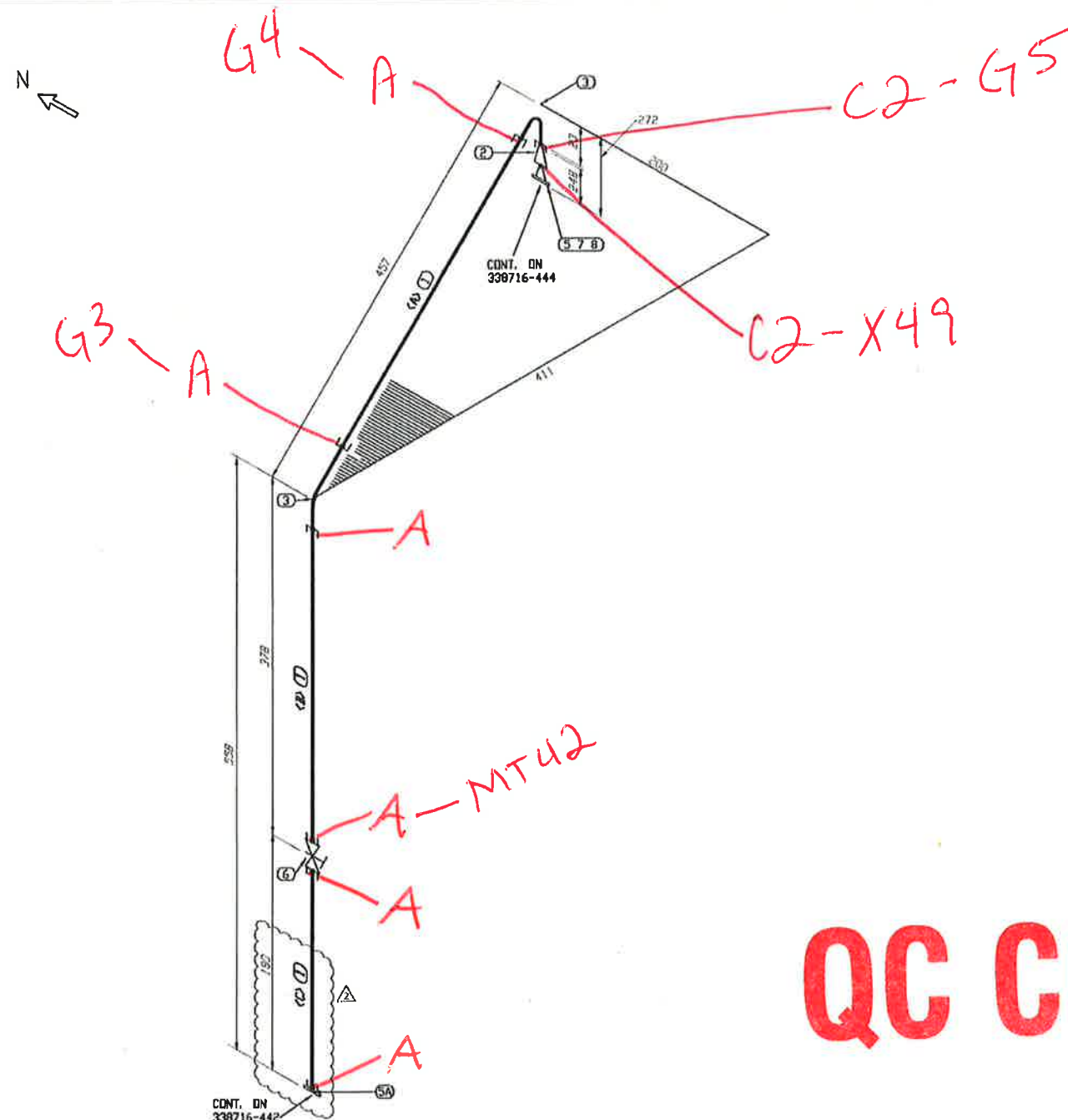
- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

1 CHANGED UNION TO FLANGE & RELATED ITEMS					LK	AA	AA	JUN 02/10
0 ISSUED FOR CONSTRUCTION					LK	AA	AA	APR 09/15
DESCRIPTION					DWN	CHK	APP	DATE
DRAIN OUTLET TO V-08069 SPOOL DETAIL								

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 BLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
 DATE: APR 06/15 UNV#: 338716-442-Rev1
 DATE: APR 09/15
 DATE: APR 09/15 PAGE: 1 OF 1 QAD: N/A



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	1	PIPE, SMLS, SCH XS, ASTM A333-6	833 MM	
FITTINGS				
2	2X1	SWAGE CONC, SCH XS, ASTM A420-WPL-6 BLE PSE	1	
3	1	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	2	
4	-	REMOVED	-	
FLANGES				
5	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL. 1	1	
5A	1	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	1	
VALVES / IN-LINE ITEMS				
6	1	GATE VALVE, SV, REF. 338716-100 ITEM #23	1	

ERECTION MATERIALS

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
7	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
8	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	409	1
	310	1
<C>	114	1

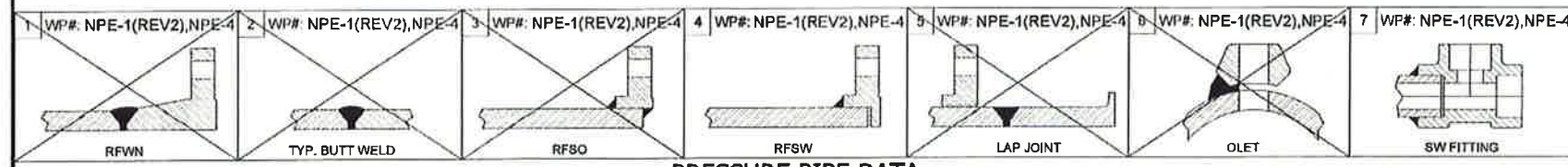
ISSUED FOR CONSTRUCTION

15/06/16
DATE: YY/MM/DD

[Signature]
SIGNATURE

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QC COPY



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CJ M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

DRAIN OUTLET TO V-08069 SPOOL DETAIL

REV	DESCRIPTION	OWN	CHK	APP	DATE
2	CHANGED UNION TO FLANGE & RELATED ITEMS	LK	AA	AA	JUN 02/15
1	ADDED 1<C>, REMOVED #4, CHANGED QTY OF #1 & NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/16

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PROJECT NAME: CARMON CREEK PROJECT

CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING

LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

TAG: 0735A-08030

SLS# 338716 QUOTE CGY2014-85 PUR# 4512-109-130

DRN: GG DATE: JUL 04/14

CHK: ET DATE: JUL 04/14

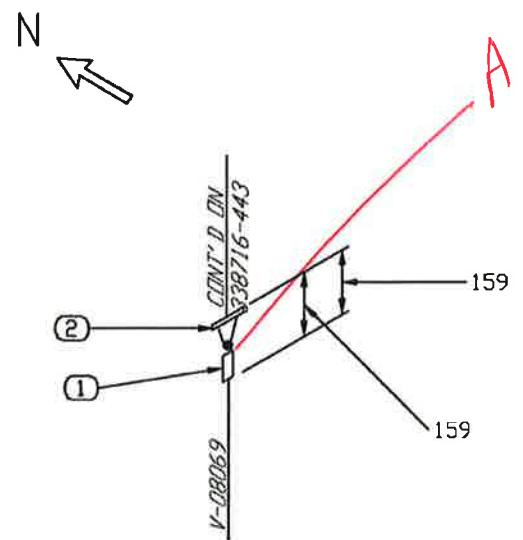
APP: COG DATE: JUL 04/14

338716-443-Rev2

PAGE: 1 OF 1 CAD: N/A

100% RT BW

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
FITTINGS				
1	2	NIPPLE, SCH XS, ASTM A333-6 BDE TUE (3' LG)	1	
FLANGES				
2	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL. 1	1	



15W

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 15/04/15
 DATE: YY/MM/DD
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- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

1 WP#: NPE-1(REV2),NPE-4	2 WP#: NPE-1(REV2),NPE-4	3 WP#: NPE-1(REV2),NPE-4	4 WP#: NPE-1(REV2),NPE-4	5 WP#: NPE-1(REV2),NPE-4	6 WP#: NPE-1(REV2),NPE-4	7 WP#: NPE-1(REV2),NPE-4
RFWN	TYP. BUTT WELD	RFSO	RFSW	LAP JOINT	OLET	SW FITTING

PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15
REV	DESCRIPTION	DWN	CHK	APP	DATE

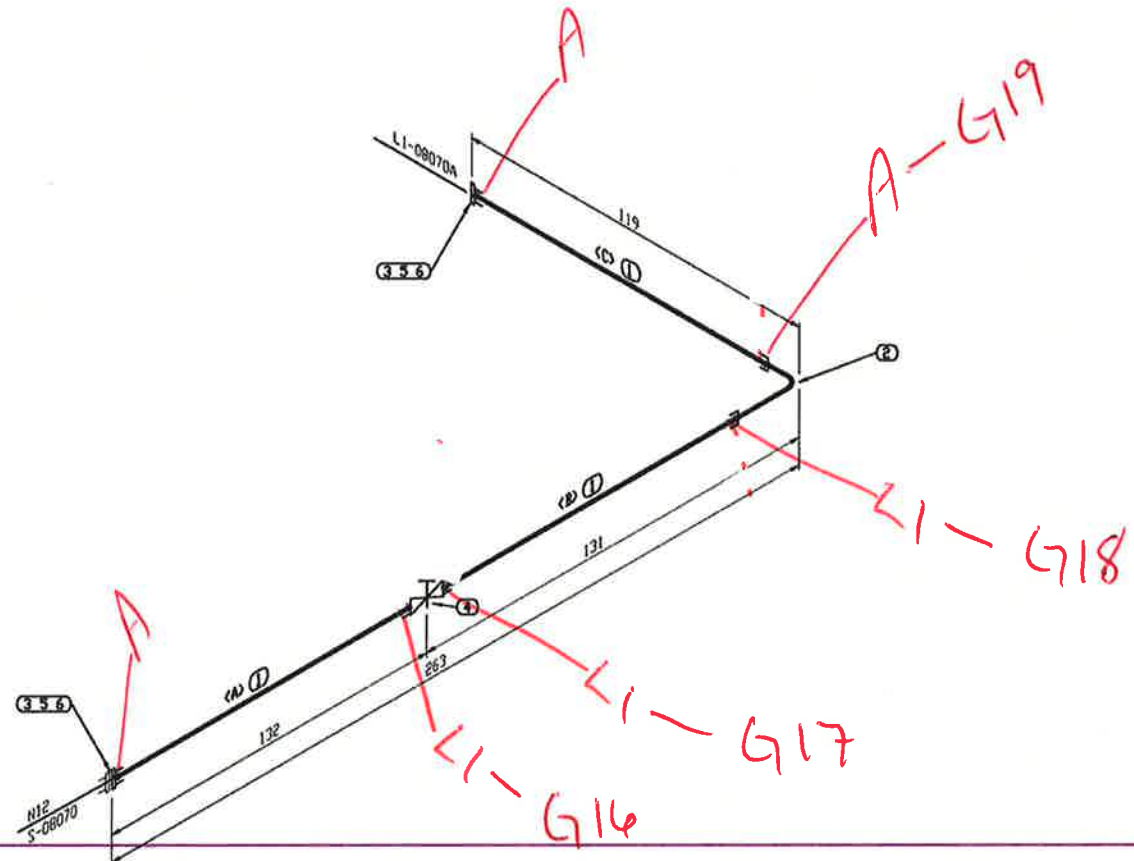
V-08069 INLET
 SPOOL DETAIL

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 POP: 4512-109-130
 DWN BY: GG DATE: JUL 04/14 DWG #: 338716-444-Rev1
 CHK BY: ET DATE: JUL 04/14
 APP BY: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A

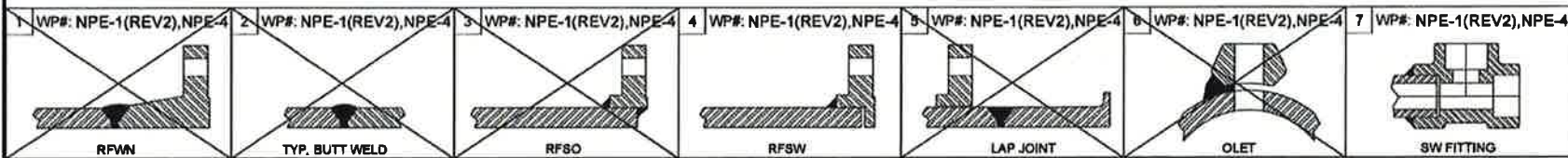
1070 MT + 1070 RT GAP



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	3/4	PIPE, SMLS, SCH XS, ASTM A333-6	229 MM	
FITTINGS				
2	3/4	90 ELL, SV, 3000LB, ASTM A350-LF2-CL. 1	1	
FLANGES				
3	3/4	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	2	6 SW
VALVES / IN-LINE ITEMS				
4	3/4	GATE VALVE, SV, REF. 338716-100 ITEM #26	1	
ERECTION MATERIALS				
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	3/4	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS DR SS OUTER RING	2	
BOLTS				
6	3/4X3 1/2	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
CUT PIPE LENGTH				
PIECE NUM	LENGTH (MM)	SIZE (INCH)		
<A>	77	3/4	6 SW	
	76	3/4		
<C>	76	3/4		

QC COPY

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE/SY/MM/DD
 SIGNATURE
 natpro



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

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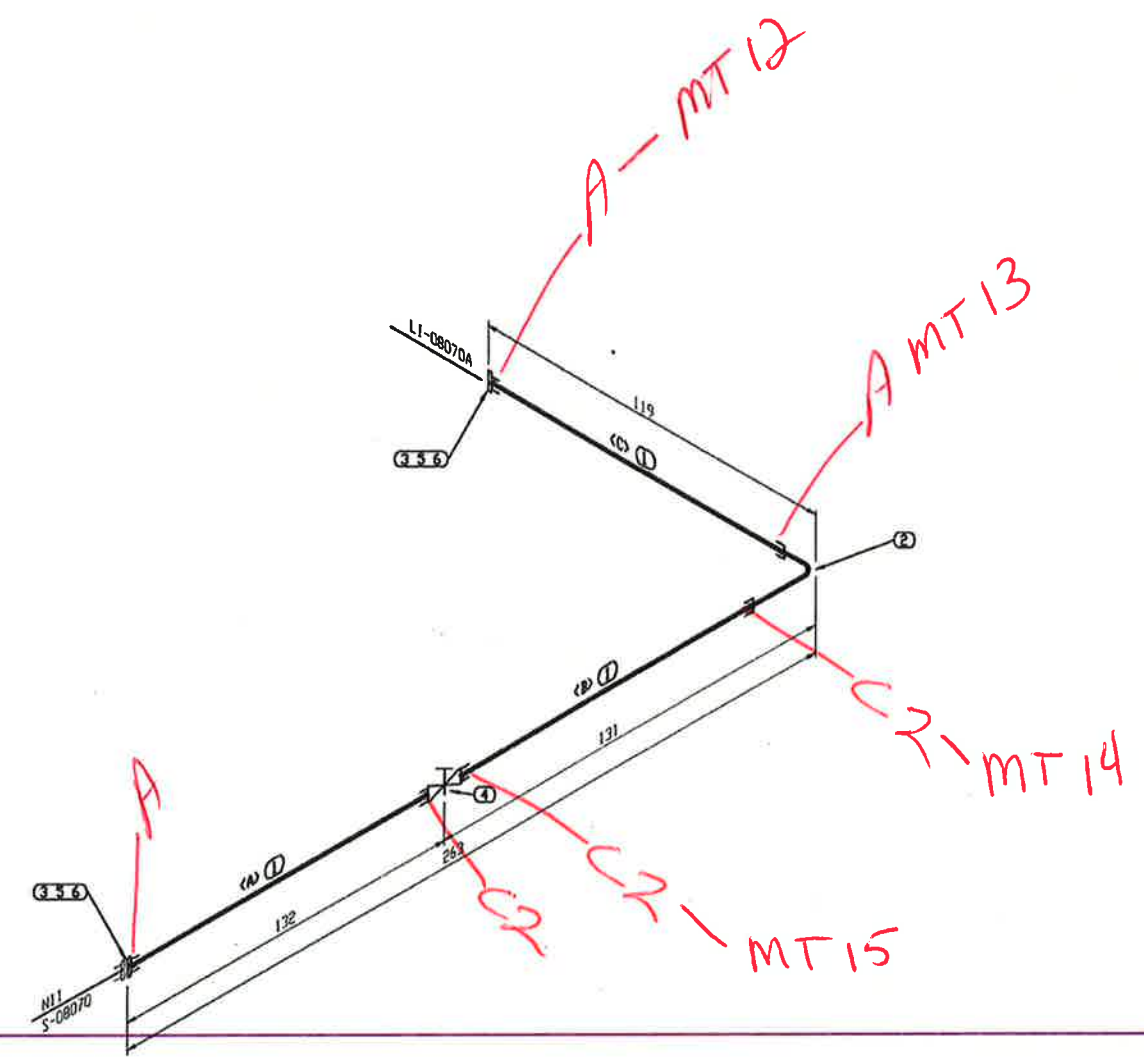
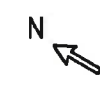
PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLR#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

DATE: APR 06/15
 DATE: APR 09/15
 DATE: APR 09/15

338716-445-Rev0
 1 OF 1
 N/A

LI-08070A INLET
 SPOOL DETAIL

10% MT + 10% RT GAP



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	3/4	PIPE, SMLS, SCH XS, ASTM A333-6	229 MM	
FITTINGS				
2	3/4	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
FLANGES				
3	3/4	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	2	6 SW
VALVES / IN-LINE ITEMS				
4	3/4	GATE VALVE, SW, REF. 338716-100 ITEM #26	1	

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	3/4	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	2	
BOLTS				
6	3/4X3 1/2	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	77	3/4
	76	3/4
<C>	76	3/4

6 SW

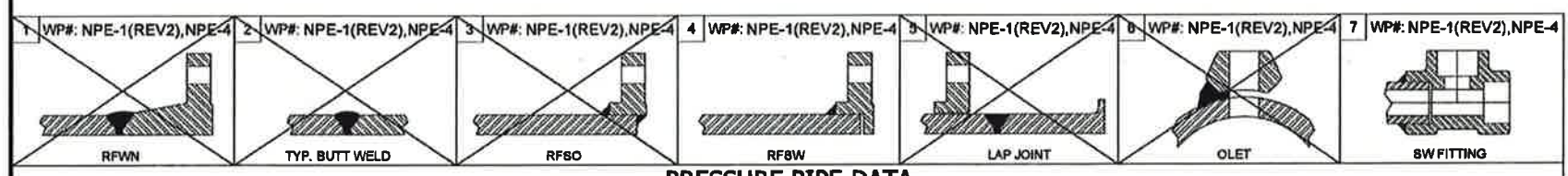
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ISSUED FOR CONSTRUCTION

15/04/15

AA

natpro



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

0	ISSUED FOR CONSTRUCTION	LK	AA	AA	APR 09/15
	DESCRIPTION	DWN	CHK	APP	DATE
	LI-08070A INLET				
	SPOOL DETAIL				

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.

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PROJECT NAME: CARMON CREEK PROJECT

CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING

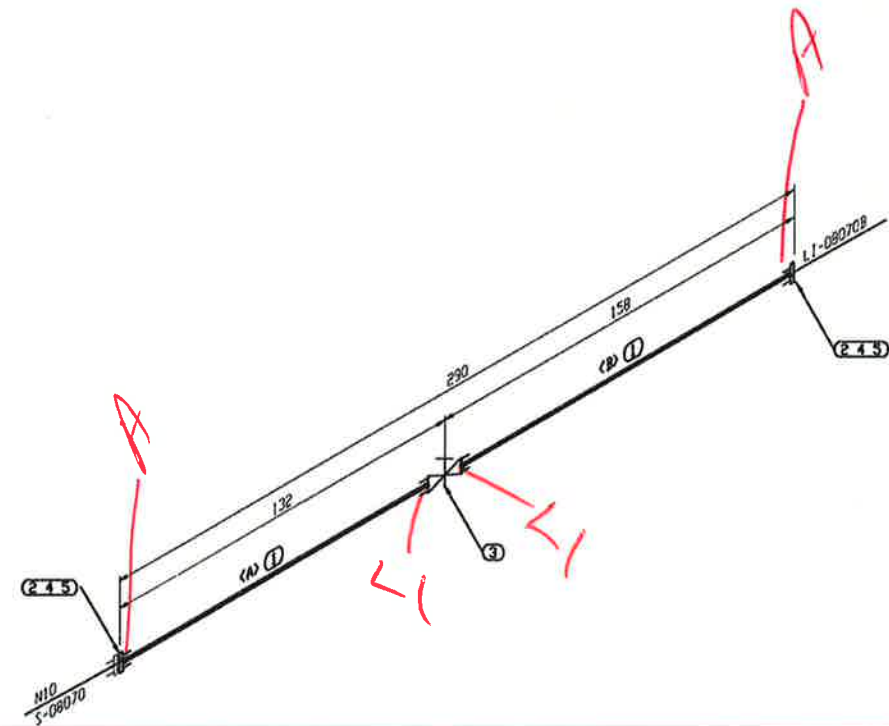
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

TAG: 0735A-08030

BLDG#: 338716 QUOTE: CGY2014-85 PDR: 4512-109-130

OWN: LK	DATE: APR 06/15	DWG#: 338716-446-Rev0
CHK: AA	DATE: APR 09/15	
APP: AA	DATE: APR 09/15	PAGE: 1 OF 1 CAD: N/A

10% MT + 10% RT GMP



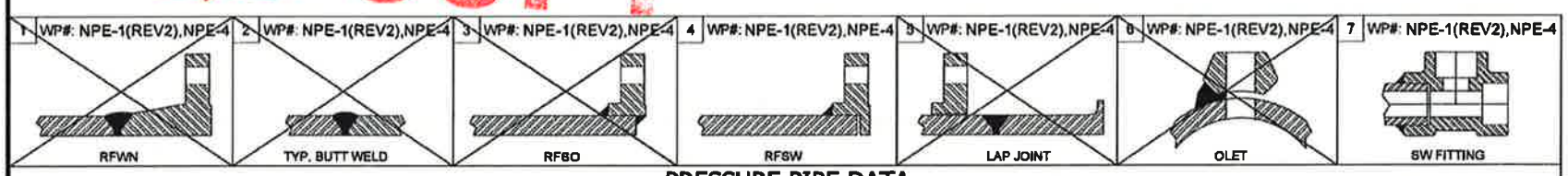
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	3/4	PIPE, SMLS, SCH XS, ASTM A333-6	179 MM	
FLANGES				
2	3/4	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	2	
VALVES / IN-LINE ITEMS				
3	3/4	GATE VALVE, SW, REF. 338716-100 ITEM #26	1	LI SW
ERECTION MATERIALS				
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
4	3/4	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS DR SS OUTER RING	2	
BOLTS				
5	3/4X3 1/2	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, 1/2 NUTS: A194-2H	8	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	77	3/4
	102	3/4

4 SW

QC COPY

ISSUED FOR CONSTRUCTION
15/04/15
DATE
AA



- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

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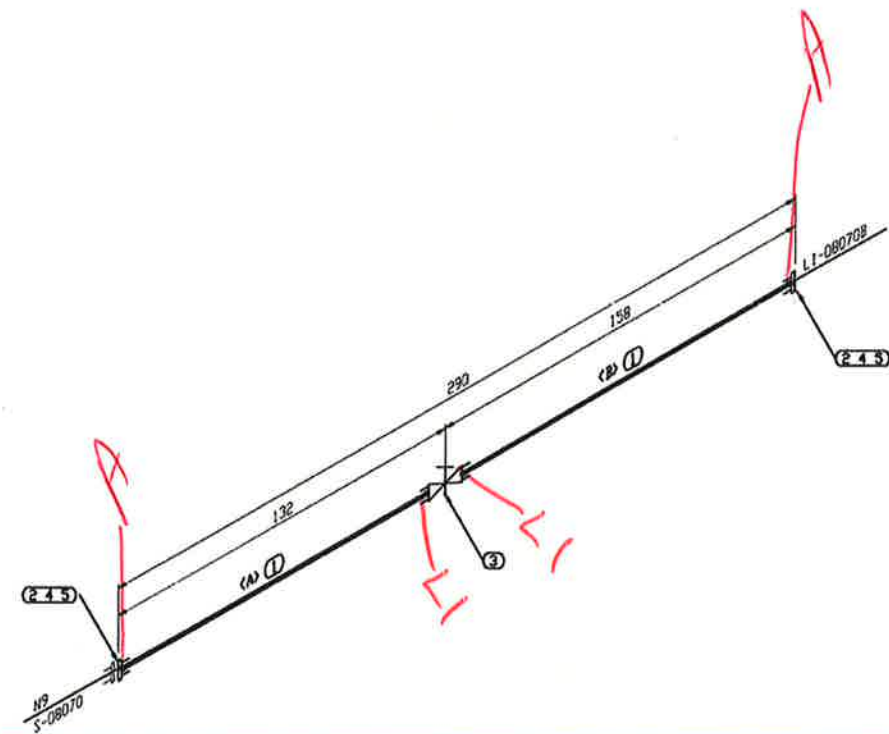
natpro

PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 BLS#: 338716 QUOTE: CGY2014-B5 POC: 4512-109-130
 DWN: LK DATE: APR 06/15 DWO: 338716-447-Rev0
 CRR: AA DATE: APR 09/15
 APP: AA DATE: APR 09/15 PAGE: 1 OF 1 CAD: N/A

PRESSURE PIPE DATA		
SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

LI-08070B INLET
SPOOL DETAIL

10% MT + 10% RT GAP



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	3/4	PIPE, SMLS, SCH XS, ASTM A333-6	179 MM	
FLANGES				
2	3/4	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	2	
VALVES / IN-LINE ITEMS				
3	3/4	GATE VALVE, SW, REF. 338716-100 ITEM #26	1	4 SW

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
4	3/4	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	2	
BOLTS				
5	3/4X3 1/2	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

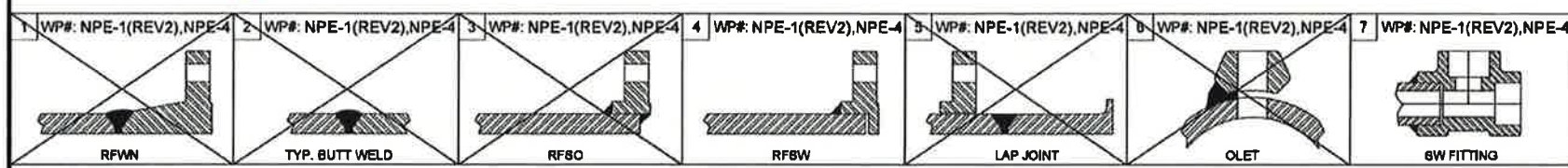
CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	77	3/4
	102	3/4

4 SW

QC COPY

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE YY/MM/DD
 natpro



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

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natpro

PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 BL# 338716 QUOTE CGY2014-85 P# 4512-109-130
 DATE: APR 06/15
 DATE: APR 09/15
 DATE: APR 09/15
 PAGE: 1 OF 1
 C# N/A

LI-08070B INLET
 SPOOL DETAIL

10% MT + 10% RT GAP

BILL OF MATERIAL

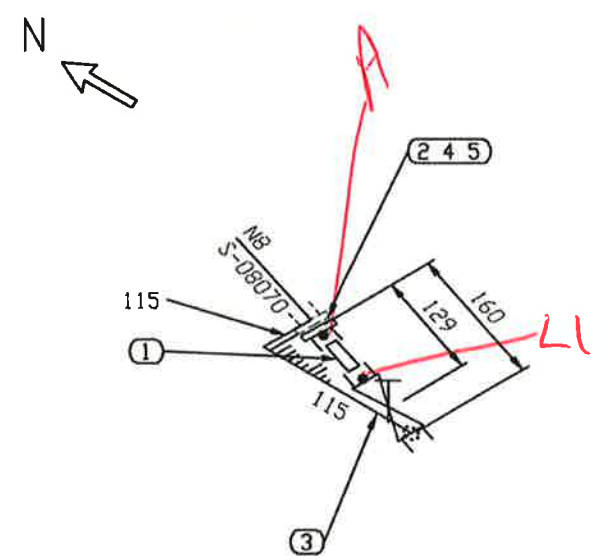
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	1/2	PIPE, SMLS, SCH XS, ASTM A333-6	76 MM	
FLANGES				
2	1/2	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	1	
VALVES / IN-LINE ITEMS				
3	1/2	GATE VALVE, SW/NPT, REF. 338716-100 ITEM #32	1	2 SW

ERECTION MATERIALS

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
4	1/2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
5	1/2X3 1/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	76	1/2



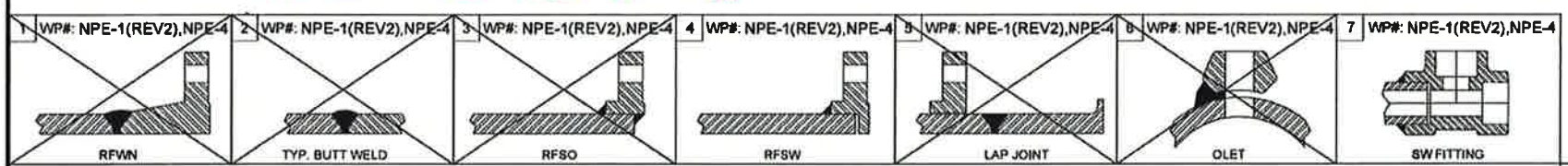
QC COPY

ISSUED FOR CONSTRUCTION

15/04/15
DATE:YY/MM/DD



- GENERAL NOTES
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

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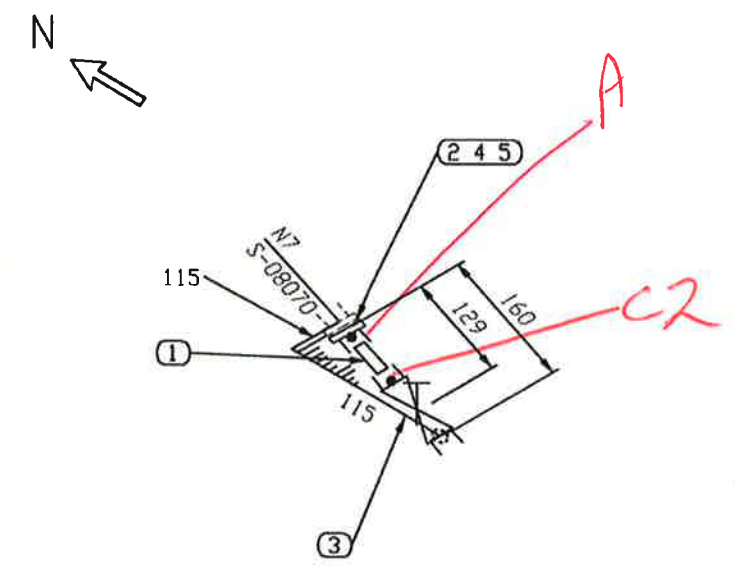
PROJECT NAME: CARMON CREEK PROJECT	CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2	TAG: 0735A-08030
BLSP: 338716	QUOTE: CGY2014-85
POF: 4512-109-130	
DATE: JUL 04/14	DATE: JUL 04/14
DATE: JUL 04/14	DATE: JUL 04/14
DATE: JUL 04/14	DATE: JUL 04/14

SPOOL DETAIL

10% MT + 10% RT GAP

BILL OF MATERIAL

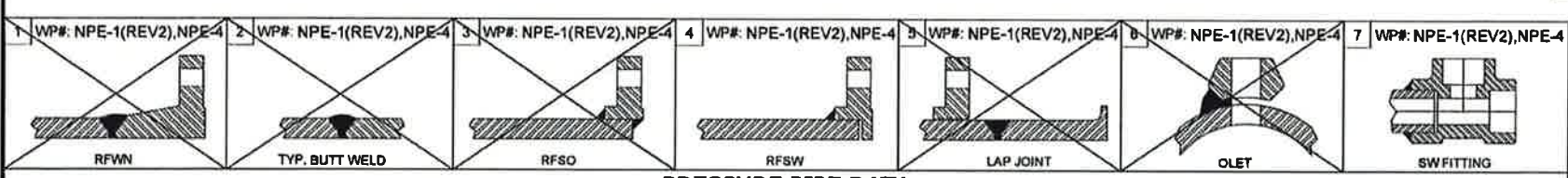
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	1/2	PIPE, SMLS, SCH XS, ASTM A333-6	76 MM	
FLANGES				
2	1/2	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	1	
VALVES / IN-LINE ITEMS				
3	1/2	GATE VALVE, SW/NPT, REF. 338716-100 ITEM #32	1	2 Sw
ERECTION MATERIALS				
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
4	1/2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
5	1/2X3 1/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	
CUT PIPE LENGTH				
PIECE NUM	LENGTH (MM)	SIZE (INCH)		
<A>	76	1/2	2 Sw	



QC COPY

ISSUED FOR CONSTRUCTION
15/04/15
N/A

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	OWN	CHK	APP	DATE
1	CHANGED #1 FROM NIPPLE TO PIPE & NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 09/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

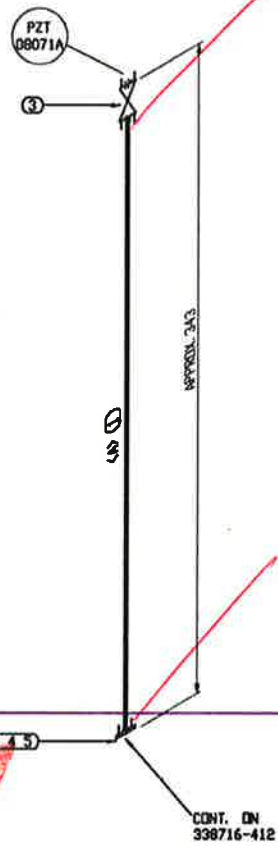
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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLB#: 338716 QUOTE: CGY2014-85 FOR: 4512-109-130
 ORG#: GG DATE: JUL 04/14 DWD #:
 CHG#: ET DATE: JUL 04/14 338716-450-Rev1
 APP#: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A

SPOOL DETAIL

10% MT + 10% RT (IMP)



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	3/4	PIPE, SMLS, SCH XS, SS316/L	76 MM	
FLANGES				
2	3/4	FLG RFSW, 1500LB, SCH XS, SS316/L	1	
VALVES / IN-LINE ITEMS				
3	3/4	MANIFOLD, SW/NPT, REF. 338716-100 ITEM #31	1	2 SW

ERECTOR MATERIALS

BILL OF MATERIAL

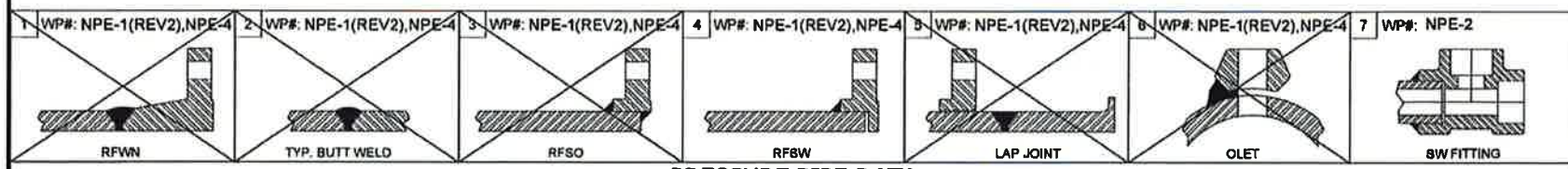
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
4	3/4	GASKET, 1500LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
5	3/4x1/2	3/4" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	76	3/4

QC COPY

ISSUED FOR CONSTRUCTION
 15/04/15
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PRESSURE PIPE DATA

SPECIFICATION: SHELL C20W CLASS 900	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: N/A
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 3330 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 2035 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 100%LPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

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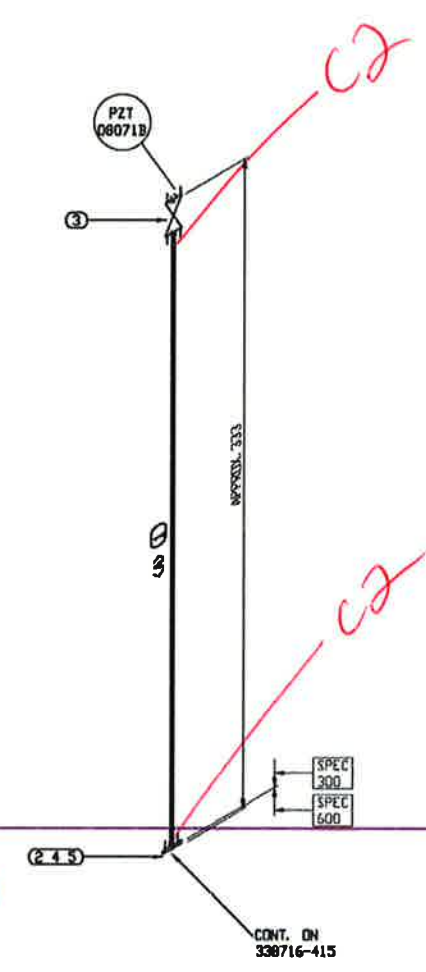
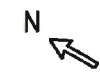
PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030

ELSR: 338716	QUOTE: CGY2014-85	PO# 4512-109-130
DRAWN: LK	DATE: APR 06/15	DWG#: 338716-451-Rev0
CHKD: AA	DATE: APR 09/15	PAGE: 1 OF 1
APPD: AA	DATE: APR 09/15	CAD: N/A

DESCRIPTION	DWN	CHK	APP	DATE
ISSUED FOR CONSTRUCTION				APR 09/15

MANIFOLD CONNECTION SPOOL DETAIL

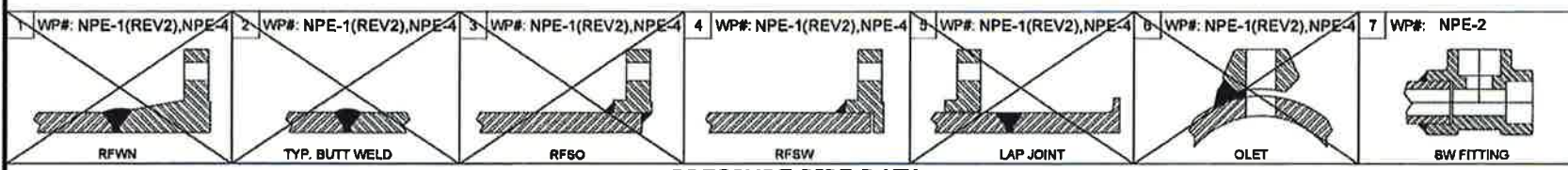
1090 MT + 1090 RT GAP



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	3/4	PIPE, SMLS, SCH XS, SS316/L	77 MM	
FLANGES				
2	3/4	FLG RFSW, 600LB, SCH XS, SS316/L	1	
VALVES / IN-LINE ITEMS				
3	3/4	MANIFOLD, SW/NPT, REF. 338716-100 ITEM #31	1	2 SW
ERECTION MATERIALS				
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
4	3/4	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
5	3/4X3 1/2	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	
CUT PIPE LENGTH				
PIECE NUM	LENGTH (MM)	SIZE (INCH)		
<A>	77	3/4	2 SW	

QC COPY

ISSUED FOR CONSTRUCTION
15/04/15
DATE
na



PRESSURE PIPE DATA

SPECIFICATION: SHELL E20W CLASS 300	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: N/A
DESIGN CODE Z662	TEST PRESSURE/TEMP/DURATION: 1110 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 680 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 100%LPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030

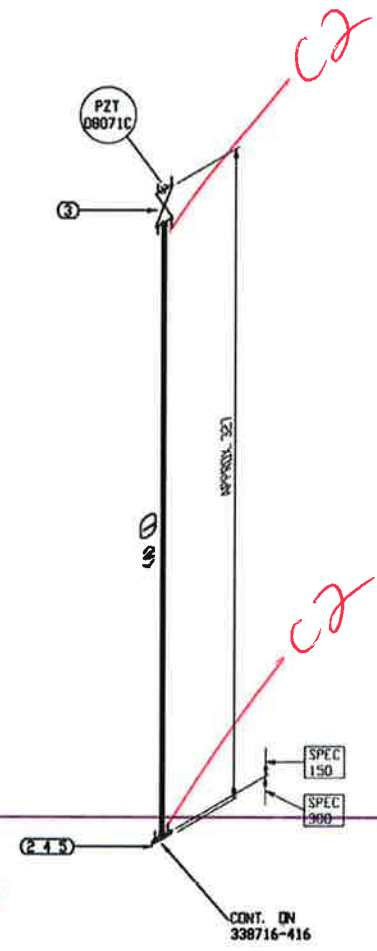
BLSP: 338716 QUOTE: CGY2014-85 PO# 4512-109-130

REV: LK DATE: APR 06/15
 CHK: AA DATE: APR 09/15
 APP: AA DATE: APR 09/15

338716-452-Rev0
 PAGE: 1 OF 1
 CND: N/A

DESCRIPTION	OWN	CHK	APP	DATE
ISSUED FOR CONSTRUCTION	LK	AA	AA	APR 09/15
MANIFOLD CONNECTION SPOOL DETAIL				

10% MT + 10% RT GAP



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	3/4	PIPE, SMLS, SCH XS, SS316/L	76 MM	
FLANGES				
2	3/4	FLG RFSW, 300LB, SCH XS, SS316/L	1	
VALVES / IN-LINE ITEMS				
3	3/4	MANIFOLD, SW/NPT, REF. 338716-100 ITEM #31	1	2 SW

ERECTOR MATERIALS

BILL OF MATERIAL

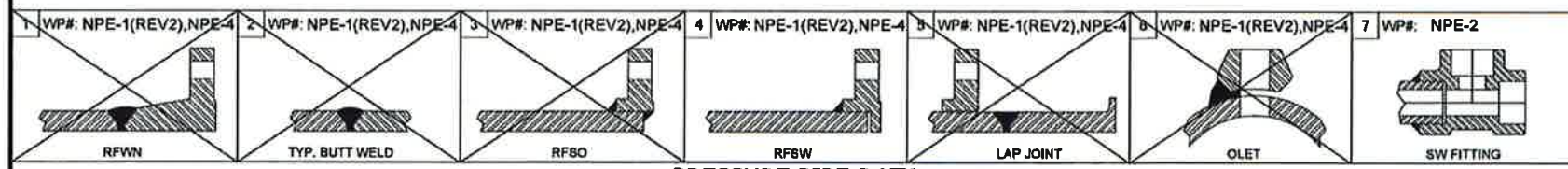
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
4	3/4	GASKET, 300LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS DR SS OUTER RING	1	
BOLTS				
5	3/4X3	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	76	3/4

QC COPY

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE: YY/MM/DD
 188



PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: N/A
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: (SW) 100%LPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030

REVISIONS:

NO	DESCRIPTION	APP	DATE
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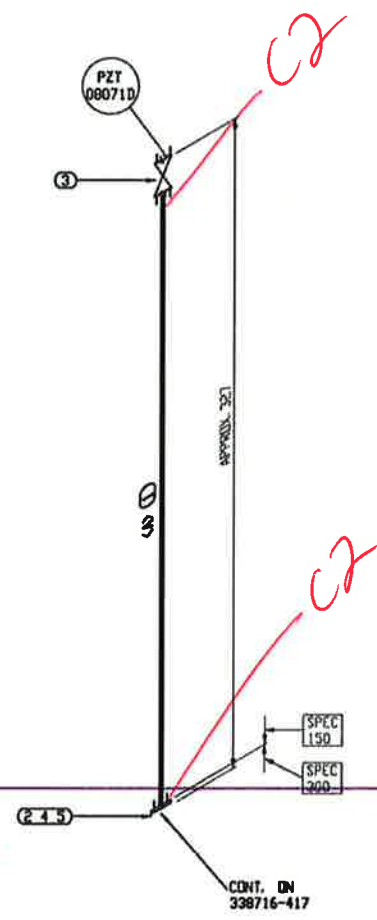
MANIFOLD CONNECTION SPOOL DETAIL

REVISIONS:

REV#	DATE	BY	CHK	APP	DATE
LK	APR 06/15				
AA	APR 09/15				
AA	APR 09/15				

BLSP: 338716 QUOTE: CGY2014-85 PDR: 4512-109-130
 DMD #: 338716-453-Rev0
 PAGE: 1 OF 1 CND: N/A

1070 MT + 1070 RT GAP



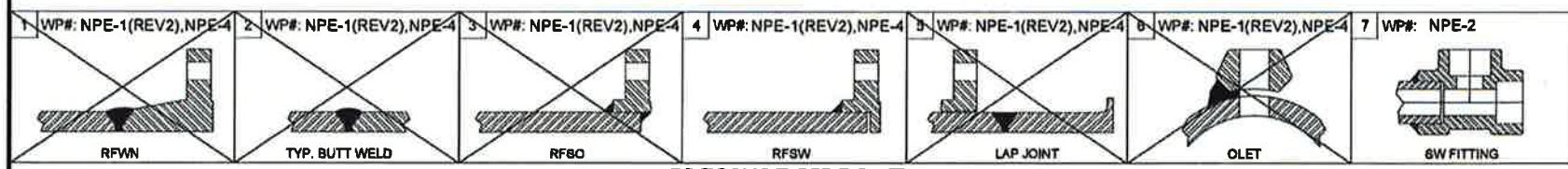
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	3/4	PIPE, SMLS, SCH XS, SS316/L	76 MM	
FLANGES				
2	3/4	FLG RFSW, 300LB, SCH XS, SS316/L	1	
VALVES / IN-LINE ITEMS				
3	3/4	MANIFOLD, SW/NPT, REF. 338716-100 ITEM #31	1	2 SW

ERECTOR MATERIALS				
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
4	3/4	GASKET, 300LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS DR SS OUTER RING	1	
BOLTS				
5	3/4X3	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	76	3/4

QC COPY

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE FORWARDED
 SIGNATURE



- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: N/A
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: (SW) 100%LPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

0	ISSUED FOR CONSTRUCTION	LK	AA	AA	APR 09/15
	DESCRIPTION	DAWN	CHK	APP	DATE
MANIFOLD CONNECTION SPOOL DETAIL					

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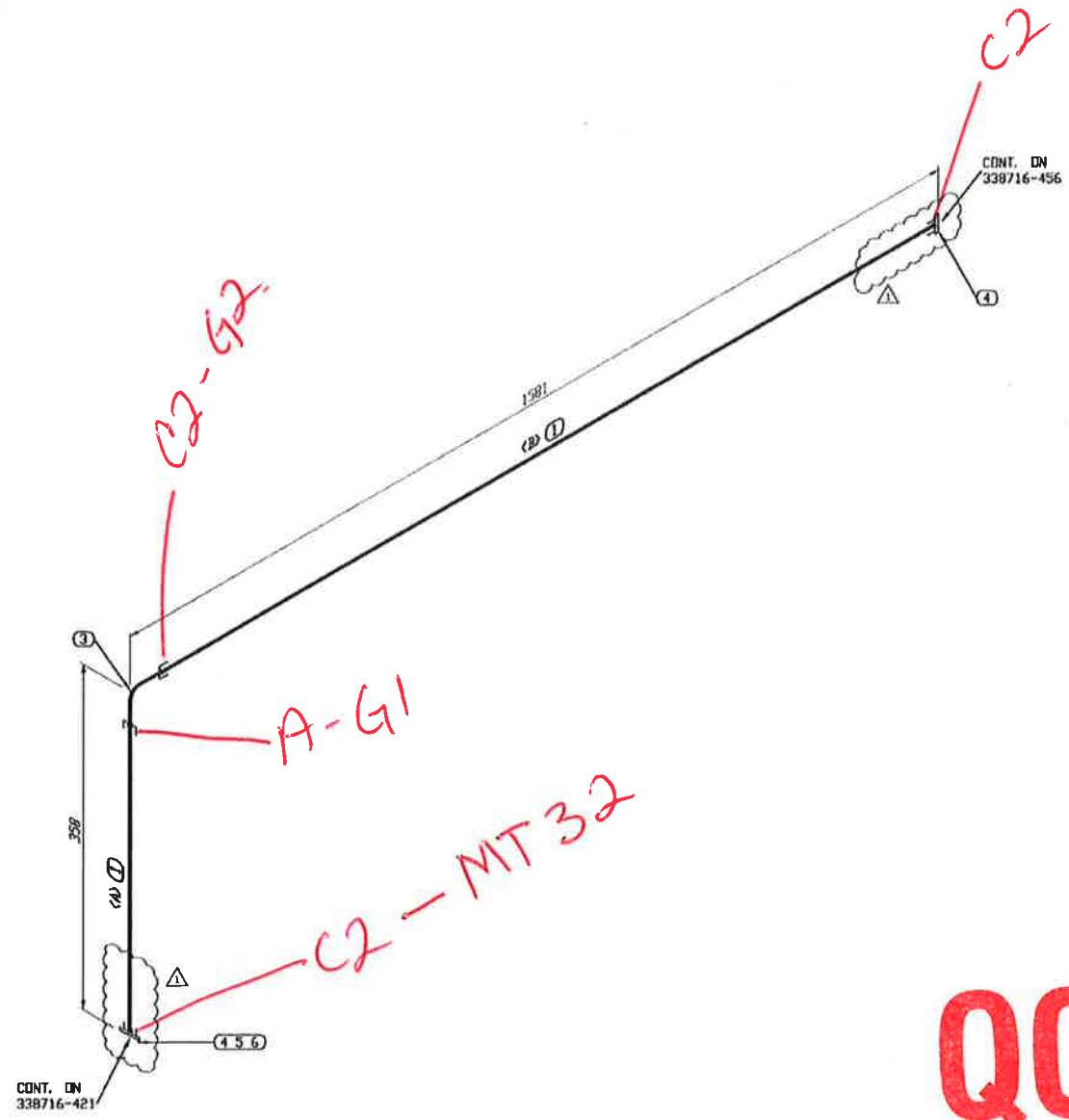
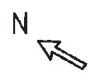
natpro

PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030

BLSP: 338716 QUOTE: CGY2014-85 POF: 4512-109-130

DATE: APR 06/15
 DATE: APR 09/15
 DATE: APR 09/15

338716-454-Rev0
 PAGE: 1 OF 1 CAD: N/A



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
△ 1	1	PIPE, SMLS, SCH XS, ASTM A333-6	1879 MM	
FITTINGS				
△ 2	-	REMOVED	-	
3	1	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
FLANGES				
△ 4	1	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL. 1	2	

ERECTION MATERIALS

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
△ 5	1	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
BOLTS				
△ 6	1X2 3/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

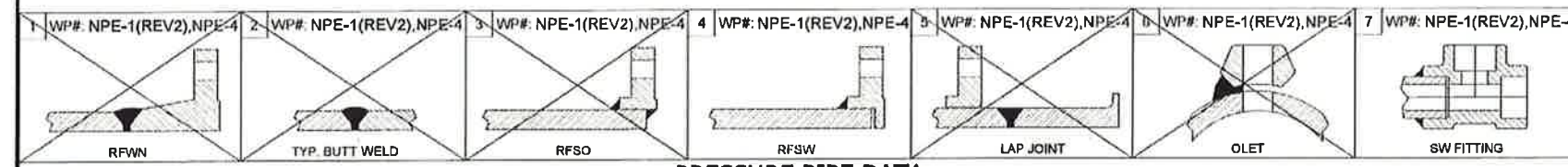
PIECE NUM	LENGTH (MM)	SIZE (INCH)
△ <A>	328	1
	1551	1

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15/06/16
 DATE:YY/MM/DD SIGNATURE

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SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

1	CHANGED UNION TO FLANGE & RELATED ITEMS	LK	AA	AA	JUN 02/15
0	ISSUED FOR CONSTRUCTION	LK	AA	AA	APR 09/15
REV	DESCRIPTION	OWN	CHK	APP	DATE
V-08116A INLET SPOOL DETAIL					

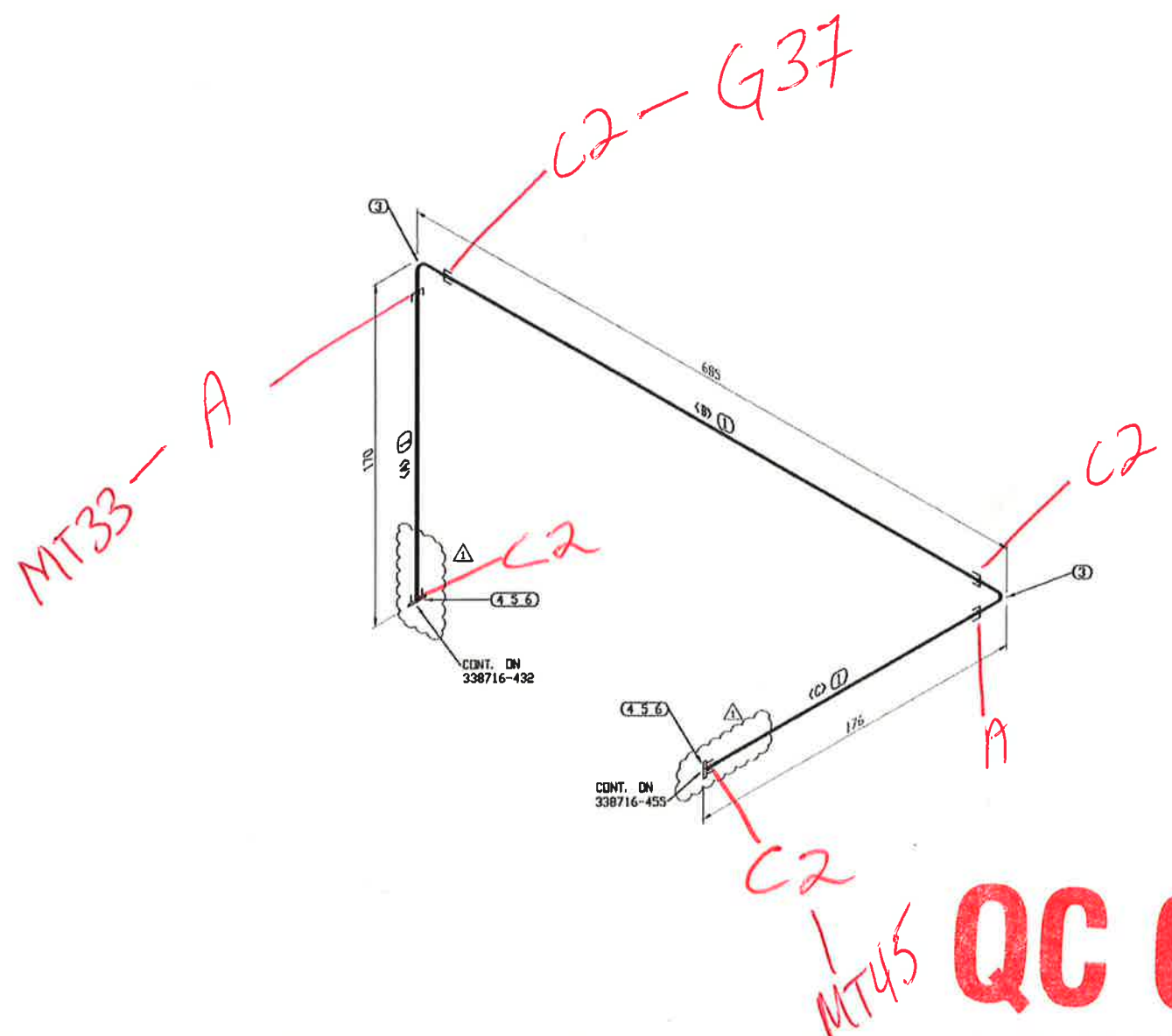
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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO# 4512-109-130

DWG#: LK DATE: APR 06/15 DWG#: 338716-455-Rev1
 CHK#: AA DATE: APR 09/15
 APP#: AA DATE: APR 09/15 PAGE: 1 OF 1 CAD: N/A



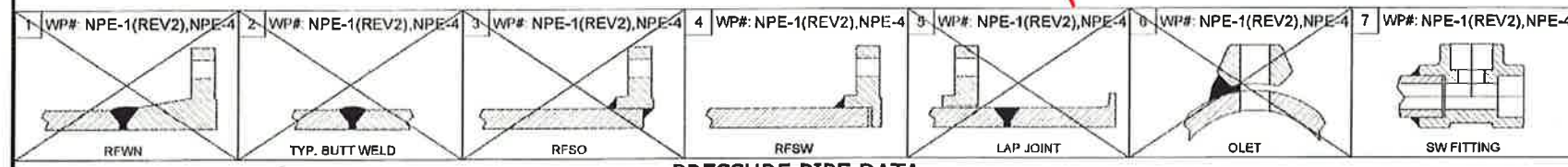
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
△ 1	1	PIPE, SMLS, SCH XS, ASTM A333-6	922 MM	
FITTINGS				
△ 2	-	REMOVED	-	
3	1	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	2	
FLANGES				
△ 4	1	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL. 1	2	

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
△ 5	1	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	2	
BOLTS				
△ 6	1X2 3/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
△ <A>	139	1
△ 	637	1
△ <C>	146	1

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PRESSURE PIPE DATA		
SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

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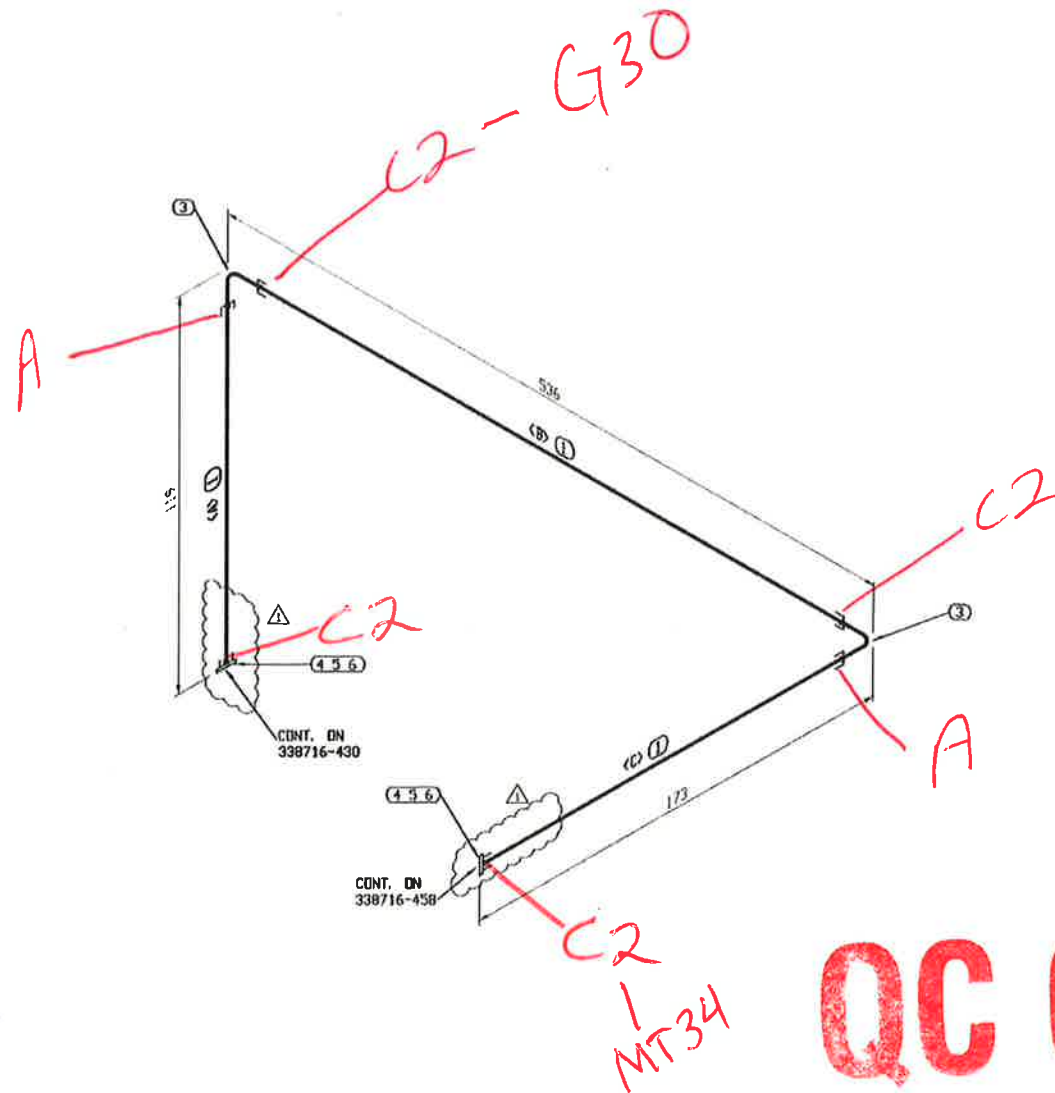
PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

TAG: 0735A-08030
 SLB#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

DATE: APR 06/15
 DATE: APR 09/15
 DATE: APR 09/15

338716-456-Rev1
 1 OF 1
 N/A

V-08116A INLET
 SPOOL DETAIL



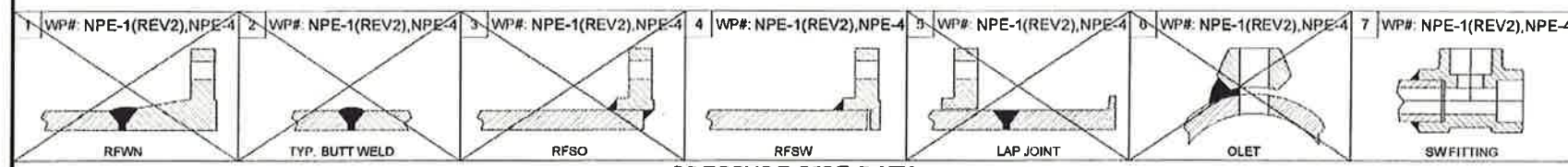
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
△ 1	1	PIPE, SMLS, SCH XS, ASTM A333-6	719 MM	
FITTINGS				
△ 2	-	REMOVED	-	
3	1	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	2	
FLANGES				
△ 4	1	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL. 1	2	

ERECTION MATERIALS				
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	1	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	2	
BOLTS				
6	1X2 3/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
△ <A>	89	1
△ 	488	1
△ <C>	142	1

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 DATE:YY/MM/DD SIGNATURE
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PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

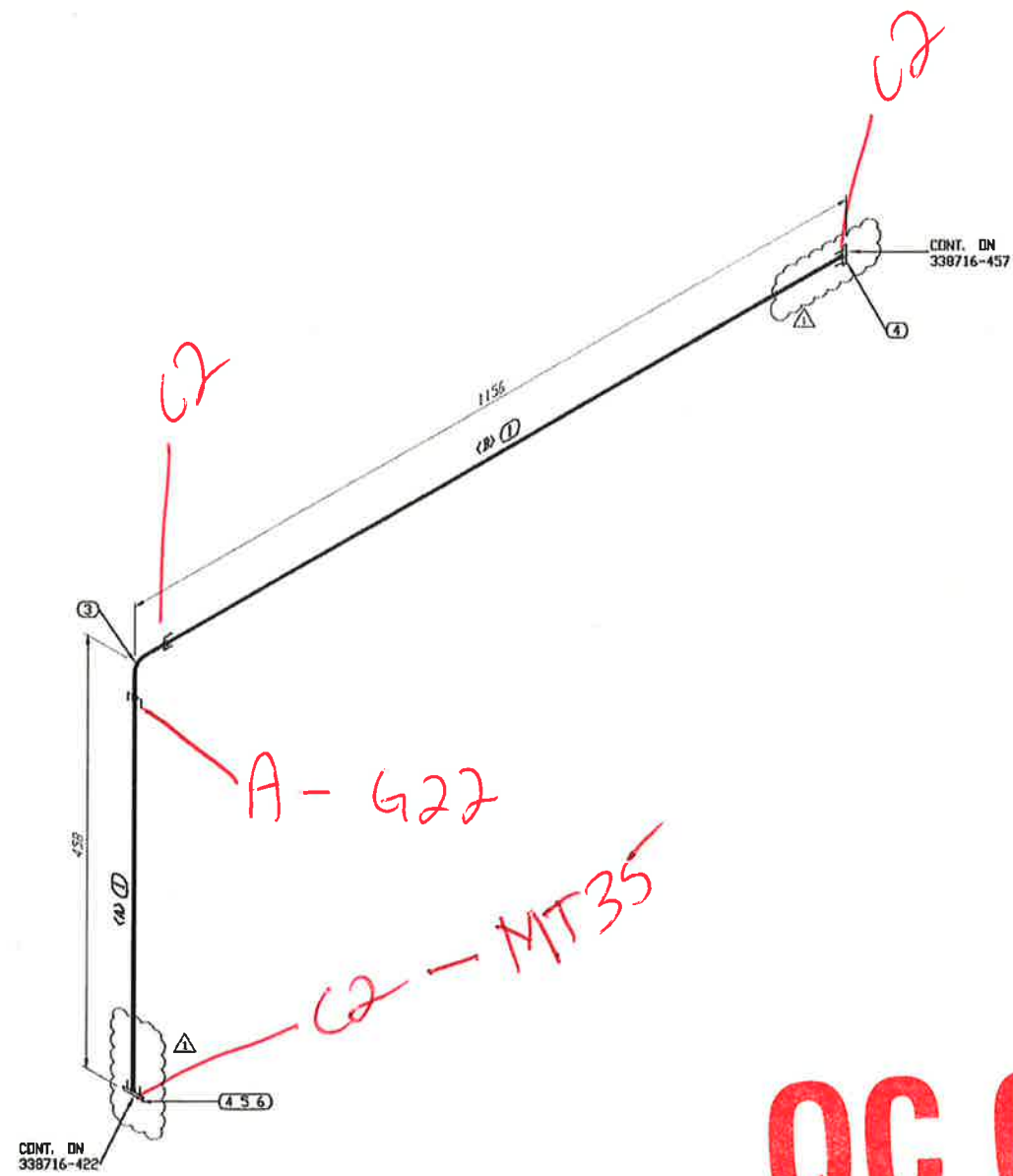
1	CHANGED UNION TO FLANGE & RELATED ITEMS	LK	AA	AA	JUN 02/15
0	ISSUED FOR CONSTRUCTION	LK	AA	AA	APR 09/15

DESCRIPTION: V-08116A OUTLET SPOOL DETAIL

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLSR: 338716 QUOTE: CGY2014-85 PUR: 4512-109-130
 DWG#: LK DATE: APR 06/15 DWSR#: 338716-457-Rev1
 DWG#: AA DATE: APR 09/15
 DWG#: AA DATE: APR 09/15 PAGE: 1 OF 1 CND: N/A



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
△ 1	1	PIPE, SMLS, SCH XS, ASTM A333-6	1554 MM	
FITTINGS				
△ 2	-	REMOVED		
3	1	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
FLANGES				
△ 4	1	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL. 1	2	

ERECTOR MATERIALS				
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
△ 5	1	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
BOLTS				
6	1X2 3/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
△ <A>	428	1
	1126	1

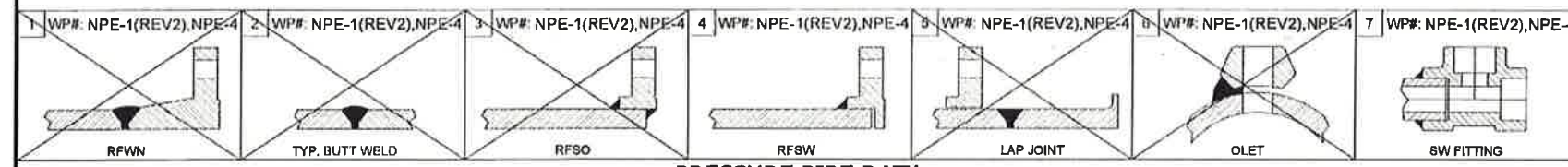
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 DATE: YY/MM/DD SIGNATURE
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PROJECT NAME:	CARMON CREEK PROJECT
CUSTOMER:	SHELL CANADA c/o JACOBS ENGINEERING
LOCATION:	CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG:	0735A-08030
BL#:	338716
QUOTE:	CGY2014-85
PO#:	4512-109-130
DWN:	LK
DATE:	APR 06/15
DWG#:	338716-458-Rev1
CHK:	AA
DATE:	APR 09/15
APP:	AA
DATE:	APR 09/15
PAGE:	1 OF 1
CAD:	N/A



PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

GENERAL NOTES

- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCAW ALLOWED BY SHELL.

DESCRIPTION	DWN	CHK	APP	DATE
1 CHANGED UNION TO FLANGE & RELATED ITEMS	LK	AA	AA	JUN 02/15
0 ISSUED FOR CONSTRUCTION	LK	AA	AA	APR 09/15

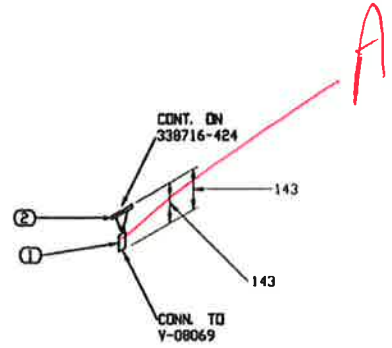
**V-08116A OUTLET
SPOOL DETAIL**

1070 MT + 1070 RT GAP.



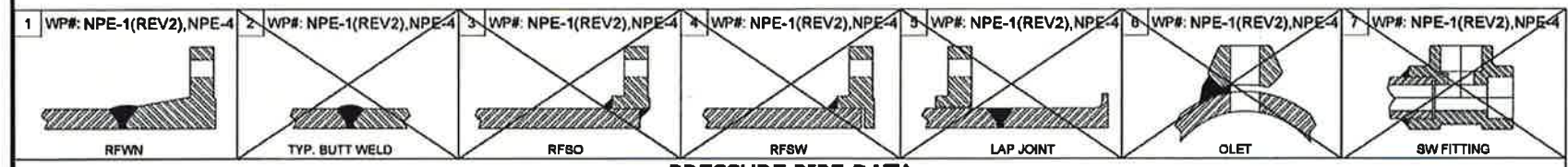
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
FITTINGS				
1	2	NIPPLE, SCH XS, ASTM A333-6 BDE TDE (3' LG)	1	
FLANGES				
2	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL. 1	1	15w

15w



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PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

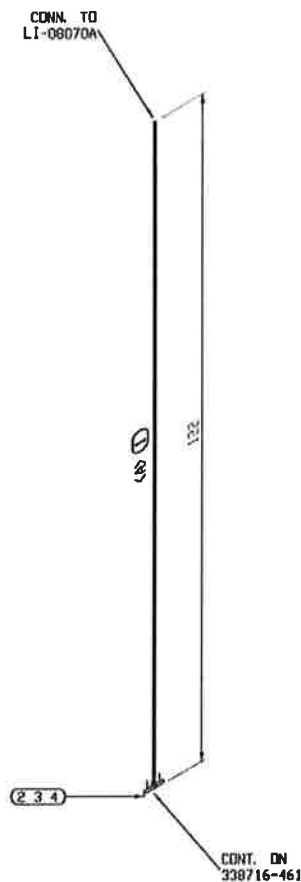
- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLR#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
 DATE: APR 06/15
 DATE: APR 09/15
 DATE: APR 09/15
 DRAWN: LK
 CHECKED: AA
 APPR: AA
 DWG#: 338716-459-Rev0
 PAGE: 1 OF 1
 CAD: N/A

V-08069 VENT OUTLET SPOOL DETAIL



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	1/2	PIPE, SMLS, SCH XS, ASTM A333-6	101 MM	
FLANGES				
2	1/2	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL.1	1	

ERECTION MATERIALS

BILL OF MATERIAL

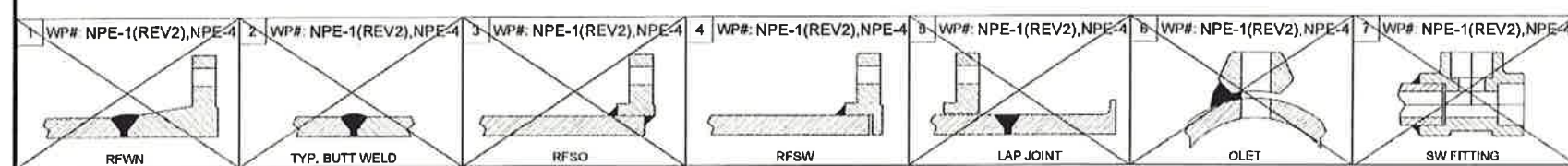
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
3	1/2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS DR SS OUTER RING	1	
BOLTS				
4	1/2X3 1/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	101	1/2

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 DATE: YY/MM/DD
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PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

GENERAL NOTES

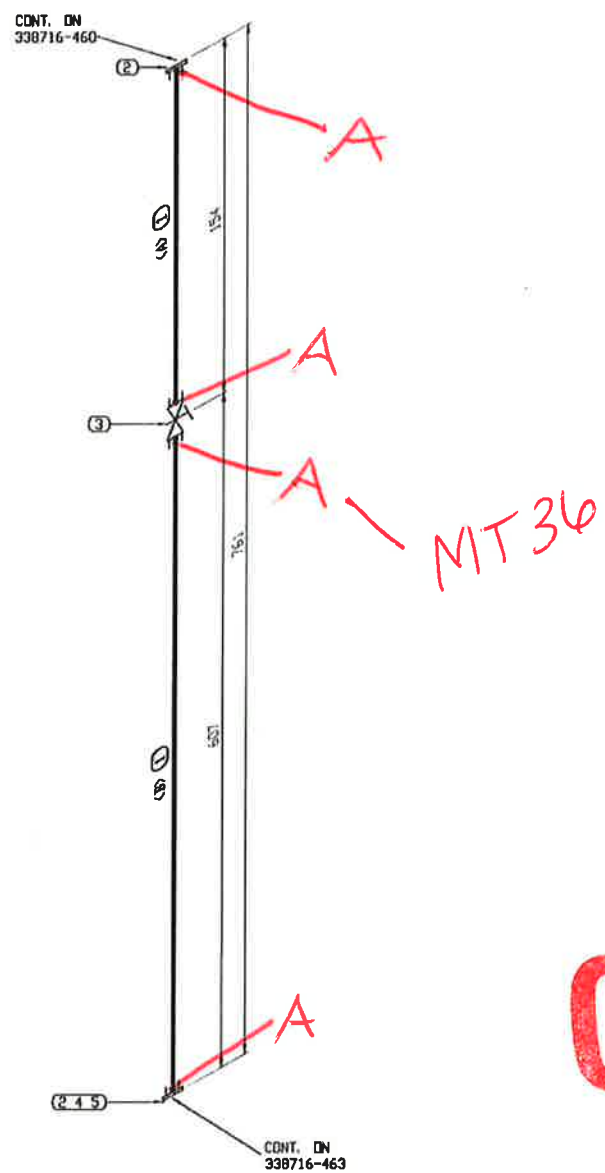
- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
 DWN BY: LK DATE: MAY 29/15 DWO#: 338716-460-Rev0
 CHK BY: AA DATE: JUN 02/15
 WPR BY: AA DATE: JUN 02/15 PAGE: 1 OF 1 CAD: N/A

LI-08070A DRAIN SPOOL DETAIL



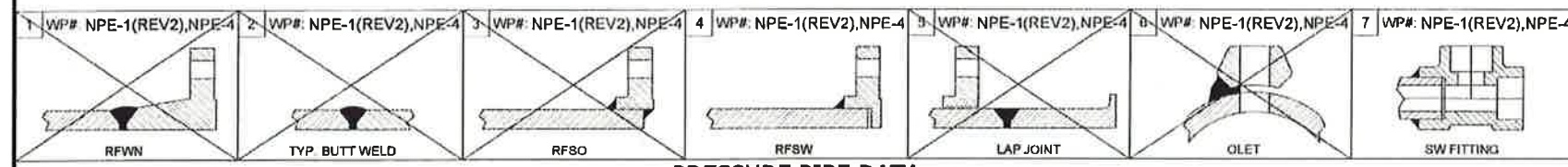
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	1/2	PIPE, SMLS, SCH XS, ASTM A333-6	656 MM	
FLANGES				
2	1/2	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	2	
VALVES / IN-LINE ITEMS				
3	1/2	GATE VALVE, SW, REF. 338716-100 ITEM #33	1	

ERECTOR MATERIALS				
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
4	1/2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS DR SS OUTER RING	1	
BOLTS				
5	1/2X3 1/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	101	1/2
	555	1/2

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 15/06/15
 DATE: YY/MM/DD
 SIGNATURE: [Signature]
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PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

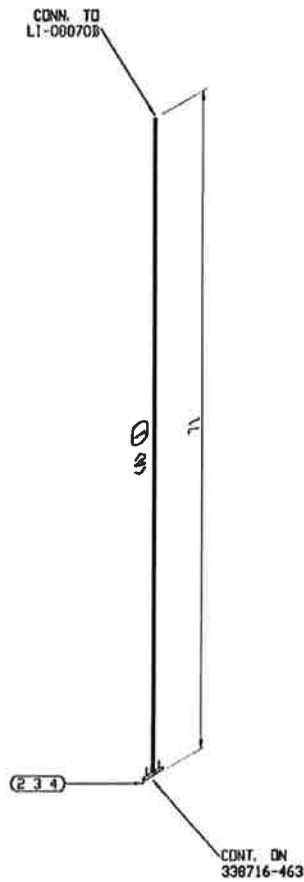
- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

0	ISSUED FOR CONSTRUCTION	LK	AA	AA	JUN 02/15
	DESCRIPTION	DWN	CHK	APP	DATE
LI-08070A DRAIN SPOOL DETAIL					

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 BL# 338716 QUOTE CGY2014-85 P# 4512-109-130
 DWN: LK DATE: MAY 29/15 DWO# 338716-461-Rev0
 CHK: AA DATE: JUN 02/15
 APP: AA DATE: JUN 02/15 PAGE: 1 OF 1 CAD: N/A



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	1/2	PIPE, SMLS, SCH XS, ASTM A333-6	51 MM	
FLANGES				
2	1/2	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	1	

ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
3	1/2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
4	1/2X3 1/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE
<A>	51	

Field Fit

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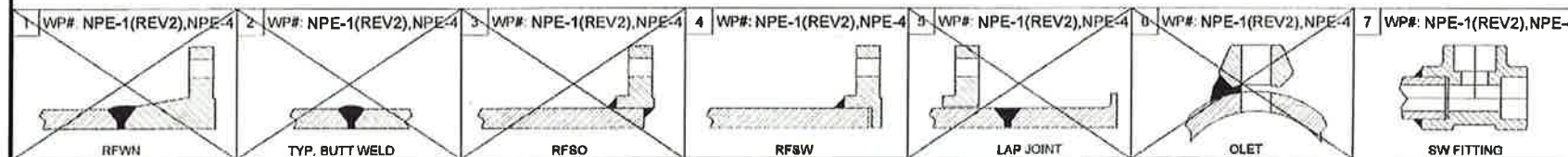
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15/06/16

[Signature]

DATE: YY/MM/DD SIGNATURE

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PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

GENERAL NOTES

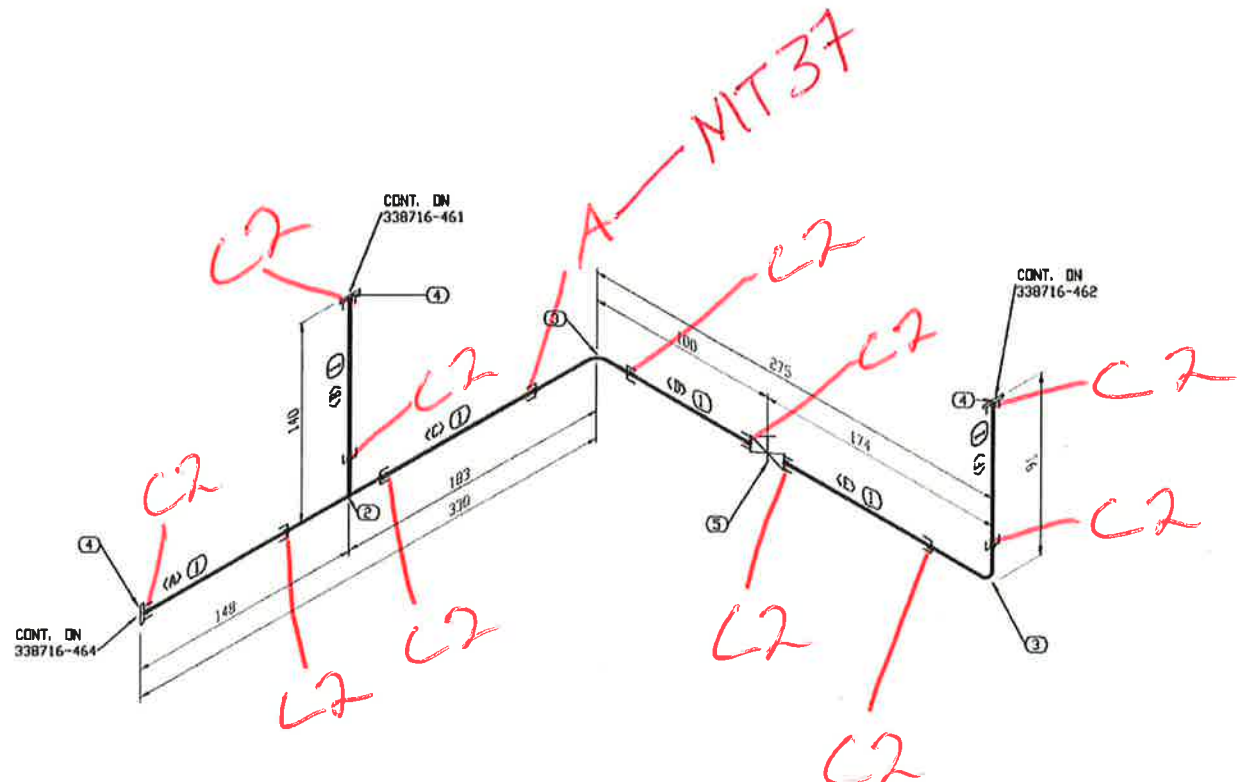
1. ALL DIMENSIONS ARE IN mm U.N.O.
2. FABRICATION TOLERANCE +/- 3mm U.N.O.
3. CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
4. ROOT GAP TO BE 1.6mm MAX.
5. NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT	
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING	
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2	
TAG: 0735A-08030	
BL# 338716	QUOTE: CGY2014-85 PO# 4512-109-130
DWG# LK	DATE: MAY 29/15
CHK# AA	DATE: JUN 02/15
APP# AA	DATE: JUN 02/15
338716-462-Rev0	
PAGE: 1 OF 1	CAD: N/A

**LI-08070B DRAIN
SPOOL DETAIL**

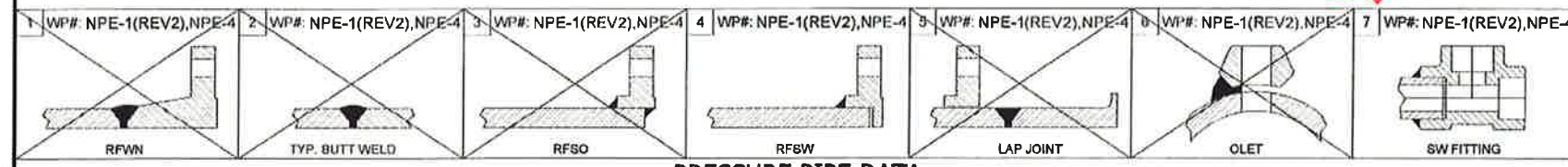


BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
<u>PIPE</u>				
1	1/2	PIPE, SMLS, SCH XS, ASTM A333-6	589 MM	
<u>FITTINGS</u>				
2	1/2X1/2	TEE, SW, 3000LB, ASTM A350-LF2-CL.1	1	
3	1/2	90 ELL, SW, 3000LB, ASTM A350-LF2-CL.1	2	
<u>FLANGES</u>				
4	1/2	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL.1	3	
<u>VALVES / IN-LINE ITEMS</u>				
5	1/2	GATE VALVE, SW, REF. 338716-100 ITEM #33	1	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	109	1/2
	102	1/2
<C>	148	1/2
<D>	51	1/2
<E>	125	1/2
<F>	54	1/2

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PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

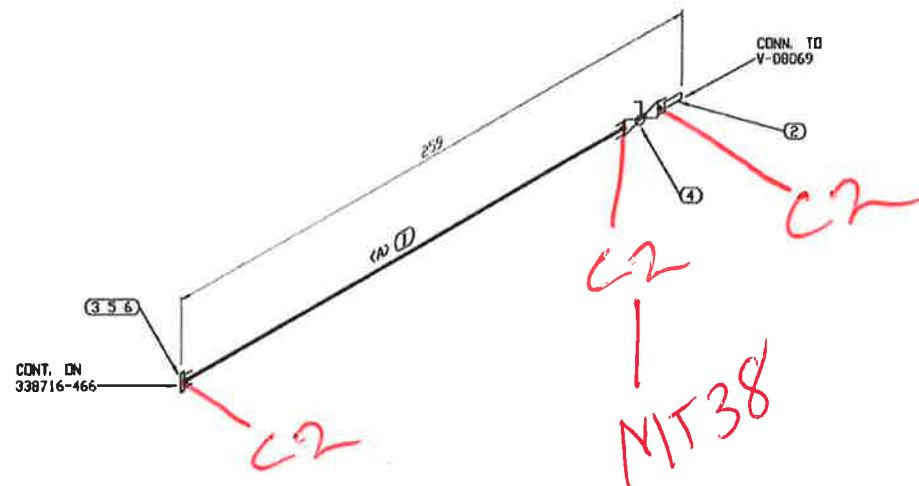
- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLB#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
 DWN#: LK DATE: MAY 29/15 DWO#: 338716-463-Rev0
 CDR#: AA DATE: JUN 02/15
 APP#: AA DATE: JUN 02/15 PAGE: 1 OF 1 CAD: N/A

DESCRIPTION	DWN	CHK	APP	DATE
ISSUED FOR CONSTRUCTION	LK	AA	AA	JUN 02/15
LI-08070A & LI-08070B DRAIN SPOOL DETAIL				



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	1	PIPE, SMLS, SCH XS, ASTM A333-6	76 MM	
FITTINGS				
2	1	NIPPLE, SCH 160, ASTM A333-6 PDE TDE (4' LG)	1	
FLANGES				
3	1	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL. 1	1	
VALVES / IN-LINE ITEMS				
4	1	BALL VALVE, SW, REF. 338716-100 ITEM #24A	1	

ERECTION MATERIALS

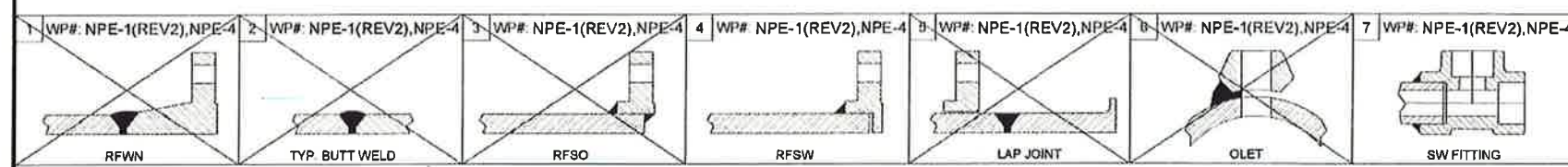
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	1	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
BOLTS				
6	1X2 3/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	76	1

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PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

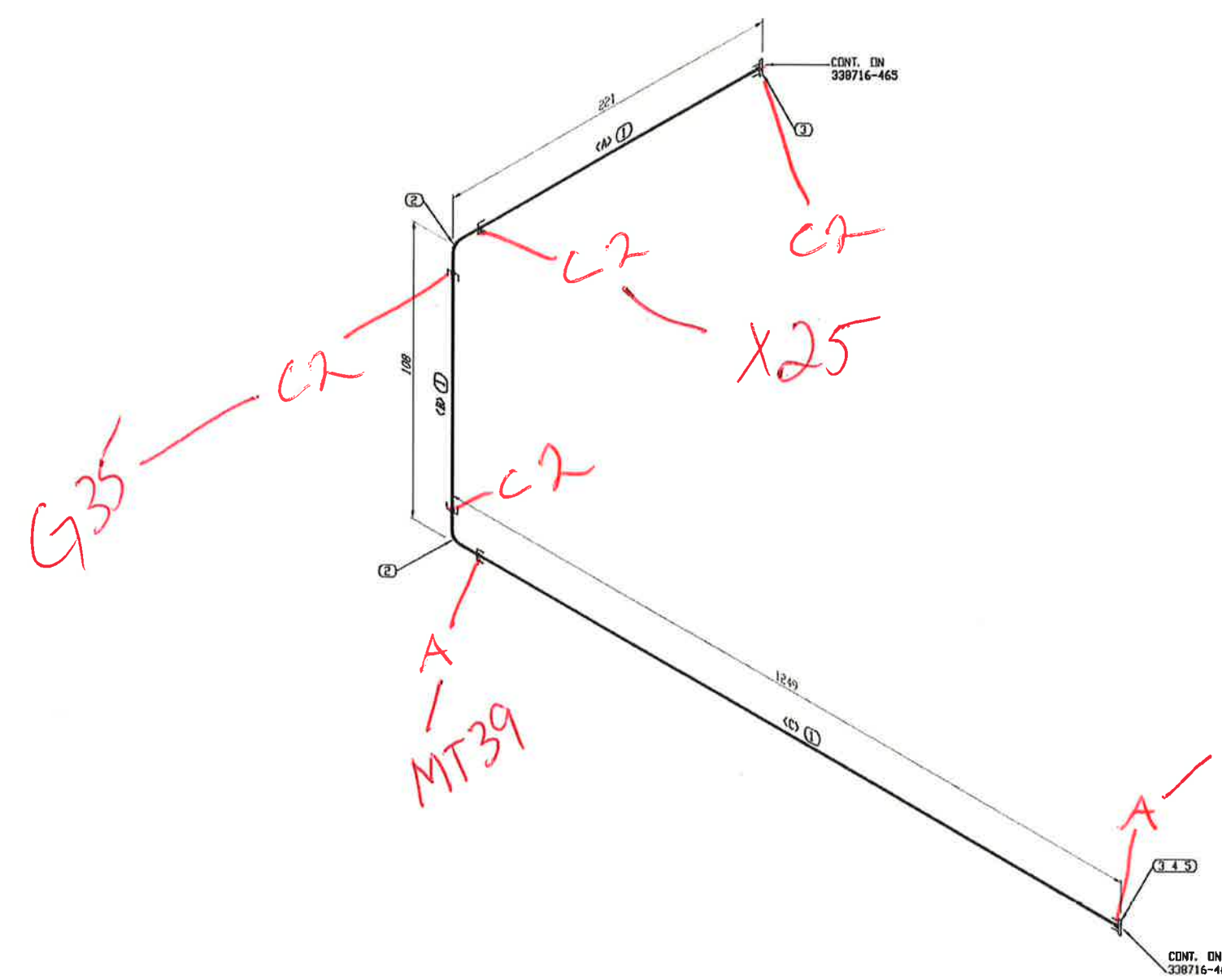
- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
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 - NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLB# 338716 QUOTE CGY2014-85 P/N# 4512-109-130
 DWN# LK DATE MAY 29/15
 DWN# AA DATE JUN 02/15
 DWN# AA DATE JUN 02/15
 DWD# 338716-465-Rev0
 PAGE: 1 OF 1 CND: N/A

V-08069 DRAIN SPOOL DETAIL



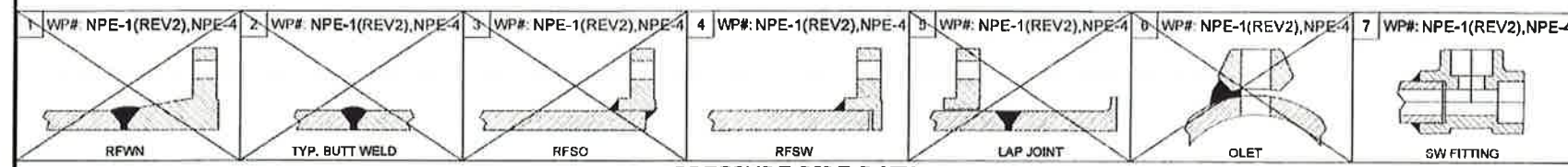
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	1	PIPE, SMLS, SCH XS, ASTM A333-6	1470 MM	
FITTINGS				
2	1	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	2	
FLANGES				
3	1	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL. 1	2	

ERECTOR MATERIALS				
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
4	1	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
BOLTS				
5	1X2 3/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	191	1
	60	1
<C>	1219	1

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 DATE:YY/MM/DD SIGNATURE
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PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

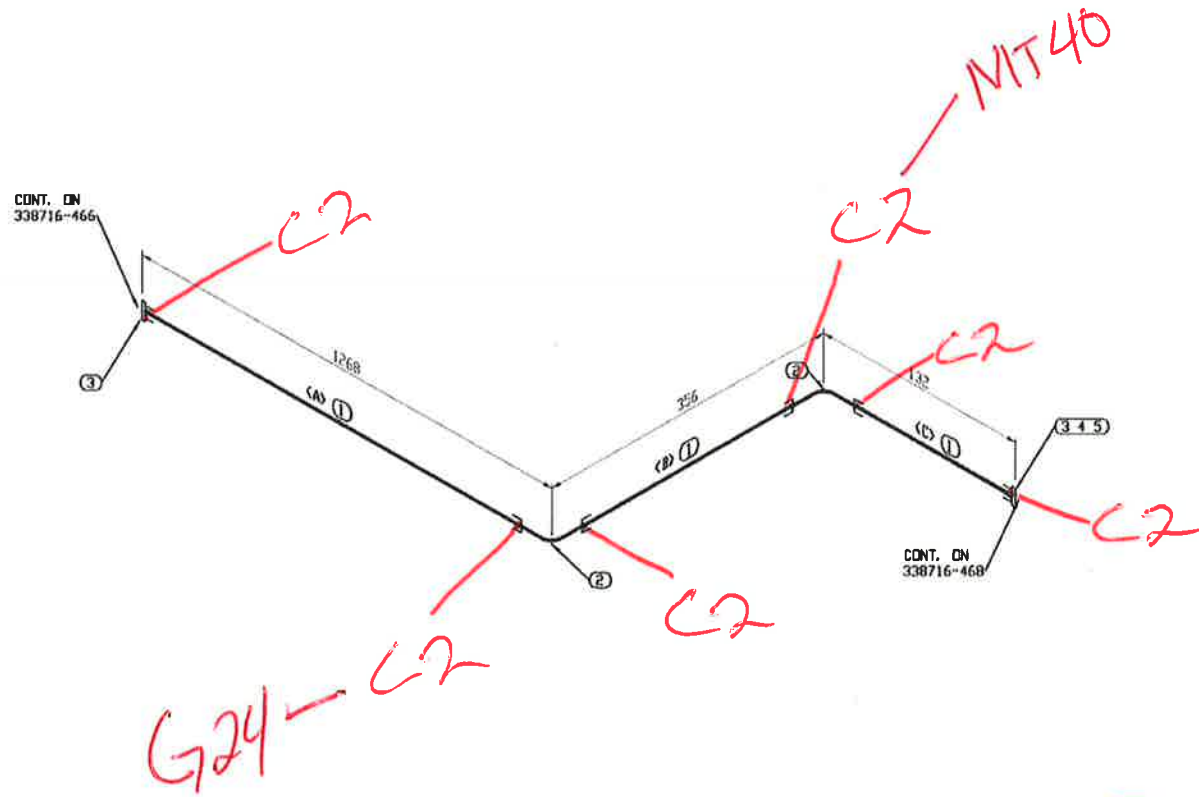
- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

ISSUED FOR CONSTRUCTION		LK	AA	AA	JUN 02/15
DESCRIPTION	DWN	CHK	APP	DATE	
V-08069 DRAIN SPOOL DETAIL					
DRN: LK	DATE: MAY 29/15	DRAW# 338716-466-Rev0			
CHK: AA	DATE: JUN 02/15	PAGE: 1 OF 1			
APP: AA	DATE: JUN 02/15	CAD: N/A			

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 BL# 338716 QUOTE: CGY2014-85 PD# 4512-109-130
 DATE: MAY 29/15
 DATE: JUN 02/15
 DATE: JUN 02/15



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	1	PIPE, SMLS, SCH XS, ASTM A333-6	1649 MM	
FITTINGS				
2	1	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	2	
FLANGES				
3	1	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL. 1	2	

ERECTION MATERIALS

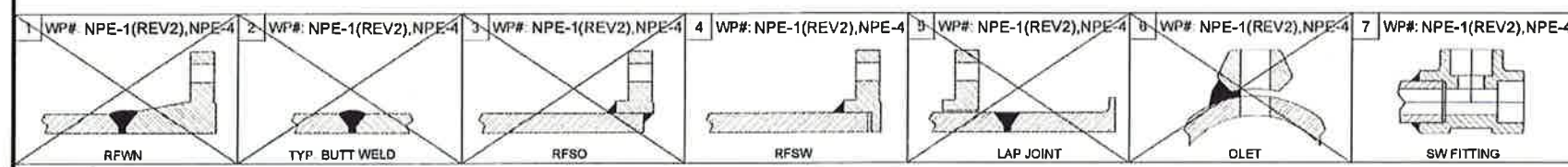
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
4	1	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
BOLTS				
5	1X2 3/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	1239	1
	308	1
<C>	102	1

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 15/06/16
 DATE:YY/MM/DD
 SIGNATURE
 natpro



PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
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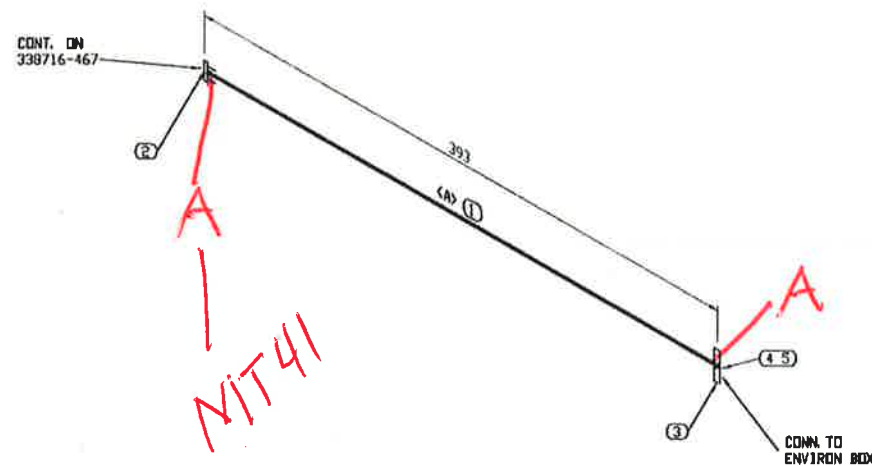
PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 BLS#: 338716 QUOTE: CGY2014-85 PDR: 4512-109-130

ISSUED FOR CONSTRUCTION

DESCRIPTION	DWN	CHK	APP	DATE
V-08069 DRAIN SPOOL DETAIL				

DATE: MAY 29/15
 DATE: JUN 02/15
 DATE: JUN 02/15

338716-467-Rev0
 PAGE: 1 OF 1
 CAD: N/A



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	1	PIPE, SMLS, SCH XS, ASTM A333-6	386 MM	
FLANGES				
2	1	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL. 1	1	
3	3	HUB FLG, RF, 150LB, C/W 1" DRILL SW, SCH XS, ASTM A350-LF2-CL. 1	1	

ERECTION MATERIALS

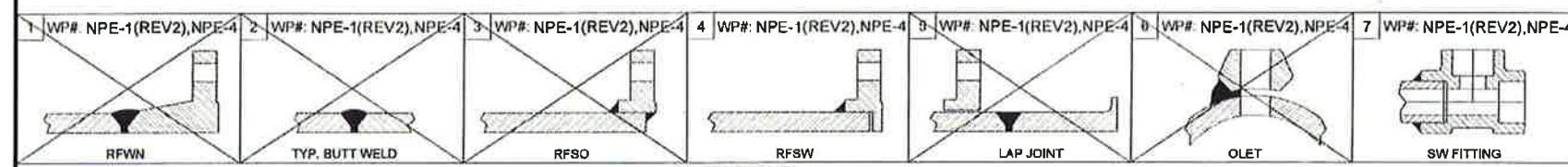
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
4	3	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
BOLTS				
5	3X3 3/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	386	1

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ISSUED FOR CONSTRUCTION
 15/06/16
 DATE: YY/MM/DD
 natpro



- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

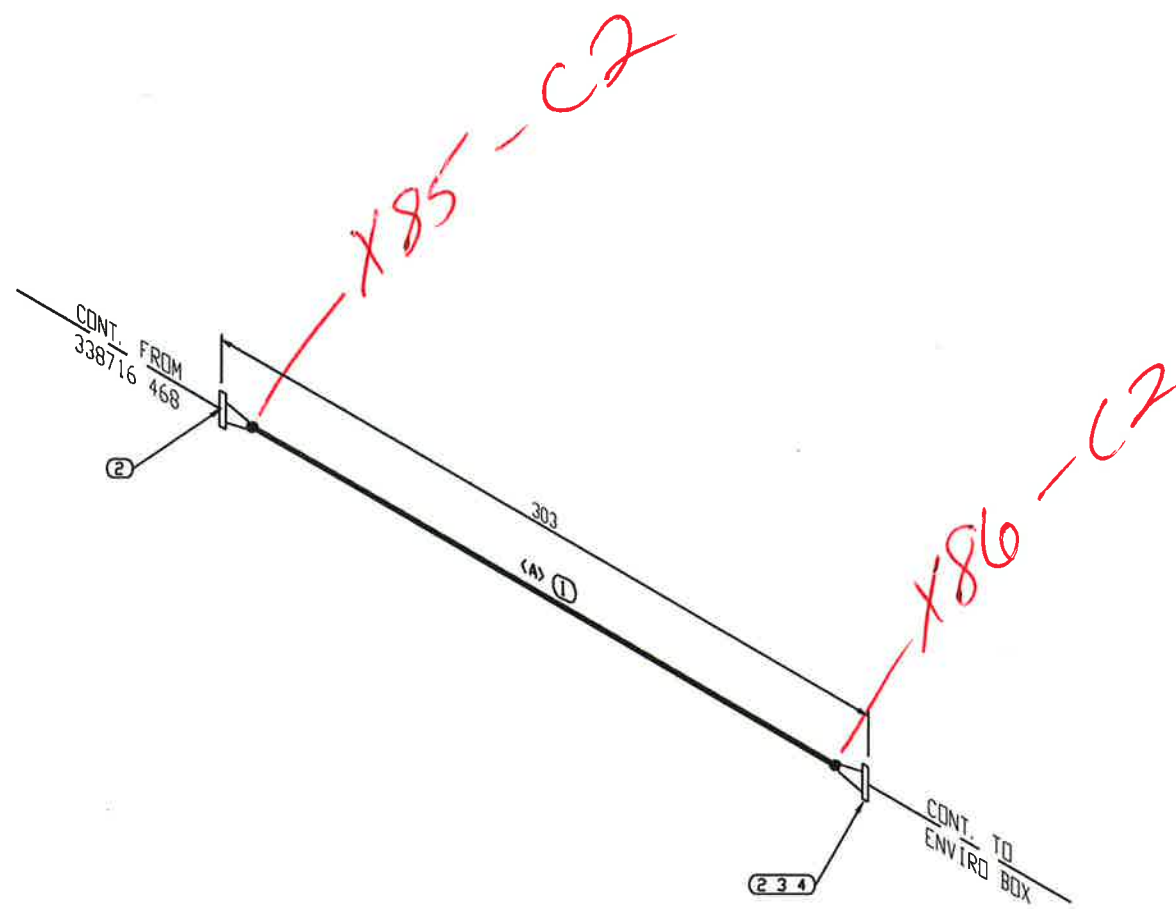
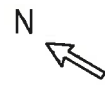
PRESSURE PIPE DATA		
SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

DESCRIPTION	DWN	CHK	APP	DATE
ISSUED FOR CONSTRUCTION				15/02/15
V-08069 DRAIN SPOOL DETAIL				

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
 DWN: LK DATE: MAY 29/15 DWO#: 338716-468-Rev0
 APP: AA DATE: JUN 02/15
 APP: AA DATE: JUN 02/15 PAGE: 1 OF 1 CAD: N/A



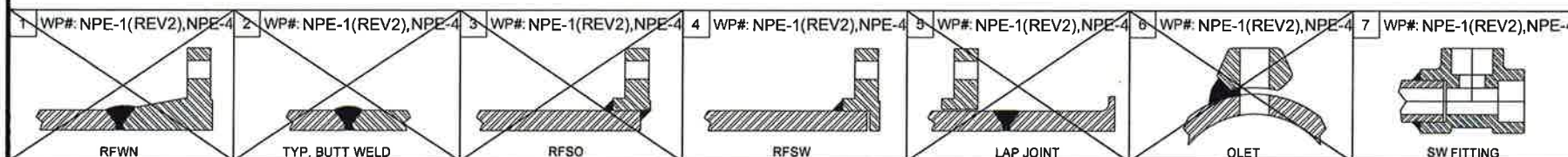
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
<u>PIPE</u>				
1	3	PIPE, SMLS, SCH STD, ASTM A106 GR B BBE	157 MM	
<u>FLANGES</u>				
2	3	FLG WELD NECK, 150LB, SCH STD, ASTM A105	2	
<u>GASKETS</u>				
3	3	GASKET, 150LB, 1/8" THK	1	
<u>BOLTS</u>				
4	5/8X3 3/4	(4) STUD BOLTS W/ NUTS, 3 3/4" LG, ASTM A193/194 GR B7/2H	1	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	157	3

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15/07/27, 
 DATE:YY/MM/DD SIGNATURE



PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

GENERAL NOTES

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- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT	CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2	TAG: 0735A-08030
SLS#: 338716	QUOTE: CGY2014-85
DATE: JULY 27/15	PO#: 4512-109-130
OWNED BY: NSP	DATE: JULY 27/15
OWNED BY: AA	DATE: JULY 27/15
APP BY: AA	DATE: JULY 27/15
PAGE: OF	CAD: N/A

V-08069 DRAIN
SPOOL DETAIL

revised 28 JUL-15



STANDARD PIPING SPECIFICATIONS

A150/LT

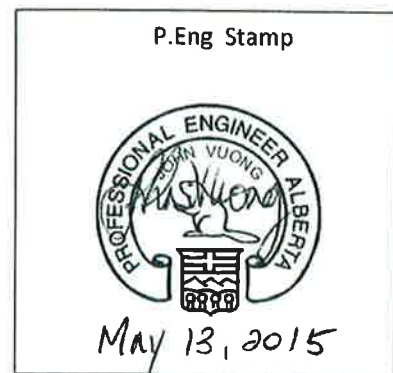
B300/LT

C600/LT

D900/LT

May 12, 2015

REVISION 0





**SPECIFICATION
FOR
PIPING**

**Natpro Standard Piping
Specifications**

LINE SPECIFICATION: A150/LT
FLANGE RATING / CLASS: 150
CORR. ALL: 1.0 mm PWHT: NO

SERVICE: <u>LOW TEMPERATURE</u> – SWEET NATURAL GAS	General Material Specification: Piping: CS Valves: CS
SERVICE LIMITS: Design Standard: To ASME B 31.3 Temperature: Min. -45°C Max. +149°C Pressure Rating: To ASME B 16.5 Table 2 Class 150 Flange Limits 1965 kPag @ 38°C (285 PSIG @ 100°F), 1586 kPag @ 149°C (230 PSIG @ 300°F)	NDE Inspection Required: 15% RT on BW 15% MT on Fillets (Branch) 100% on VT
STANDARD CONSTRUCTION: NPS 1-1/2 and below Socket Welded. NPS 2 and above Butt Welded	

ITEM	SIZE NPS		CLASS RATING	ENDS	VALVE TRIM	DESCRIPTION	ITEM TAG	MFG STD	COMPANY STD	
	FROM	TO								
V A L V E S	GATE	½	1 ½	800	SW	316 SS	¾" SW x NPT Bolted Bonnet Gate Valve, Class 800, ASTM A350 LF2 CL1 Body & Bonnet Material, Trim F316/HF (API TRIM #12), Bonney Forge Model HL-1L3S-SW-T, LO Temp NACE or equivalent	VG801-ELD	ASME B16.34	Shell STD 3-2.01 Appendix F
	GLOBE	2	--	150	RF	316 SS	2" CL150 RF Globe Valve, A350-LF2 CL 1 Body, A350-LF2 CL1 Bonnet, ASTM A276-410/ATL Overlay, SST Stem, API Trim 12, HF Seat Ring, LO-Temp NACE, NEWAY GL1RC12-NC or equivalent	VO104-ELD	ASME B16.34	Shell STD 3-2.01 Appendix G
		4	--	150	RF	316 SS	4" CL150 RF Globe Valve, A350-LF2 CL 1 Body, A350-LF2 CL 1 Bonnet, ASTM A276-410/ATL Overlay, SST Stem, API Trim 12, HF Seat Ring, LO-Temp NACE, NEWAY GL1RC12-NC or equivalent	VO104-ELD	ASME B16.34	Shell STD 3-2.01 Appendix G
	BALL	½	--	2000	SW	316 SS	½" SW x SW Full Port Ball Valve, 3 PC Bolted Construction, Swing Out Design, FIRESAFE API 607 Rev 6, NACE LCC Body, SS Ball, RTFE Seat, SS Stem, Graphite Packing, SA 320-L7M Cap Screw C/Locking Device, JAG B3-F05SW09N, 3000 WOG or equivalent	VB2001-ELD	ASME B16.34	Shell STD 3-2.01 Appendix H
		1	--	2000	SW	316 SS	1" SW x SW Full Port Ball Valve, 3 PC Bolted Construction, Swing Out Design, FIRESAFE API 607 Rev 6, NACE LCC Body, SS Ball, RTFE Seat, SS Stem, Graphite Packing, SA 320-L7M Cap Screw C/Locking Device, JAG B3-F10SW09N, 3000 WOG or equivalent	VB2001-ELD	ASME B16.34	Shell STD 3-2.01 Appendix H
		1	--	150	RF	316 SS	1" CL150 RF Full Port Ball Valve, 2-Piece Bolted Body, A352 LCC Body, 316 SS Ball, 316 SS Stem, RPTFE Seat, Graphite Packing, STARLINE 175-SGS-G, NACE LO Temp or equivalent	VB114-ELD	ASME B16.34	Shell STD 3-2.01 Appendix H
		2	--	150	RF	316 SS	2" 150# RF Full Port Ball Valve, Trunnion Mounted, DBB, A350 LF2 CL1 Body, Carbon Steel + 3MIL ENP Ball & Stem, HNBR/RTFE Seats, JAG FIG TB3-F20R01LH-S1-01 or equivalent (Note 2)	VB114-ELD	ASME B16.34	Shell STD 3-2.01 Appendix H
		4	--	150	RF	316 SS	4" CL150 RF Full Port Ball Valve, 2-Piece Bolted Body, A352 LCC Body, 316 SS Ball, 316 SS Stem, RPTFE Seat, Graphite Packing, JAG FIG FB2-R40R01LH or equivalent	VB134-ELD	ASME B16.34	Shell STD 3-2.01 Appendix H
	NEEDLE	½	¾	6000	TE	316 SS	½" MNPT x FNPT Needle Valve, Hard Seat, SS Body Materials, SS Bonnet, SS Stem, Teflon Packing, 6000 CWP, Century CM2-1-M44T-DN-T or equivalent	VN6019-ELC		



**SPECIFICATION
FOR
PIPING**

**Natpro Standard Piping
Specifications**

LINE SPECIFICATION: A150/LT
FLANGE RATING / CLASS: 150
CORR. ALL: 1.0 mm PWHT: NO

	MONOFLANGE 3-VALVE MANIFOLD	½	¾	6000	SW x TE	316 SS	Model# Parker HPM6LS3DBBB-MD4-14299EHXJ Type: HI-PRO MANIFOLD (10MM BORE) Valve CONFIGURATIONSC: 316 STAINLESS STEEL Inlet: ¾" NB Socket Weld SCH 80 EXTENDED 4" Outlet: ¾" NPT Female With 5MM Bore Orifice Restriction Vent: ½" FNPT Female With 5MM Bore Orifice Restriction Pressure: 6000 PSI Valve Packing: Graphite Seating: PTFE (Note 1)		
	FITTINGS, O'LETS, PLUGS ETC.	½	1 ½	3000	TE		Carbon steel ASTM A-350 LF2 CL1 (Plugs only)	ASME B16.11	Shell STD 3-2.01 Appendix B
		½	1 ½	3000	SW		Carbon steel ASTM A-350 LF2 CL1	ASME B16.11	
		2	8	--	BE		Carbon steel ASTM A-420 WPL6 fitting, schedule to match pipe	ASME B16.9	
	FLANGES	½	1 ½	150	SW		RF SW Carbon steel ASTM A-350 LF2 CL1, bore to match pipe	ASME B16.5	Shell STD 3-2.01 Appendix C
		2	Over	150	WN		RFWN Carbon steel ASTM A-350 LF2 CL1, bore to match pipe		
	PIPE	½	1 ½	Sched. 80 min. Seamless PE, ASTM A-333 Gr 6				ASME 36.10 M	Shell STD 3-2.01 Appendix A
		1 ½	2	Sched. 80 min. Seamless BE, ASTM A-333 Gr 6					
		3	8	Sched. 40 min. Seamless BE, ASTM A-333 Gr 6					
	PIPE NIPPLES	½	1 ½	Sched. 80 min. Seamless PE, ASTM A-333 Gr 6 (Note 3)				ASME 36.10 M	Shell STD 3-2.01 Appendix A
	SWAGES	½	1 ½	Swages, Sched. 80 min. Smls. PE / BE, ASTM A-333 Gr 6 or A420-WPL6				MSS SP-95	Shell STD 3-2.01 Appendix A
BOLTING: ASTM A-320 L7 alloy steel studs with two ASTM A-194 2H hex nuts								ASME B16.5	Shell STD 3-2.01 Appendix A
GASKETS: Class 150 304 SS spiral wound, graphite filled, 316 SS inner ring, CS outer ring, 3.2 mm (1/8") thick								ASME B16.20	Shell STD 3-2.01 Appendix E
NOTES:									
(1) Parker Monoflange To Be Used For Pressure Transmitter Isolation Valve.									
(2) Trunnion mounted full port ball valves will be used when DBB is shown in P&ID									
NOMENCLATURE: NPS = Nominal Pipe Size, TE = Threaded End, SW = Socket Weld, BW = Butt Weld, THD = Threaded, PE = Plain End BE = Bevelled End, FL = Flanged, RF = Raised Face, WN = Weld Neck, RTJ = Ring Type Joint, PWHT = Post Weld Heat Treatment, CS = P1 Carbon Steel, NDE = Non Destructive Examination, RT = Radiographic Testing, MT = Magnetic Particle Testing									



**SPECIFICATION
FOR
PIPING**

**Natpro Standard Piping
Specifications**

LINE SPECIFICATION: B300/LT
FLANGE RATING / CLASS: 300
CORR. ALL: 1.0 mm **PWHT:** NO

SERVICE: <u>LOW TEMPERATURE</u> – SWEET NATURAL GAS	General Material Specification:	Piping: CS	Valves: CS
SERVICE LIMITS:	Design Standard: To ASME B 31.3 Temperature: Min. -45°C Max. +204°C Pressure Rating: To ASME B 16.5 Table 2 Class 300 Flange Limits 5102 kPag @ 38°C (740 PSIG @ 100°F), 4378 kPag @ 204°C (635 PSIG @ 400°F)	NDE Inspection Required:	15% RT on BW 15% MT on fillets (Branch) 100% on VT
STANDARD CONSTRUCTION: NPS 1-1/2 and below Socket Welded or Butt Welded. NPS 2 and above Butt Welded.			

ITEM	SIZE NPS		CLASS RATING	ENDS	VALVE TRIM	DESCRIPTION	ITEM TAG	MFG STD	COMP ANY STD
	FROM	TO							
V A L V E S	GATE	½	1 ½	800	SW / TE	316 SS	VG803- ELD	ASME B16.34	Shell STD 3- 2.01 Appendix F
	MONOFLANGE 3-VALVE MANIFOLD	½	¾	6000	SW x TE	316 SS		Model# Parker HPM6LS3DBBB-MD4- 14299EHXJ Type: HI-PRO MANIFOLD (10MM BORE) Valve CONFIGURATIONSC: 316 STAINLESS STEEL Inlet: ¾" NB Socket Weld SCH 80 EXTENDED 4" Outlet: ¾" NPT Female With 5MM Bore Orifice Restriction Vent: ½" FNPT Female With 5MM Bore Orifice Restriction Pressure: 6000 PSI Valve Packing: Graphite Seating: PTFE (Note 1)	
FITTINGS, O'LETS, PLUGS ETC.	½	1 ½	3000	TE	Carbon steel ASTM A-350 LF2 CL1 (Plugs only)		ASME B16.11	Shell STD 3- 2.01 Appendix B	
	½	1 ½	3000	SW	Carbon steel ASTM A-350 LF2 CL1		ASME B16.11		
	2	4	--	BE	Carbon steel ASTM A-420 WPL6 fitting, schedule to match pipe		ASME B16.9		
FLANGES	½	1 ½	300	SW	RFSW Carbon steel ASTM A-350 LF2 CL1, bore to match pipe		ASME B16.5	Shell STD 3- 2.01 Appendix C	
	2	4	300	WN	RFWN Carbon steel ASTM A-350 LF2 CL1, bore to match pipe				
PIPE	½	1 ½	Sched. 80 min. Seamless PE, ASTM A-333 Gr 6				ASME 36.10M	Shell STD 3- 2.01 Appendix A	
	2	-	Sched. 80 min. Seamless BE, ASTM A-333 Gr 6						
	3	4	Sched. 40 min. Seamless BE, ASTM A-333 Gr 6						
PIPE NIPPLES	½	1 ½	Sched. 160 min. Seamless PE, ASTM A-333 Gr 6				ASME 36.10M	Shell STD 3- 2.01 Appendix A	
SWAGES	½	1 ½	Sched. 160 min. Seamless PE / BE, ASTM A-333 Gr 6 or A-420-WPL6				MSS SP-95	Shell STD 3- 2.01 Appendix A	



**SPECIFICATION
FOR
PIPING**

**Natpro Standard Piping
Specifications**

LINE SPECIFICATION: B300/LT
FLANGE RATING / CLASS: 300
CORR. ALL: 1.0 mm PWHT: NO

BOLTING:	ASTM A-320 L7 alloy steel studs with two ASTM A-194 2H hex nuts	ASME B16.5	Shell STD 3- 2.01 Appendix A
GASKETS:	Class 300 304 SS spiral wound, graphite filled, 316 SS inner ring, CS outer ring, 3.2 mm (1/8") thick	ASME B16.20	Shell STD 3- 2.01 Appendix E
NOTES:			
(1) Parker Monoflange To Be Used For Pressure Transmitter Isolation Valve.			
NOMENCLATURE:	NPS = Nominal Pipe Size, TE = Threaded End, SW = Socket Weld, BW = Butt Weld, THD = Threaded, PE = Plain End BE = Bevelled End, FL = Flanged, RF = Raised Face, WN = Weld Neck, RTJ = Ring Type Joint, PWHT = Post Weld Heat Treatment CS = P1 Carbon Steel, NDE = Non Destructive Examination, RT = Radiographic Testing, MT = Magnetic Particle Testing		



**SPECIFICATION
FOR
PIPING**

**Natpro Standard Piping
Specifications**

LINE SPECIFICATION: C600/LT
FLANGE RATING / CLASS: 600
CORR. ALL: 1.0 mm PWHT: NO

SERVICE: <u>LOW TEMPERATURE</u> – SWEET NATURAL GAS	General Material Specification: Piping: CS Valves: CS
SERVICE LIMITS: Design Standard: To ASME B 31.3 Temperature: Min. –45°C Max. +204°C Pressure Rating: To ASME B 16.5 Table 2 Class 600 Flange Limits 10205 kPag @ 38°C (1480 PSIG @ 100°F), 8757 kPag @ 204°C (1270 PSIG @ 400°F)	NDE Inspection Required: 100% RT on BW 10% MT on fillets (Branch) 100% on VT
STANDARD CONSTRUCTION: NPS 1-1/2 and below Threaded or Socket Welded. NPS 2 and above Butt Welded.	

ITEM	SIZE NPS		CLASS RATING	ENDS	VALVE TRIM	DESCRIPTION	ITEM TAG	MFG	COMP ANY
	FROM	TO						STD	STD
GATE	½	--	800	SW / TE	316 SS	½" SW x NPT Bolted Bonnet Gate Valve, Class 800, ASTM A350 LF2 CL1 Body & Bonnet Material, Trim F316/HF (API Trim #12), Bonney Forge Model HL-1L3S-SW-T, LO Temp NACE or Equivalent	VG803-ELD	ASME B16.34	Shell STD 3-2.01 Appendix F
	½	--	800	SW	316 SS	½" SW x SW Bolted Bonnet Gate Valve, Class 800, ASTM A350 LF2 CL1 Body & Bonnet Material, Trim F316/HF (API Trim #12), Bonney Forge Model HL-1L3S-T, LO Temp NACE or Equivalent	VG801-ELD	ASME B16.34	Shell STD 3-2.01 Appendix F
	¾	--	800	SW / TE	316 SS	¾" SW x NPT Bolted Bonnet Gate Valve, Class 800, ASTM A350 LF2 CL1 Body & Bonnet Material, Trim F316/HF (API Trim #12), Bonney Forge Model HL-1L3S-SW-T, LO Temp NACE or equivalent	VG803-ELD	ASME B16.34	Shell STD 3-2.01 Appendix F
	¾	--	800	SW	316 SS	¾" SW x SW Bolted Bonnet Gate Valve, Class 800, ASTM A350 LF2 CL1 Body & Bonnet Material, Trim F316/HF (API Trim #12), Bonney Forge Model HL-1L3S-SW, LO Temp NACE or equivalent	VG801-ELD	ASME B16.34	Shell STD 3-2.01 Appendix F
GLOBE	2	--	600	RF	316 SS	2" CL600 RF Globe Valve, CF8M Body, CF8M Bonnet & DISC, 316 Stem, CF8M + STL. 6 Seat Ring, GRAPHITE+GRAPHITE with Inconel Packing, PK Model 02-601RF12SH GRF or equivalent (Note 3)		API 600	Shell STD 3-2.01 Appendix G
CHECK	1	--	800	SW	316 SS	1" SW x SW Piston Check Valve, Class 800, ASTM A350 LF2 CL1 Body/Bonnet Material, Trim F316/HF (API Trim #12), Bonney Forge Model HL-4L3S-SW, LO Temp NACE or equivalent	VG841-ELD	ASME B16.34	Shell STD 3-2.01 Appendix F
BALL	2	--	600	RF	316 SS	2" CL600 RF Full Port Ball Valve, Trunnion Mounted, DBB, A350 LF2 Body, Carbon Steel + 3MIL ENP Ball & Stem, HNBR/RTFE Seats, JAG FIG TB3-F20R06LH-S1-01 or equivalent (Note 2)	VB614-ELD	ASME B16.34	Shell STD 3-2.01 Appendix H
	3	--	600	RF	316 SS	3" CL600 RF Full Port Ball Valve, Trunnion Mounted, DBB, A350 LF2 Body, Carbon Steel + 3MIL ENP Ball & Stem, HNBR/RTFE Seats, JAG FIG TB3-F30R06LH-S1-01 or equivalent (Note 2)	VB614-ELD	ASME B16.34	Shell STD 3-2.01 Appendix H
	4	--	600	RF	316 SS	4" CL600 RF Full Port Ball Valve, Trunnion Mounted, DBB, A350 LF2 Body, Carbon Steel + 3MIL ENP Ball & Stem, HNBR/RTFE Seats, JAG FIG TB3-F40R06LH-S1-01 or equivalent (Note 2)	VB614-ELD	ASME B16.34	Shell STD 3-2.01 Appendix H
NEEDLE	½	¾	6000	TE	316 SS	½" MNPT x FNPT Needle Valve, Hard Seat, SS Body Materials, SS Bonnet, SS Stem, Teflon Packing, 6000 CWP, Century CM2-1-M44T-DN-T or equivalent	VN6019-ELC		



**SPECIFICATION
FOR
PIPING**

**Natpro Standard Piping
Specifications**

LINE SPECIFICATION: C600/LT
FLANGE RATING / CLASS: 600
CORR. ALL: 1.0 mm PWHT: NO

	MONOFLANGE 3-VALVE MANIFOLD	½	¾	6000	SW x TE	316 SS	Model# Parker HPM6LS3DBBB-MD4-14299EHXJ Type: HI-PRO MANIFOLD (10MM BORE) Valve CONFIGURATIONSC: 316 STAINLESS STEEL Inlet: ¾" NB Socket Weld SCH 80 EXTENDED 4" Outlet: ¾" NPT Female With 5MM Bore Orifice Restriction Vent: ½" FNPT Female With 5MM Bore Orifice Restriction Pressure: 6000 PSI Valve Packing: Graphite Seating: PTFE (Note 1)		
	FITTINGS, O'LETS, PLUGS ETC.	½	1 ½	3000	TE	Carbon steel ASTM A-350 LF2 CL1 (Plugs only)		ASME B16.11	Shell STD 3- 2.01 Appendix B
		½	1 ½	3000	SW	Carbon steel ASTM A-350 LF2 CL1		ASME B16.11	
		2	4	--	BE	Carbon steel ASTM A-420 WPL6 fitting, schedule to match pipe		ASME B16.9	
	SPECTACLE BLIND	½	4	600	RF	A-516, GRADE 70N, ASME B16.48		ASME B16.48	
	FLANGES	½	1 ½	600	SW	RF SW Carbon steel ASTM A-350 LF2 CL1, bore to match pipe		ASME 16.5	Shell STD 3- 2.01 Appendix C
		2	4	600	WN	RFWN Carbon steel ASTM A-350 LF2 CL1, bore to match pipe			
	PIPE	½	1 ½	Sched. 80 min. Seamless PE & BE, ASTM A-333 Gr 6			ASME 36.10M	Shell STD 3- 2.01 Appendix A	
		2	2	Sched. 80 min. Seamless BE, ASTM A-333 Gr 6					
		3	4	Sched. 40 min. Seamless BE, ASTM A-333 Gr 6					
	PIPE NIPPLES	½	1 ½	Sched. 80 min. Seamless PE & BE, ASTM A-333 Gr 6			ASME 36.10M	Shell STD 3- 2.01 Appendix A	
	SWAGES	½	1 ½	Swages Sched. 160 min. Seamless PE & BE, ASTM A-333 Gr 6 or A-420 WPL6			MSS SP-95	Shell STD 3- 2.01 Appendix A	
	BOLTING:	ASTM A-320 L7 alloy steel studs with two ASTM A-194 2H hex nuts						ASME 16.5	Shell STD 3- 2.01 Appendix A
	GASKETS:	Class 600 304 SS spiral wound, graphite filled, 316 SS inner ring, CS outer ring, 3.2 mm (1/8") thick						ASME B16.20	Shell STD 3- 2.01 Appendix E

- NOTES:**
- (1) Parker Monoflange To Be Used For Pressure Transmitter Isolation Valve.
 - (2) Trunnion Mounted full port ball valves will be used when DBB is shown in P&ID.
 - (3) SST Globe Valve body per HAZOP requirements.

NOMENCLATURE: NPS = Nominal Pipe Size, TE = Threaded End, SW = Socket Weld, BW = Butt Weld, THD = Threaded, PE = Plain End
 BE = Bevelled End, FL = Flanged, RF = Raised Face, WN = Weld Neck, RTJ = Ring Type Joint, PWHT = Post Weld Heat Treatment
 CS = P1 Carbon Steel, NDE = Non Destructive Examination, RT = Radiographic Testing, MT = Magnetic Particle Testing



**SPECIFICATION
FOR
PIPING**

**Natpro Standard Piping
Specifications**

LINE SPECIFICATION: D900/LT
FLANGE RATING / CLASS: 900
CORR. ALL: 1.0 mm **PWHT:** NO

SERVICE: <u>LOW TEMPERATURE</u> – SWEET NATURAL GAS	General Material Specification: Piping: CS Valves: CS
SERVICE LIMITS: Design Standard: To ASME B 31.3 Temperature: Min. -45°C Max. +204°C Pressure Rating: To ASME B 16.5 Table 2 Class 900 Flange Limits 15306 kPag @ 38°C (2220 PSIG @ 100°F), 13100 kPag @ 204°C (1900 PSIG @ 400°F)	NDE Inspection Required: 100% RT on BW 10% MT on fillets (Branch) 100% on VT
STANDARD CONSTRUCTION: NPS 1-1/2 and below Butt Welded or Socket Welded. NPS 2 and above Butt Welded only.	

ITEM	SIZE NPS		CLASS RATING	ENDS	VALVE TRIM	DESCRIPTION	ITEM TAG	MFG STD	COMP ANY STD	
	FROM	TO								
V A L V E S	GATE	½	1 ½	1500	SW / TE	¾" SW x NPT Bolted Bonnet Gate Valve, Class 1500, ASTM A350 LF2 CL1 Body & Bonnet Material, Trim F316/HF (API Trim #12), Bonney Forge Model 9HL-1L3S-SW-T, LO Temp NACE or Equivalent	VG150 3-ELD	ASME B16.34	Shell STD 3- 2.01 Appendix F	
		½	1 ½	1500	SW	¾" SW Bolted Bonnet Gate Valve, Class 1500, ASTM A350 LF2 CL1 Body & Bonnet Material, TRIM F316/HF (API Trim #12), Bonney Forge Model 9HL-1L3S-SW, LO Temp NACE or Equivalent	VG150 1-ELD	ASME B16.34	Shell STD 3- 2.01 Appendix F	
		½	1 ½	1500	SW	1" SW x NPT Bolted Bonnet Gate Valve, Class 1500, ASTM A350 LF2 CL1 Body & Bonnet Material, Trim F316/HF (API Trim #12), Bonney Forge Model 9HL-1L3S-SW, LO Temp NACE or Equivalent	VG150 1-ELD	ASME B16.34	Shell STD 3- 2.01 Appendix F	
	BALL	2	--	1500	RF	316 SS	2" CL1500 RF Full Port Ball Valve, Trunnion Mounted, A350 LF2 CL1 Body, Carbon Steel + 3MIL ENP Ball & Stem, Nylon Seats, CSA Z245-15, JAG FIG TB3-F20R15LH-S1-01 or Equivalent (Note 2)	VB152 4-ELD	ASME B16.34	Shell STD 3- 2.01 Appendix H
		4	--	900	RF	316 SS	4" CL900RF Full Port Ball Valve, Trunnion Mounted, A350 LF2 Body, Carbon Steel + 3MIL ENP Ball & Stem, Nylon Seats, CSA Z245-15, JAG FIG TB3-F40R09LH-S1-01 or Equivalent (Note 2)	VB924- ELD	ASME B16.34	Shell STD 3- 2.01 Appendix H
	NEEDLE	½	¾	6000	TE	316 SS	½" MNPT x FNPT Needle Valve, Hard Seat, SS Body Materials, SS Bonnet, SS Stem, Teflon Packing, 6000 CWP, Century CM2-1-M44T-DN-T or Equivalent	VN601 9-ELC		
MONOFLANGE 3-VALVE MANIFOLD	½	¾	6000	SW x TE	316 SS	Model# Parker HPM6LS3DBBB-MD4-14299EHXJ Type: HI-PRO MANIFOLD (10MM BORE) Valve CONFIGURATIONSC: 316 STAINLESS STEEL Inlet: ¾" NB Socket Weld SCH 80 EXTENDED 4" Outlet: ¾" NPT Female With 5MM Bore Orifice Restriction Vent: ½" FNPT Female With 5MM Bore Orifice Restriction Pressure: 6000 PSI Valve Packing: Graphite Seating: PTFE (Note 1)				



**SPECIFICATION
FOR
PIPING**

**Natpro Standard Piping
Specifications**

LINE SPECIFICATION: D900/LT
FLANGE RATING / CLASS: 900
CORR. ALL: 1.0 mm PWHT: NO

FITTINGS, O'LETS PLUGS ETC.	½	1 ½	6000	TE	Carbon steel ASTM A-350 LF2 CL1 (Plugs Only)	ASME B16.11	Shell STD 3- 2.01 Appendix B
	½	1 ½	3000	SW	Carbon steel ASTM A-350 LF2 CL1	ASME B16.11	
	2	4	--	BE	Carbon steel ASTM A-420 WPL6 fitting, schedule to match pipe	ASME B16.9	
FLANGES	½	1 ½	1500	SW	RF SW CS ASTM A-350 LF2 CL1	ASME 16.5	Shell STD 3- 2.01 Appendix C
	2	--	1500	WN	RF WN Carbon steel ASTM A-350 LF2 CL1, bore to match pipe		
	3	--	900	WN	RF WN Carbon steel ASTM A-350 LF2 CL1, bore to match pipe		
PIPE	½	1 ½	Sched. 80 min. Seamless BE, PE, SW, ASTM A-333 Gr 6			ASME 36.10M	Shell STD 3- 2.01 Appendix A
	2	2	Sched. 80 min. Seamless BE, ASTM A-333 Gr 6				
	4	4	Sched. 80 min. Seamless BE, ASTM A-333 Gr 6				
PIPE NIPPLES	½	1 ½	Sched. 160 min. Seamless PE, SW or BE, ASTM A-333 Gr 6			ASME 36.10M	Shell STD 3- 2.01 Appendix A
SWAGES	½	1 ½	Swages Sched. 160 min. Seamless PE, SW or BE, ASTM A-333 Gr 6 or A-420 WPL6			MSS SP-95	Shell STD 3- 2.01 Appendix A
BOLTING:	ASTM A-320 L7 alloy steel studs with two ASTM A-194 2H hex nuts					ASME 16.5	Shell STD 3- 2.01 Appendix A
GASKETS:	CL 1500 (½ - 2") & CL 900 (3" & up) 304 SS spiral wound, graphite filled, 316 SS inner ring, CS outer ring, 3.2 mm (1/8") thick					ASME B16.20	Shell STD 3- 2.01 Appendix E

NOTES:

- (1) Parker Monoflange To Be Used For Pressure Transmitter Isolation Valve.
- (2) Trunnion mounted full port ball valves will be used when DBB is shown in P&ID.

NOMENCLATURE:

NPS = Nominal Pipe Size, TE = Threaded End, SW = Socket Weld, BW = Butt Weld, THD = Threaded, PE = Plain End
 BE = Bevelled End, FL = Flanged, RF = Raised Face, WN = Weld Neck, RTJ = Ring Type Joint, PWHT = Post Weld Heat Treatment
 CS = P1 Carbon Steel, NDE = Non Destructive Examination, RT = Radiographic Testing, MT = Magnetic Particle Testing

3.2 Data Reports & Certifications



CERTIFICATE OF ORIGIN

Natpro Order No SLS 338716

Customer Name Shell

Customer Purchase Order No. 4512109130 – CMT

Package Tag No. 0735-08030

EQUIPMENT	TAG NO.	COUNTRY OF ORIGIN
Heater	H - 08071	U.K
Filter	S - 08070	Canada
Odorizer	V - 08116A	U.S

Signature:  _____
Project Manager

Date: July 7/15

Declaration of Origin

We the undersigned, Exheat Ltd, Threxton Road Industrial Estate, Thetford, Norfolk, IP25 6NG, United Kingdom – hereby certify that the equipment hereon the purchase order nos. PUR630248/PUR630251, Exheat ref: 041167/041168 was manufactured in the United Kingdom.



Sara Carpenter

Despatch Assistant



Customer Name:

Natpro/ DXP

Project:

Shell , Carmen Creek, CMT

Pre Installation Equipment Check list

QTY	Equipment Description	CSA/UL	Volts	Amps	AC/DC	Factory Sealed	Rated for Area Class
1	Distribution Panel	CSA/UL	600v	100A Main	AC	N/A	Gen
1	45 KVA transformer	CSA	600/240v	45 KVA	AC	N/A	Gen
1	Lighting/Utilities Panel	CSA/UL	240/120v	100A Main	AC	N/A	Gen
2	Fluorescent Light Fixtures	CSA	120v	.49A	AC	N/A	Gen
2	Ext. Light Fixtures (HP)	CSA/UL	120v	.8A	AC	N/A	C1 Z2
2	Int. Light Fixtures (HP)	CSA/UL	120v	1.6A	AC	N/A	C1 Z2
1	Recepticle (Electrical Room)	CSA/UL	120v	15A	AC	N/A	Gen
1	Recepticle (NG Room)	CSA	120v	20A	AC	N/A	C1 Z2
3	Switches (Electrical Room)	CSA/UL	120v	15A	AC	N/A	Gen
2	Thermostats (Electrical Room)	CSA/UL	120v	16A	AC	N/A	Gen
2	Exhaust Fans (Electrical Room)	CSA/UL	120v	6.8A	AC	Yes	C1, C0
2	Exhaust Fans (NG Room)	CSA/UL	120v	6.8A	AC	Yes	C1, C, D
1	Heater (Electrical Room)	CSA	600v	7.5A	AC	N/A	Gen
1	Heater (NG Room)	CSA	600v	11.9	AC	NO	C1 D1
1	Photocell	CSA	120v	8.3A	AC	Yes	Gen
1	UPS System	CSA	120v/24	16/30	AC	N/A	Gen
1	Contactor Panel	CSA	120v	15A	AC/DC	N/A	Gen
1	IPS Panel	CSA	240v	15A	DC	N/A	Gen
1	NG Heater Control Panel	CSA	600v	6A	AC	N/A	Gen
1	PIC Control Panel	CSA	120/240v	15/15	AC/DC	N/A	Gen
3	Switches (NG Room)	CSA	120v	20A	AC	Yes	C1-D1
2	Thermostats (NG Room)	CSA/UL	120v	22A	AC	NO	C1-D1
4	Red Strobes	ULus	24v		DC		
1	Horn	CSA	24v		DC		
1	Exit/Emerg Light (E Room)	CSA	120v	.13	AC	N/A	Gen
1	Exit/Emerg Light (NG Room)	CSA	120v	.9	AC	NO	C1 D1
3	Temperature Transmitters	CSA	24v	4-20mA	DC	Yes	C1 D1
1	Building temperature transmitter	CSA	24v	4-20mA	DC	Yes	C1 D1

Date: Sept 3 2015

Completed By: Jason Jepp

Signature:

Approved by:

Signature:



HOLCOR
INDUSTRIAL RESOURCES

Customer Name: Natpro/ DXP

Project: Shell, Carmen Creek, CMT

Distribution Center - AC/DC/UPS Inspection Report

Description	600v Distribution Panel
Equipment #	PDP-21620
Voltage	600VAC
Amperage	100amp Main
Phase	3
Main lug or main breaker	Main Breaker
Number of circuits	18
Interrupting capacity	18 KAIC
Breakers or fuses	Breakers
Are breakers visi-break	Yes
Push in or bolt in breakers	Bolt in
CSA or UL approved	CSA and UL
Are lock offs installed	Yes
Copper or alluminum bus	Tinned Copper
NEMA 1 or NEMA 4	12
Is panel tagged property (lamicoid)	Yes
Is fire alarm breaker painted red	N/A
Are bolts torqued and painted	Yes
Is panel schedule filled out/ installed	Yes
Is arc flash warning label installed	Yes

Notes:

Date: Sept 16 2015	
Completed By: J. Sepp	Signature:
Approved by:	Signature:



HOLCOR
INDUSTRIAL RESOURCES

Customer Name: Natpro/ DXP

Project: Shell, Carmen Creek, CMT

Distribution Center - AC/DC/UPS Inspection Report

Description	208/120VAC Lighting/Utilities Panel
Equipment #	LPN 21620
Voltage	120/208 VAC
Amperage	100amp Main
Phase	3
Main lug or main breaker	Main Breaker
Number of circuits	24
Interrupting capacity	10KAIC
Breakers or fuses	Breakers
Are breakers visi-break	Yes
Push in or bolt in breakers	Bolt
CSA or UL approved	CSA and UL
Are lock offs installed	Yes
Copper or alluminum bus	Tinned Copper
NEMA 1 or NEMA 4	12
Is panel tagged property (lamicoid)	Yes
Is fire alarm breaker painted red	N/A
Are bolts torqued and painted	Yes
Is panel schedule filled out/ installed	Yes
Is arc flash warning label installed	Yes

Notes:

Date: Sept 17 2015	
Completed By: J. Jepp	Signature:
Approved by:	Signature:



Customer: Natpro/DXP

Project: Shell, Carmen Creek, CMT

Inspection of conduit raceways before pulling wire

Inspection Description	Acceptable/ Yes/No/NA	Defeciciencies (list in deficiency document if not complete)	Date Re-work Completed
Ensure all conduit is complete according to customer specification and CEC	Yes		
All different systems raceways are seperated i.e Analog, discrete, 120v, 480....	Yes		
Is conduit supported sufficiently	Yes		
Is conduit run in practical spaces i.e not touching process piping...	Yes		
No more than 360 degrees of bends in conduits with out pull fitting.	Yes		
All conduit is free of oil, shavings, and sharp edges	Yes		
All necessary conduit meets CEC for amount of wires needed	Yes		
Flexible connections are in place where required by code	Yes		
1.5m of clearance outside from exfans vents where applicable	Yes		
All conduits are run neat and orderly fashion	Yes		
Junction boxes are located in orer and location specified on prints	Yes		
Fiberglass junction boxes have grounding Meyers hubs installed. MANDATORY	Yes		

Date: Sept 18 2015	
Completed By: Jason Jepp.	Signature: 
Approved by:	Signature:



Customer: Natpro/DXP
Project: Shell, Carmen Creek, CMT

Inspection of conduit raceways before pulling wire

Inspection Description	Acceptable/ Yes/No/NA	Defeciciencies (list in deficiency document if not complete)	Date Re-work Completed
All conductors are rated for load and classification	Yes		
Conductors are not damaged during wire pull. Physical and visual check has been done	Yes		
Bending radius has been followed for wire specifiaction	Yes		
All wire is complete with wire tags	Yes		
Manufacturers specifications have been followed during wire/cable installation	Yes		
Belden shield has been isolated at the device end	Yes		
Sufficient wire length has been let to allow for loop at device end	Yes		
Cable identification tags are installed where required	N/A		
Phase taping complete on three phase conductors	Yes		

Date: Sept 21 2015
Completed By: Jason Sepp. **Signature:** 
Approved by: **Signature:**



Customer: Natpro/ DXP

Project: Shell, Carmen Creek, CMT

POWER Wiring Test List

20V
UTROL
OWEL

20V

Conductor Tag #	Description	Megger Reading	Continuity Test Yes/No	Test Pass/Fail
70232, 70233, 70239	E-ROOM SUPPLY FAN C-08168		YES	PASS
70262, 70263, 70269	E-ROOM SUPPLY FAN C-08169		YES	PASS
70292, 70293, 70299	NG ROOM SUPPLY FAN C-08165		YES	PASS
70322, 70283, 70239	NG ROOM SUPPLY FAN C-08166		YES	PASS
RED CCT-1,3,5	45KVA TRANSFORMER	11.06Ω	YES	PASS
BLUE SPLE 40A BREAKER	FEEDERS	11.06Ω	YES	PASS
BLUE		11.06Ω	YES	PASS
RED BLACK CCT-2,4,6 BLUE	H H-08167 UNIT HEATER	11.06Ω	YES	PASS
RED		11.06Ω		
BLACK CCT-7,9,11 BLUE		11.06Ω		
RED BLACK CCT-8,10,12 BLUE	H-08170 ELECT. ROOM UNIT HEATER	11.06Ω	YES	PASS
RED		11.06Ω		
BLACK CCT-8,10,12 BLUE		11.06Ω		

Megger Make	Megger Model	Megger Serial #	Yes	Date of last Calibration

Date: SEPT 28 / 2015

Completed By: MIKE CARBONS **Signature:**

Approved by: **Signature:**



Customer: Natpro/DXP
Project: Shell, Carmen Creek, CMT


Power Wiring Test List

120VAC

Conductor Tag # PREFIX FOR ALL TAGS LPN-21620	Description	Megger Reading	Function Test Yes/No	Test Pass/Fail
CCT-1H&N	Interior Lights Electrical Room		Yes	Pass
CCT-2H&N	Interior Lights NG HTR Room		Yes	Pass
CCT-3H&N	UPS-21601 AC Power		Yes	Pass
CCT-4H&N	Contactor Panel CP-21604 Power		Yes	Pass
CCT-5H&N	CP-21601 Panel Receptacle		Yes	Pass
CCT-6H&N	Exterior Lights		Yes	Pass
CCT-7H&N	Receptacle NG HTR Room		Yes	Pass
CCT-8H&N	Receptacle Electrical Room		Yes	Pass
CCT-9H&N	Emergency / Exit Lights		Yes	Pass
CCT-10H&N	CP-21601 Cabinet FAN/T-Stat		Yes	Pass
CCT-11H&N	C-08165 Supply Fan NG Room		Yes	Pass
CCT-12H&N	C-08169 Supply Fan Electrical Room		Yes	Pass
CCT-13H&N	C-08166 Supply Fan NG Room		Yes	Pass
CCT-14H&N	C-08169 Supply Fan Electrical Room		Yes	Pass
UPS-21601 CCT 1 + E/N 9121 & 9129	PLC Power from UPS (24V) Flow Transmitter Pwr (24V)		Yes	Pass
UPS-21601 CCT 2 + E/N 1131 & 1139	IPS PWR Power 24v Gas Detector A Power 24v		Yes	Pass
1141 & 1149	Gas Detector B Power 24v		Yes	Pass
1161 & 1169	Flame Detector Power 24v		Yes	Pass
1242 & 1249	E-Room Smoke Detector Pwr 24v		Yes	Pass

MUDC

Megger Make	Megger Model	Megger Serial #	Yes	Date of last Calibration

Date: Sept 21 2015
 Completed By: Jason Japp and Mike G
 Approved by: _____
 Signature: 



Customer: Natpro/DXP

Project: Shell, Carmen Creek, CMT

Control Wiring Test List

Conductor Tag #	Description	Megger Reading	Function Test Yes/No	Test Pass/Fail
10001 & 10009	UPS-21601 AC Failure		Yes	Pass
10011 & 10019	UPS-21601 DC Low		Yes	Pass
10031 & 10039	CP-21602 Common Alarm		Yes	Pass
10041 & 10049	HVAC Common Alarm		Yes	Pass
10051 & 10059	Skid trip Alarm		Yes	Pass
10061 & 10069	CP-21603 Common Alarm		Yes	Pass
10071 & 10079	SMOKE Detector Alarm		Yes	Pass
20001 & 20011	LCP-21601/02/03 Common Alarm		Yes	Pass
20021 & 20031	XI-08071 B1 Skid trip Alarm		Yes	Pass
20041 & 20051	HVAC Common Alarm		Yes	Pass
20061 & 20071	BLDG Temp. Alarm		Yes	Pass
20081 & 20091	LEL Common Alarm		Yes	Pass
20101 & 20111	BLDG Flame Det Common Alarm		Yes	Pass
20121 & 20131	SDV-08070A OPEN (Rotary)		Y	
1361 & 1362	Beacon / Horn Test		Yes	Pass
1502 & 1503	Alarm Silence		Yes	Pass
1241 & 1242	Smoke Detector Reset		Yes	Pass
1551 & 1552	Trip Reset		Yes	Pass
1192 & 1199	NG Room Strobe Interior		Yes	Pass
1202 & 1209	NG Room Strobe Exterior		Yes	Pass
1212 & 1219	E-Room Strobe Interior		Yes	Pass
1222 & 1229	E-Room Strobe Exterior		Yes	Pass
1281 & 1282	E-Room Smoke Detector		Yes	Pass

Megger Make	Megger Model	Megger Serial #	Yes	Date of last Calibration

Date: SEPT 28 / 2015

Completed By: MIKE GIBBONS **Signature:**

Approved by: **Signature:** _____



Customer: Natpro/ DXP
Project: Shell, Carmen Creek, CMT

Building Inspection List Page # 1

<i>Inspection Description</i>	<i>Acceptable Yes/No/NA</i>	<i>Defeciciencies (list in deficiency document if not complete)</i>	<i>Date Re-work Completed</i>
Junction boxes are c/w terminal #, lamicooids, panduit, ground lug & drain if located outdoors	Yes		
All conduits entering bulding walls siliconed or firestopped both sides	Yes		
Conduits penetrating building walls have sealing covers installed	Yes		
Equipment mounted outside clears 1.5 m from exhaust fans	Yes		
All switches, receptacles, lights... are as specified by customer	Yes		
All seals, unions flexes are installed as required	Yes		
All straps, fittings, plugs... checked for tightness	YES		
All conduit and strut mounted squarely & supported properly	Yes		
All gaskets & covers are installed on fittings & equipment		NOT UNTIL FAT TEST	
Teck glands packed or poured where used	N/A	N/A	N/A
All fixtures set screws installed & tightened a required	Yes		
All grounding requirements met as per code/ customer preferences	Yes		
Div1 Flexes are painted & taped if in H2S environment	N/A	N/A	N/A
Ensure all devices have been wired for proper voltage	Yes		
MMS switches c/w properly sized Ois are used where motors are not thermally protected	NA	NA	NA
All lamicooid labelling is complete for all switches, jbs, panels etc	YES		
Seals not poured tags are attached to all un-poured seals	Yes		
All support welding is complete	YES		
Has the foreman checked all motor terminations over 120 Volt	Yes		
Has the foreman checked all terminations for tightness & correct positioning	Yes		
Check project against drawings & scope of work	Yes		



Customer: Natpro/ DXP
Project: Shell, Carmen Creek, CMT

Building Inspection List Page # 2

Inspection Description	Acceptable/ Yes/No/NA	Defeciciencies (list in deficiency document if not complete)	Date Re-work Completed
All wire tags are heat shrunk		FAT TEST	
Ship loose items are in boxes & secured for shipment		FAT TEST	
Panel interiors cleaned. Check for filings on components	YES		
Overloads on startes have been set to 125% of motor FLA	N/A	N/A	N/A
Panel schedule has been filled out & placed on panel door	YES		
Work place clean	YES		
Check to ensure proper clearance has been left for lights to nearedt object (i.e Crane...)	Yes		
Ensure all screws have been replaced/filled where removed from walls	YES		
Fire alarm system has been verified	N/A	N/A	N/A
Accredited inspection agency has been notified for final inspection	Yes		
Equipment manuals or data sheets handed in to customer	YES	ADAM SEPT 28/2015	
All fluourescent lamps removed & packaged for shipping		FAT TEST	
Heaters taken down & packaged for shipping		FAT TEST	
Pictures taken & downloaded into job pics & labelled accordingly		FATTEST	

Notes:

Date:	
Completed By:	Signature:
Approved by:	Signature:



Customer: Natpro/DXP

Project: Shell, Carmen Creek, CMT

Document Check List

<i>Paperwork description</i>	<i>Notes</i>	<i>Date Completed</i>	<i>Signed off</i>
Ship loose slip complete, & signed. One copy left with materials & one handed in to Holcor	PAPER WORK DONE WAITING ON FAT TEST		
Two copies of as builts c/w date & foremans signature are complete. One left with building & one handed in to the office			
Additional daily sheets for work beyond scope filled out, handed to the office & job quote marked up to show actual work done		SEPT 30/15	
Timecard summary filled out & handed into office		SEPT 30/15	
Material take off completed & handed to the office		SEPT 30/15	
Quality control paperwork filled out & handed to the office	FAT TEST TO COMPLETE	SEPT 30/15	
Wholesalers packing slips handed to Holcor office		SEPT 30/15	

Notes:

Date:	
Completed By:	Signature:
Approved by:	Signature:



CSA

Assembly & Final Inspection Checklist for Control Panels

Test Plan No.: _____ - CP

Customer: National Process Equipment Inc Job No.: W068035 Qty: 1

Catalog No.: CP 23075-01 Volts: 600 Phase: 3 Hz: 60 Amps: 6

Assembly Drawing, Sheet and Revision No.: D23075-01

Equipment Tag No.: _____

Inspect the following attributes:

OK	N/A		
<input checked="" type="checkbox"/>	<input type="checkbox"/>	1.0 Verify Amperage Rating and Continuity of the following:	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	1.1 Power fuses	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	1.2 SCR fuses	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	1.3 Pump/fan Fuses	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	1.4 Primary and secondary transformer control fuses	<u>AS</u> INT.
<input checked="" type="checkbox"/>	<input type="checkbox"/>	2.0 Verify and Record Voltages for the following:	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	2.1 Contactor coils <u>120</u> Volts	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	2.2 Relay coils <u>120</u> Volts	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	2.3 Magnetic Starter coil _____ Volts	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	2.4 Transformer: primary <u>600</u> Volts, secondary <u>120</u> Volts	<u>AS</u> INT.
<input checked="" type="checkbox"/>	<input type="checkbox"/>	2.5 _____	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	3.0 Ensure all connections are tight/torque to manufacturer's specs and check the quality of stripping and crimping of wire.	<u>AS</u> INT.
<input checked="" type="checkbox"/>	<input type="checkbox"/>	4.0 Preparation for Test	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	4.1 Clean and remove all debris	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	4.2 Check electrical clearances per QSWF205I	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	4.3 Check power, control and instrumentation wiring matches drawing for wiring type, colour and gauge	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	4.4 Wire numbers added per drawing.	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	4.5 Enclosure dimensional check including mounting lugs, legs, etc.	<u>AS</u> INT.
<input checked="" type="checkbox"/>	<input type="checkbox"/>	5.0 Dielectric strength test of complete product per QSWF 216I.	
		(Note: If product includes SCR, disconnect wires prior to testing - if in doubt consult engineer.): Power Side: <u>2640</u> volts for 1 sec.	
		Control Side: <u>1200</u> volts for 1 sec.	<u>AS</u> INT.
<input checked="" type="checkbox"/>	<input type="checkbox"/>	6.0 Operational Test	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	6.1 Control and Interlocks	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	6.1.1 Isolate control transformer primary.	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	6.1.2 Energize control circuit (primary <u>603</u> volts, secondary <u>125.2</u> volts)	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	6.1.3 Operate control circuit switch or control circuit breaker.	
		Notes: (1) De-energize if there is abnormal noise, smell, burning, etc.	
		(2) Certain systems must be isolated temporarily in order to continue testing.	
		These systems are completely verified below:	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	6.1.4 Check operation of high limit (temperature, pressure level, trip and reset functions).	

OK N/A

✓
✓
✓
✓
✓
✓
✓
✓
✓
✓

7.0 Final Check (cont'd)

- 7.11 Test wiring removed.
- 7.12 Bonding conductors installed.
- 7.13 Shields grounded per drawing.
- 7.14 Document assembled and delivered as specified per Gen Sheet.
- 7.15 Quality Record package assembled.
- 7.16 Request final release from Q.C.
- 7.17 Verify:
Special regulatory/agency approval requirements.

AS
INIT.

8.0 Inspection and Test Notes (refer to drawing and work order)

**Initial & Date
After Completion**

8.1	_____	_____
8.2	_____	_____
8.3	_____	_____
8.4	_____	_____
8.5	_____	_____
8.6	_____	_____
8.7	_____	_____
8.8	_____	_____
8.9	_____	_____
8.10	_____	_____

AS
QUALITY INSPECTOR

11, 13, 14
DATE



RECORD OF CONFIGURATION FOR RKC SA100L SERIES LIMIT CONTROLLER

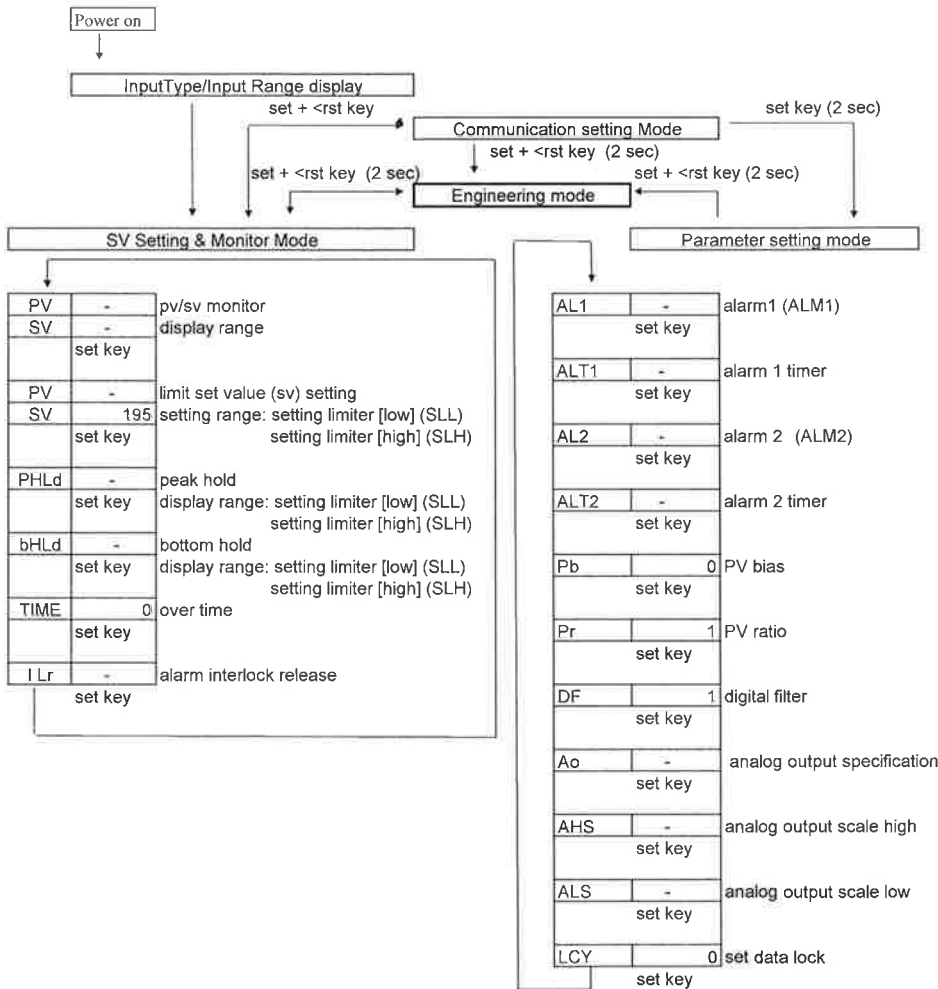
Model number: SA100LK02-MN-4*NN-D1/Y _____

Tag number: TSHH-1, TSHH-2 _____

S.O. number: W068035 _____

1.0 GENERAL

- 1.1 THE CONTROL HAS BEEN PRE-CONFIGURED IN OUR FACTORY AS FOLLOWS. PRIOR TO OPERATION, CONFIRM THAT THE SET POINT AND ANY ALARMS ETC. ARE SUITABLE FOR THE INTENDED PURPOSE. FACTORY SET AT: 195°C
- 1.2 NOT ALL MENU ITEMS WILL BE VISIBLE OR ENABLED, DEPENDING ON OPTIONS PURCHASED AND EXTENT OF CUSTOM PROGRAMMING. REFER TO THE I THE MANUAL FOR AVAILABLE FEATURES FOR THE MODEL NUMBER SHOWN ABOVE.
- 1.3 THE DATA LOCK FUNCTION IS A MEANS OF PREVENTING UNAUTHORIZED CHANGES IN PARAMETERS. PARAMETERS MAY BE CHECKED WHEN THE LOCK CODE IS ENFORCED. IF PARAMETERS ARE LOCKED, THE CODE MAY BE CHANGED IN THE OPERATIONS PARAMETERS.



PREPARED BY: S.D. _____

DATE: 13-Nov-14 _____

PARAMETERS SET BY: AS _____

DATE: 13 Nov 14 _____



RECORD OF CONFIGURATION FOR RKC SA100L SERIES LIMIT CONTROLLER

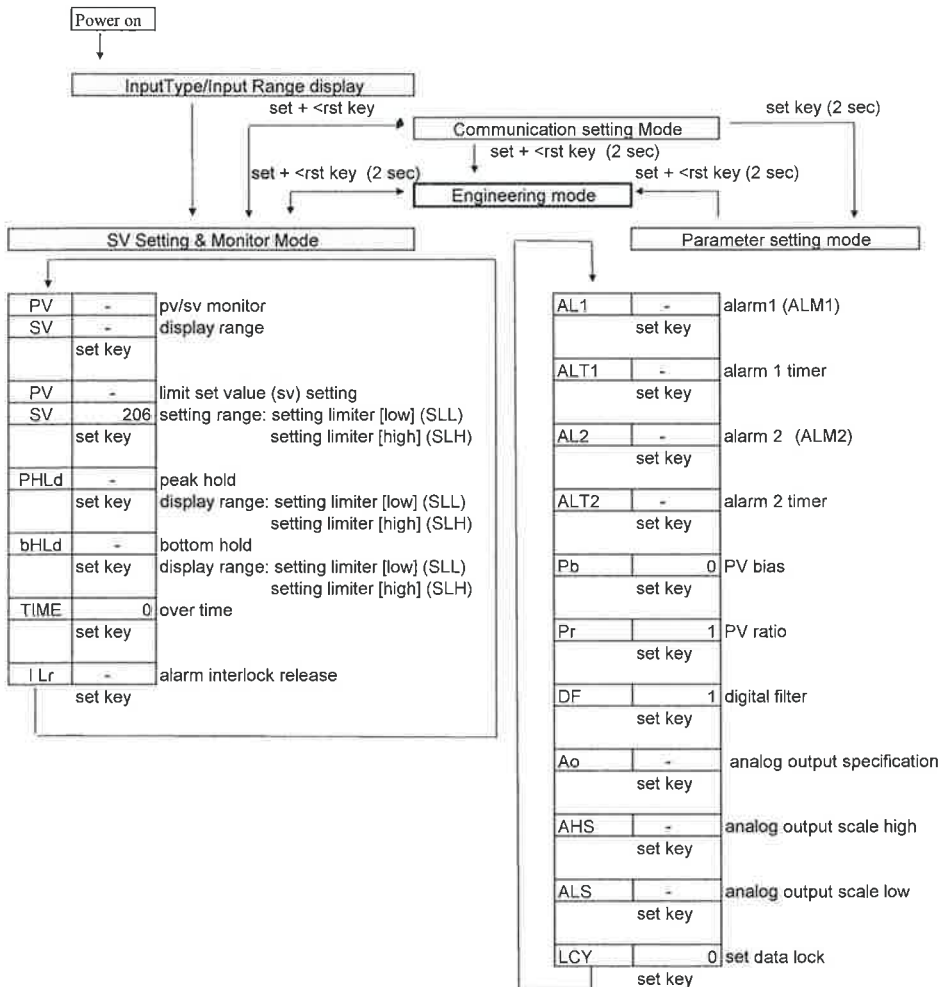
Model number: SA100LK02-MM-4*HH-D1/Y _____

Tag number: TSHH-3 _____

S.O. number: W068035 _____

1.0 GENERAL

- 1.1 THE CONTROL HAS BEEN PRE-CONFIGURED IN OUR FACTORY AS FOLLOWS. PRIOR TO OPERATION, CONFIRM THAT THE SET POINT AND ANY ALARMS ETC. ARE SUITABLE FOR THE INTENDED PURPOSE. FACTORY SET AT: 206°C
- 1.2 NOT ALL MENU ITEMS WILL BE VISIBLE OR ENABLED, DEPENDING ON OPTIONS PURCHASED AND EXTENT OF CUSTOM PROGRAMMING. REFER TO THE I THE MANUAL FOR AVAILABLE FEATURES FOR THE MODEL NUMBER SHOWN ABOVE.
- 1.3 THE DATA LOCK FUNCTION IS A MEANS OF PREVENTING UNAUTHORIZED CHANGES IN PARAMETERS. PARAMETERS MAY BE CHECKED WHEN THE LOCK CODE IS ENFORCED. IF PARAMETERS ARE LOCKED, THE CODE MAY BE CHANGED IN THE OPERATIONS PARAMETERS.



PREPARED BY: S.D. _____

DATE: 13-Nov-14 _____

PARAMETERS SET BY: AS _____

DATE: 13 Nov 14 _____



RECORD OF CONFIGURATION FOR RKC SA100L SERIES LIMIT CONTROLLER

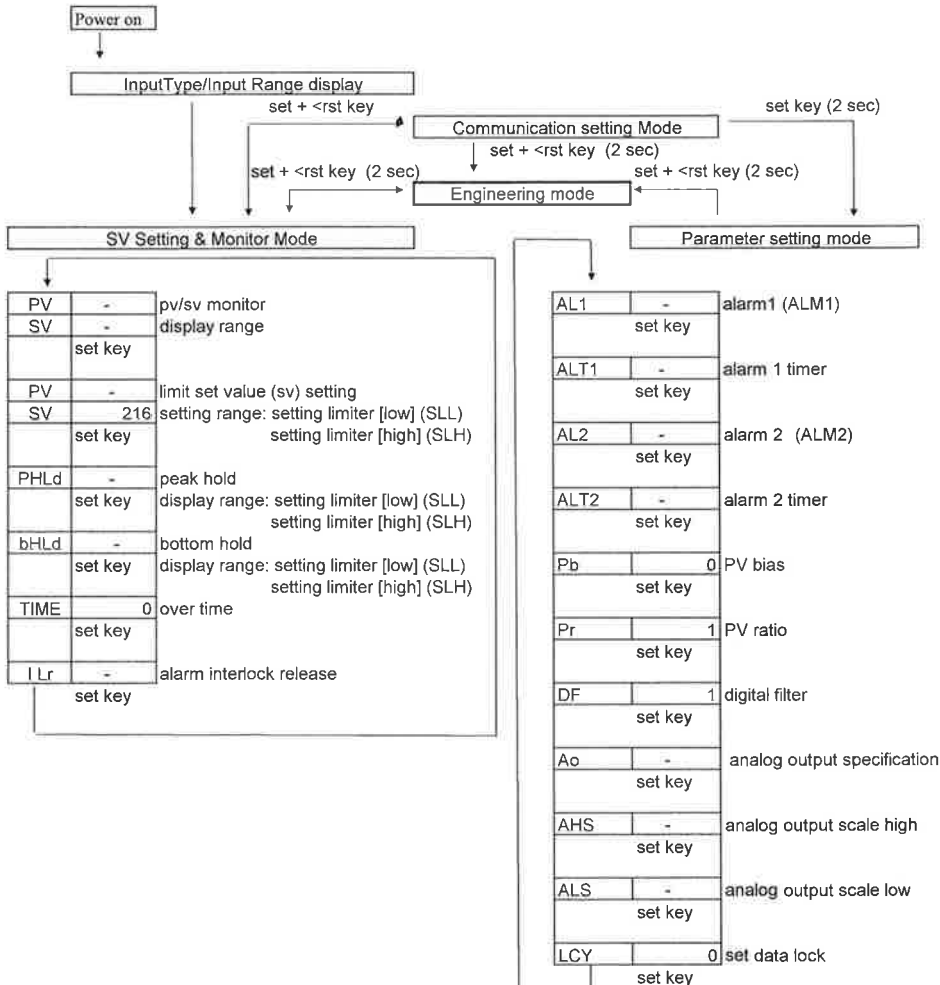
Model number: SA100LK02-MN-4*NN-D1/Y _____

Tag number: TSHH-4 _____

S.O. number: W068035 _____

1.0 GENERAL

- 1.1 THE CONTROL HAS BEEN PRE-CONFIGURED IN OUR FACTORY AS FOLLOWS. PRIOR TO OPERATION, CONFIRM THAT THE SET POINT AND ANY ALARMS ETC, ARE SUITABLE FOR THE INTENDED PURPOSE. FACTORY SET AT: 216°C
- 1.2 NOT ALL MENU ITEMS WILL BE VISIBLE OR ENABLED, DEPENDING ON OPTIONS PURCHASED AND EXTENT OF CUSTOM PROGRAMMING. REFER TO THE MANUAL FOR AVAILABLE FEATURES FOR THE MODEL NUMBER SHOWN ABOVE.
- 1.3 THE DATA LOCK FUNCTION IS A MEANS OF PREVENTING UNAUTHORIZED CHANGES IN PARAMETERS. PARAMETERS MAY BE CHECKED WHEN THE LOCK CODE IS ENFORCED. IF PARAMETERS ARE LOCKED, THE CODE MAY BE CHANGED IN THE OPERATIONS PARAMETERS.



PREPARED BY: S.D. _____



DATE: 13-Nov-14 _____

PARAMETERS SET BY: AS _____

DATE: 13 NOV 14 _____

Quality Assurance

Battery Load Test <input checked="" type="checkbox"/>	Chart Recorder: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Sales Order #:	SLS 338716
Gauge Type:	DC Volt Meter, Fluke 87	Client Reference:	K 04
Test Gauge #:	Holcor 1	Drawing No.:	
Test Gauge Range:	0 – 50 vDC	Date tested:	Sept 28, 2015
Test Draw:	Full draw from PLC & IPS	Test Duration:	240 Min.

ITEM IDENTIFICATION:	
Test UPS battery for duration at full load from PLC: CP21601 & IPS: CP21602	
10:00 am: 26.30 vDC	
11:00 am: 25.61 vDC	
12:00 pm: 25.32 vDC	
1:00 pm: 25.28 vDC	
2:00 pm: 25.25 vDC	
3:00 pm: 25.21 vDC	
IMPORTANT: A/C power Off, PLC On, IPS On	
TESTED BY: Adam Robert	Signature:  Testor
WITNESSED BY: Peter Mrakawa	Signature:  NPE Representative
INSPECTOR:	Signature: _____ Inspector

FORM # Holcor	LEAK TEST PROCEDURE	REV # 1	DATE	ORIGINATOR QA	REVIEW SERVICE/ PRODUCTION	APPROVAL
-------------------------	--------------------------------	-------------------	------	------------------	----------------------------------	----------

BATTERY CHARGER FACTORY INSPECTION

CATALOGUE NO. CCE24A30R19H17
 SERIAL NO. 21581A NRTL/C NO. 3581
RATINGS
 AC INPUT 120 VOLTS 16 AMPS 1 PHASE 60 HZ
 DC OUTPUT 24 VOLTS 30 AMPS 12LA CELLS

		AC INPUT		DC OUTPUT		
		VOLTS	AMPS	VOLTS	AMPS	RMS RIPPLE
FLOAT	NOM	120	0.9	27.3	0	2.6 mV
		120	15.0	27.2	30	77.0 mV
	HIGH	132	0.9	27.3	0	2.6 mV
		132	15.4	27.3	30	76.0 mV
	LOW	108	0.8	27.3	0	2.6 mV
		108	14.4	27.2	30	72.0 mV
EQU	NOM	=====	=====	=====	=====	=====
		=====	=====	=====	=====	=====
LIMITING <i>Electronic</i> BAT. RECH LIMITING	NOM	120	15.4	26.9	31	74.0 mV
		=====	=====	=====	=====	=====

VOLTAGES SHOWN IN HEAVY BOX ARE FACTORY SETTINGS FOR FLOAT & EQUALIZE

UNIT TESTED ON RES. LOAD BATT. LOAD _____ A.H.

Hipot	Duration	Sec	OK	N/A
AC I/P HIPOT	<u>1300</u>	V-RMS	<input checked="" type="checkbox"/>	<input type="checkbox"/>
DC O/P HIPOT	<u>1100</u>	V-RMS	<input checked="" type="checkbox"/>	<input type="checkbox"/>
ALARM HIPOT	<u>1100</u>	V-RMS	<input type="checkbox"/>	<input checked="" type="checkbox"/>
PRIMARY TAP	<u>0 - H</u>		<input checked="" type="checkbox"/>	<input type="checkbox"/>
SECONDARY TAP	<u>N/A</u>		<input checked="" type="checkbox"/>	<input type="checkbox"/>
LIMIT RESISTOR	<u>25</u>	OHMS	<input checked="" type="checkbox"/>	<input type="checkbox"/>
CU SHUT-DOWN	<u>30</u>	VOLTS	<input checked="" type="checkbox"/>	<input type="checkbox"/>
LOW VOLTAGE AL	<u>24</u>	VOLTS	<input checked="" type="checkbox"/>	<input type="checkbox"/>
BATTERY LOW	<u>21</u>	VOLTS	<input checked="" type="checkbox"/>	<input type="checkbox"/>
GND. FAULT TRIP	<u>4.7 K</u>	OHMS	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Hipot Tester: CRI No: 376 :			<input checked="" type="checkbox"/>	
Functional test:			<input checked="" type="checkbox"/>	

TESTED BY 

DATE 13 Apr. 2015

Hayley Industrial Electronics Ltd.

BOM As Built Report

Item #: BDP-5-1DC-H10
BREAKER DISTRIBUTION PANEL

Schematic
Layout DWG

SEQ	Designator	Part #	Part Description	UOM	Qty Per
0001		WIRE#4AWG	WIRE #4 AWG	FT	5
0002		WIRE#4AWG	WIRE #4 AWG	FT	5
0003		WIRE#8AWG	WIRE #8 AWG	FT	5
0004		WIRE#10TEW	WIRE #10 TEW BLACK	FT	10
0005		WEI030356	SAK 35 TERMINAL BLOCK	EA	2
0006		WEI030436	SAK 35 BARRIER	EA	1
0007		WEI035476	EK35 GND TERMINAL	EA	1
0008		WEI019936	EWK 2 END BRACKET	EA	2
0009		WEI011006	SAK 10 TERMINAL BLOCK	EA	10
0010	DC I/P+	WEI011796	SAK 10 AP (1.5) END PLATE	EA	1
0011		WEI013016	SAK 10 BARRIER	EA	1
0012		WEI045740	SAK 10 (10) POLE JUMPER	EA	1
0013		WEI020616	EWK 1 END BRACKET	EA	2
0014		WEI012280	RAIL(J CHANNEL) TS-32 TERMINAL	IN	15
0015		SM104D105	SM-104-D-105	EA	1
0016		FFDD312B	FFDD-312-B 10.5" DOOR / 5-CD1	EA	1
0017		E59935505	E5-99-355-05 PAWL FOR SM UNIT	EA	1
0018		E56005UU1	E5-6-005-UU1 1/4 TURN CAM BODY	EA	1
0019		CD1B3DCW15	CD1-B3DCW-15-125DC-2	EA	4
0020	BKR JUMPER	CD1B3DCW25	CD1-B3DCW-25-125DC-2	EA	1
0001		FFSM104BTOP	FFSM-104-B-TOP 10"x15"DEEP TOP	EA	2
0002		FFSM104105BSIDE	FFSM-104-105-B-SIDE	EA	2
0003		FFSM104105BBRK	FFSM-104-105-B-BRK10.5 SD BRAC	EA	2
0004		FFSM104105BRPL	FFSM-104-105-B-RPL	EA	1

DC BREAKER PANEL FACTORY INSPECTION

CATALOGUE NO. BDP-5-1DC-H10

SERIAL NO. 21581B NRTL/C NO. 3581

RATINGS

DC BUS RATING 30 VOLTS 100 AMPS

HIPOT 1100 V-RMS at 60 sec

- | | | |
|------------------|-------------------------------------|--------|
| MECHANICAL CHECK | <input checked="" type="checkbox"/> | OK |
| TERMINAL MARKING | <input checked="" type="checkbox"/> | OK |
| GROUND MARKING | <input checked="" type="checkbox"/> | OK |
| BREAKER RATINGS | <input checked="" type="checkbox"/> | OK |
| RATING SHEET | <input type="checkbox"/> | OK N/A |
| METERS | <input type="checkbox"/> | OK N/A |

Hipot Tester: CRI No: 376 :

Functional test:

TESTED BY 

DATE 13 Apr. 2015

Shell Canada Energy
Carmon Creek CMT
NG Pressure Reduction
Factory Acceptance Test Plan and Protocol

Project Tag: 0735A-08030

Rev. 0

1 October, 2015

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1. Test Protocol

1.1 Introduction

This document outlines the Factory Acceptance Test, and includes what tests are to be performed, the procedure for carrying out each test, the expected results of each test, and verification that each test has been performed as outlined.

1.2 Scope

This FAT Procedure covers the following components:

- Physical and Electrical Control Panel Inspections
- Instrumentation Power and Configuration
- SIL Safety Functions
- PLC Control System Logic Functions

This FAT is designed to ensure electrical and software compliance and safety in regards to the PLC and SIL units. It also insures compliance and completeness in respect to control cabinet wiring, grounding, and labelling.

1.3 Roles and Responsibilities

Each test will have a Lead Technician responsible for performing the test. It is the responsibility of the Lead to understand how each test is to be performed and carried out.

Required Technicians are to assist the Lead in completing each test.

Witness is required to verify that each test is completed in a satisfactory manner.

Technician roles vary from test to test, as listed below:

Section	Name	Lead Technician	Required Technicians
2	Panel Inspection	Electrical Technician	
3	Control Panel Ground Testing	Electrical Technician	
4	PDP-21620 (600 VAC Power Distribution)	Electrical Technician	
5	LPN-21620 (120/208 VAC Power Distribution)	Electrical Technician	
6	Control Panel Power Distribution	Electrical Technician	
7	Control Panel Start-Up	Electrical Technician	
8	PLC Start-Up	PLC Technician	Electrical Technician
9	PLC Inspection	PLC Technician	
10	HMI Inspection	PLC Technician	
11	Discrete IO	PLC Technician	Electrical Technician
12	Analog IO	PLC Technician	Electrical Technician/ Instrument Technician
13	Data Transfer Points	PLC Technician	
14-19	Function Test	PLC Technician	Electrical Technician

1.4 Equipment Required

The following equipment is required for this FAT

- Laptop
- Ethernet Cabling
- SIL Serial Cable
- RSLogix 5000 software V21.11
- Moore STA Software V2.1
- Factorytalk View ME software V7.0
- Multimeter with Sourcing capabilities

Electrical Test Equipment		
Make / Model	Serial Number	Calibration Date
FLUKE/773	14690043	Oct-22-2015
FLUKE/375	20430165	Oct-22-2015
MATRIX/IRTN424-2L	E0071001241	Oct-22-2015

1.5 Reference Documents

As shown on documents


The following documents should be present during the FAT procedure for reference.

Document Number	Document Name	Rev	Code
CCK-4512109130-0735-K05-00001-000	Pre-FAT testing report (Natpro's internal FAT)	N/A	
CCK-4512109130-0735-C03-00001-001	ELECTRICAL SINGLE LINE DIAGRAMS - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE	1	
CCK-4512109130-0735-C05-00001-001	INST TELECOMMS SYSTEM SCHEMATIC DIAGRAMS - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE	2	
CCK-4512109130-0735-E01-00001-01	INTERCONNECTION DIAGRAM - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE	2	
CCK-4512109130-0735-E01-00001-02	INTERCONNECTION DIAGRAM PAGE 2 OF 10 - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE	2	
CCK-4512109130-0735-E01-00001-03	INTERCONNECTION DIAGRAM PAGE 3 OF 10 - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE	3	
CCK-4512109130-0735-E01-00001-04	INTERCONNECTION DIAGRAM PAGE 4 OF 10 - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE	2	
CCK-4512109130-0735-E01-00001-05	INTERCONNECTION DIAGRAM PAGE 5 OF 10 - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE	3	
CCK-4512109130-0735-E01-00001-06	INTERCONNECTION DIAGRAM PAGE 6 OF 10 - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE	2	
CCK-4512109130-0735-E01-00001-07	INTERCONNECTION DIAGRAM PAGE 7 OF 10 - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE	2	
CCK-4512109130-0735-E01-00001-08	INTERCONNECTION DIAGRAM PAGE 8 OF 10 - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE	3	
CCK-4512109130-0735-E01-00001-09	INTERCONNECTION DIAGRAM PAGE 9 OF 10 - CMT - NATURAL NATURAL GAS PRESSURE REDUCTION SKID PACKAGE	2	
CCK-4512109130-0735-E01-00001-10	INTERCONNECTION DIAGRAM PAGE 10 OF 10 - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE	2	
CCK-4512109130-0735-E01-00001-11	INTERCONNECTION DIAGRAM, DWG 214067-7342	2	

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Bot

D.N. of Materials
D.N. of General Arrangement

8

Project 0735A-08030 Factory Acceptance Test

CCK-4512109130-0735-E01-00001-12	INTERCONNECTION DIAGRAM, DWG 214067-7602A / PLC/SIL/CONTACT PANEL LAYOUT AND WIRING SCHEMATICS	2	
CCK-4512109130-0735-E01-00001-13	INTERCONNECTION DIAGRAM, DWG 214067-7604	3	
CCK-4512109130-0735-E01-00001-004	Miscellaneous Schematic	1	
CCK-4512109130-0735-E02-00001-001	PANEL / CABINET LAYOUT, 1 OF 2	2	
CCK-4512109130-0735-E02-00001-002	PANEL / CABINET LAYOUT, 2 OF 2	1	
CCK-4512109130-0735-E02-00002-001	PLC/SIL/CONTACT PANEL LAYOUT AND WIRING SCHEMATICS, 1 OF 4	2	
CCK-4512109130-0735-E02-00002-002	PLC/SIL/CONTACT PANEL LAYOUT AND WIRING SCHEMATICS, 2 OF 4	2	
CCK-4512109130-0735-E02-00002-003	PLC/SIL/CONTACT PANEL LAYOUT AND WIRING SCHEMATICS, 3 OF 4	2	
CCK-4512109130-0735-E02-00002-004	PLC/SIL/CONTACT PANEL LAYOUT AND WIRING SCHEMATICS, 4 OF 4	2	
CCK-4512109130-0735-E05-00001-001	CABLE SCHEDULE - CMT - NATURAL PRESSURE REDUCTION SKID PACKAGE	1	
CCK-4512109130-0735-E05-00001-002	CABLE SCHEDULE PAGE 2 OF 2 - CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE	1	
CCK-4512109130-0735-E10-00001-001	INSTRUMENT LAYOUT DRAWINGS, 1 OF 4	1	
CCK-4512109130-0735-E10-00001-002	INSTRUMENT LAYOUT DRAWINGS, 2 OF 4	1	
CCK-4512109130-0735-E10-00001-003	INSTRUMENT LAYOUT DRAWINGS, 3 OF 4	1	
CCK-4512109130-0735-E10-00001-005	INSTRUMENT LAYOUT DRAWINGS, 4 OF 4	1	
CCK-4512109130-0735-C14-00001-000	Process Cause & Effect Charts- CMT - Natural Gas Pressure Reduction Skid Package	2	
CCK-4512109130-0735-C14-00002-000	Fire & Gas Cause & Effect Charts- CMT - Natural Gas Pressure Reduction Skid Package	2	
CCK-4512109130-0735-C15-00001-000	Control Philos. and Block Logic Diagrams- CMT - Natural Gas Pressure Reduction Skid Package	1	← Shen Revision
CCK-4512109130-0735-C01-00001-001	P&ID	8	
CCK-4512109130-0735-E09-00001-000	Instrument Data Sheets	2	← Shen Rev.
CCK-0735-MS-7303-000-00001-000	Material Requisition		
CCK-0000-IN-4302-000-00001-000	CMT Alarm and Trip Summary		
CCK-0000-IN-4327-000-00002-000	CMT Input - Output List		
CCK-4512109130-0735-K04-00001-000	Electrical QAQC Document/ Megger Test Report	1	← Shen Revision
	IPS Panel Schematic CP-21602		
CCK-4512109130-0735-C18-00003-001	CCI Control Panel		

~~E01-00001-004 Misc. Schematic~~

+

1.6 Appendixes

Certain tests reference an Appendix. Each Appendix contains a table that must be verified, and each line initialed, before the corresponding test can be signed off. The list of appendixes is:

- Appendix A – Discrete IO List
- Appendix B - Analog IO List
- Appendix C - Data Transfer Points Summary
- Appendix D - Function List

2. Panel Inspection

Each Panel is to be physically inspected. Panels should all be powered down at this point.

2.1 List of Panels and Documentation

The following Panels will be inspected, and the following documents will be used as reference.

Panel Tag	Description	Layout	Power Distribution Schedule
CP-21601	PLC Panel	CCK-4512109130-0735-E02-00002-002	CCK-4512109130-0835-E01-00001-002
CP-21602	IPS Panel	CCK-4512109130-0735-E02-00002-004	CCK-4512109130-0735-E01-00001-008 CCK-4512109130-0735-E01-00001-013
CP-21603	CCI Control Panel		CCK-4512109130-0735-C18-00002-001
CP-21604	Contactora Panel	CCK-4512109130-0735-E02-00002-001	CCK-4512109130-0735-E02-00002-002-02 CCK-4512109130-0735-E02-00002-004-02
UPS-21601	Uninterruptible Power Supply (Hayley)		CCK-4512109130-0735-C18-00003-001
LPN-21620	Lighting Distribution Panel		CCK-4512109130-0735-E02-00001-002-02
PDP-21620	Power Distribution Panel		
SW-21620	Power Junction Box		
XJB-21601	Junction Box	CCK-4512109130-0735-E01-00001-011.	
XJB-21602	Junction Box	CCK-4512109130-0735-E01-00001-011.	

2.2 Description of Tests

- Physical Damage: Inspect the cabinet for any physical damage such as paint, dents, warping, etc.
- Cabinet Approval: Each applicable cabinet will be checked for a CSA approval label. Confirm that the contents of the label are correct.
- Layout: Confirm that the internal and external layout matches the reference drawings.
- Schedule: Confirm the panel schedule complies with the reference drawings.
- Wire Management: Confirm that proper wire management has been observed.
- Labels/Lamacoids: Confirm that wires have been tagged properly, and lamacoids have been applied according to the reference drawings.
- Review electrical QAQC documents.

2.3 Panel Inspection Tests

Panel	Physical Damage	CSA Approval	Layout	Schedule	Wire Management	Labels/Lamacoids	Comments
CP-21601	✓	✓	✓	✓	✓	✓	Need label for Ethernet cable See permit list
CP-21602	✓	✓	✓	✓	✓	✓	N/A
CP-21603	✓	✓	✓	✓	✓	✓	N/A
CP-21604	✓	✓	✓	✓	✓	✓	N/A
UPS-21601	✓	✓	✓	✓	✓	✓	N/A
LPN-21620	minor ✓	✓	✓	✓	✓	✓	Paint Removed top right corner
PDP-21620	minor ✓	✓	✓	✓	✓	✓	Scratch top left
SW-21620	✓	✓	Not checked due to 600V hook-up		✓	✓	Paint removed top right corner
XJB-21601	✓	✓	✓	✓	✓	✓	N/A
XJB-21602	✓	✓	✓	✓	✓	✓	N/A

2.4 Section Sign-Off

Comments/Notes:	
Test Section is: <input checked="" type="checkbox"/> Passed () Failed	Deficiencies: None
Test Executed By (Initial & Date): AR Nov 18 2015	Test Witnessed By (Initial & Date): JB 18 Nov 2015

3. Control Panel Ground Testing

Each panel will be tested for proper grounding visually. Isolation ground bar to be tested using multi-meter to test resistance.

3.1 Panel Tests

Panel	Ground Bar Isolation	Chassis/ AC Test	Isolated Instrument Ground	Panel Ground	AC Ground Lug Testing	Comments
CP-21601	✓		Per Drawings	✓	✓	
CP-21602	✓		Per Drawings	✓	✓	
CP-21603	As per Drawings		Per Drawings	✓	✓	See punch list (ground wire size)
CP-21604	✓		Per Drawings	✓	✓	
UPS-21601	✓		N/A	✓	✓	
LPN-21620	✓		N/A	✓	✓	
PDP-21620	✓		N/A	✓	✓	
SW-21620			N/A			Not checked due to GPOV hook up
XJB-21601	✓		N/A	✓	✓	
XJB-21602	✓		N/A	✓	✓	

Shelley TA Approval for Isolated ground design

3.2 Section Sign-Off

Comments/Notes:	
Test Section is: <input checked="" type="checkbox"/> Passed <input type="checkbox"/> Failed	Deficiencies: None
Test Executed By (Initial & Date): AK Nov 18 / 2015	Test Witnessed By (Initial & Date): JD 17 Nov 2015

4. 600VAC Power Distribution Start-up (PDP-21620)

Once inspection has been completed the 600 VAC Power Distribution Panel will be powered up and tested as outlined. Temporary power will be supplied to the exterior power JB (SW-21620) with 600VAC 3PH 60HZ @ 50Amps for individual testing of the Units heaters, building transformer and the CCI NG heater controller.

4.1 Individual Breaker Tests

Do Not Test the Natural Gas heater (H-08071) without process gas or **damage** to the heater will occur.

Testing of the (CP-21603) CCI controller with 600VAC will be conducted by **first removing** the (H-08071) Natural Gas Heater power wiring from the load side of the (CP-21603) CCI controller to energize the hardware and test the controls.

Apply power to an individual feed breaker, and verify the appropriate voltage is being measured at the terminals of the corresponding cabinet or equipment. Turn breaker off and confirm that voltage has been removed.

Shop Test Voltage: _____. Measured voltage anticipated to be the same as the shop test voltage. There may be some variation from the shop test Voltage. If Measured Voltage is +/- 2% re-test shop test voltage.

	Measured Voltage (VAC)	LED Indication	Verified	Comments
(H-08170) Electrical Room Unit Heater			✓	Visual
(H-08167) Natural Gas Room Unit Heater			✓	Visual
(XFMR-21620) Building Transformer			✓	Visual
(CP-21603) CCI Controller			✓	Visual
(H-08071) NG Process Heater	NA	NA	✓	EXHEAT Manufacturer's FAT docs

4.2 Section Sign-Off

Comments/Notes: <i>See CCK-4512109130-0735-K04-00001-000</i>	
Test Section is: (✓) Passed () Failed	Deficiencies:
Test Executed By (Initial & Date):	Test Witnessed By (Initial & Date): <i>JB 18 Nov 2015</i>

5. 120/208 VAC Power Distribution Start-up (LPN-21620)

Once inspection has been completed the 120/208 VAC Power Distribution Panel will be powered on and tested as outlined. Before initial power-up, each breaker should be placed into the "Off," position.

5.1 Individual Breaker Tests

Apply power to an individual feed breaker, and verify the appropriate voltage is being measured at the terminals of the corresponding cabinet or equipment. Turn breaker off and confirm that voltage has been removed.

Shop Test Voltage: 120.5. Measured voltage anticipated to be the same as the shop test voltage. There may be some variation from the shop test Voltage. If Measured Voltage is +/- 2% re-test shop test voltage.

CCT#	Description	Measured Voltage	Verified	Comments
	Interior Lights (Electrical Room)		✓	Visual
	UPS-21601		✓	Visual
	CP-21601 Panel Receptacle	120.4	✓	
	Receptacle (NG Heater Room)	120.4		Div 2, unable to test
	Emergency Lights		✓	Visual
	SF-08168 Supply Fan (NG Heater Room)		✓	Visual
	SF-08169 Supply Fan (NG Heater Room)		✓	Visual
	Interior Lights (NG Heater Room)		✓	Visual
	CP-21604 Contactor Panel		✓	Visual
	Exterior Lights		✓	Visual
	Receptacle (Electrical Room)	120.4	✓	
	CP-21601 Cabinet Fan	120.3	✓	
	SF-08174 Supply Fan (Electrical Room)		✓	Visual
	SF-08174 Supply Fan (Electrical Room)		✓	Visual
	SDV-08071A	N/A (24V)		
	TS-AAC CP-21602	120.7	✓	

5.2 Section Sign-Off

Comments/Notes:	
Test Section is: <input checked="" type="checkbox"/> Passed <input type="checkbox"/> Failed	Deficiencies: None
Test Executed By (Initial & Date): AR Nov 12/15	Test Witnessed By (Initial & Date): Jim RB 12 Nov 2015

6. Control Panel Power Distribution

Each panel should be completely de-energized prior to testing.

6.1 AC/DC Power Distribution Tests

Confirm AC power distribution wires comply with cabinet drawings. Measure with multimeter to verify no short circuits exist between line, neutral, and ground.

Confirm AC power distribution wires comply with cabinet drawings. Measure with multimeter to verify isolation between AC and DC power.

Panel	AC Power Distribution Voltage (120 VAC)	DC Power Distribution Voltage (24 VDC)	Verified	Comments
UPS-21601	✓	✓	✓	
CP-21601	✓	✓ 27.1V	✓	
CP-21602	✓	✓ 27.1V	✓	
CP-21603	✓	✓	✓	
CP-21604	✓	✓	✓	

6.2 Section Sign-Off

Comments/Notes:	
Test Section is: <input checked="" type="checkbox"/> Passed () Failed	Deficiencies: None
Test Executed By (Initial & Date): AR Nov 18 2015	Test Witnessed By (Initial & Date): JP 18 Nov 2015

7. Control Panel Start-up

Ensure all breakers and fuses are open, then apply power to the control panel to begin testing.

7.1 Control Panel Power Tests

On each cabinet, first verify incoming supply voltage.

For Internal Power Distribution testing, close each fuse one at a time, and confirm that power has been applied to the correct equipment.

Panel	Incoming Power Supply Voltage	Internal Power Distribution	Comments
CP-21601	✓	✓	
CP-21602	✓	✓	
CP-21603	✓	✓	
CP-21604	✓	✓	

7.2 Section Sign-Off

Comments/Notes:	
Test Section is: <input checked="" type="checkbox"/> Passed <input type="checkbox"/> Failed	Deficiencies: <i>None</i>
Test Executed By (Initial & Date): <i>AR Nov 18 2015</i>	Test Witnessed By (Initial & Date): <i>JTB - 18 Nov 2015</i>

8. PLC Start-Up

8.1 Procedure

The PLC Technician will connect to the PLC to perform the following steps

Procedure	Verified
1. Set Ethernet network addresses on all Ethernet modules	✓
2. Download PLC program to primary processor	✓
3. Verify that Transmit and Receive Indicator Lights are flashes on each Ethernet Port, confirming that cabling is in place, and communicating	✓
4. Place PLC processor into Run mode.	✓
5. Verify there are no Errors or Faults on the RSlogix 5000 software or Processor	✓
<i>Only PID loops throwing errors</i>	

8.2 Section Sign-Off

Comments/Notes:	
Test Section is: <input checked="" type="checkbox"/> Passed <input type="checkbox"/> Failed	Deficiencies: <i>PID tuning errors will be removed once tuned</i>
Test Executed By (Initial & Date): <i>[Signature]</i> Nov 12, 15	Test Witnessed By (Initial & Date): <i>[Signature]</i>

9. PLC Inspection

The PLC Technician will record the following information

9.1 PLC Information

Model	Part Number	Serial Number	Firmware Version	Software Version
1769-L33ER		60667223 ✓	21.11 21.04	21.11
Panelview Plus 1000		00BD20B2	7.0.55.13 3.100 ?	7.0 ? 3.100 ?
1769-IQ16			1.1 3.1	
1769-OWB8			2.1 3.1	
1769sc-IF4IH			3.1 ✓	
1769sc-OF4IH			3.1 3.2	

9.2 PLC Performance Test

PLC Scan Time: Avg _____ms Max _____ms

Panel View: OS: 02.36.0.0

ME Station: 8.0.10.12

	Total	Available	Percent Free
PLC Memory	1,048,576 ✓	1,034,608	98.6%
HMI Memory	440004	In use 33036	92.5%

Inputs/Outputs

	Total	Available	Percent
Discrete In	16	7	50%
Discrete Out	16	5	31%
Analog In	16	3	19%
Analog Out	4	3	75%

1 DI is not in PLC (Loss power to Beacons from MS)
✓
✓
✓

9.3 Section Sign-Off

Comments/Notes:	
Test Section is: <input checked="" type="checkbox"/> Passed <input type="checkbox"/> Failed	Deficiencies: Unused VOs shall be deleted from logic
Test Executed By (Initial & Date): SA Nov 12, 15	Test Witnessed By (Initial & Date): Buney

10. HMI Inspection

10.1 Procedure

The PanelView HMI will be powered up, and the following conditions verified.

Procedure	Verified
1. Start the PanelView	✓
2. Ensure that the overview display is used as Startup Display	✓
3. Verify HMI reads data from PLC, and write commands	✓
4. Verify all provided User Logins and Passwords have been configured	✓
5. Verify Navigation	✓
6. Verify Alarm Summary page displays all current and unacknowledged alarms	✓

User Accounts

Username	Default Password
Engineer	Eng1
Operator	Op1
PM (Super User)	PM1

— Admin
— Admin

10.2 Section Sign-Off

Comments/Notes: ESD valve popup to be customized. 3s mismatch close alarm	
Test Section is: <input checked="" type="checkbox"/> Passed <input type="checkbox"/> Failed	Deficiencies: Add labels to trends screen. No bypasses required Autoscaling for trends. Smoke V2T216-2A is missing
Test Executed By (Initial & Date): [Signature] Nov 12, 15	Test Witnessed By (Initial & Date): [Signature]

11. Discrete IO

11.1 Appendix Referenced

-Appendix A - Discrete IO List



11.2 Procedure

The Electrical Technician will change the state of each discrete input. The PLC Technician will confirm the signal is being received in accordance with Appendix A – Discrete IO List. This includes address, and normally open/normally closed status.

The PLC Technician will then change the state of each discrete output. The Electrical Technician will confirm the signal is being received in accordance with Appendix A – Discrete IO List.

Procedure	Verified
1. Verify each line in Appendix A - Discrete IO List – Discrete has been verified and signed off.	✓

11.3 Section Sign-Off

Comments/Notes:	
Test Section is: <input checked="" type="checkbox"/> Passed <input type="checkbox"/> Failed	Deficiencies: None
Test Executed By (Initial & Date):  Nov 12, 15	Test Witnessed By (Initial & Date):  12 Nov. 2015

12. Analog IO

12.1 Appendix Referenced

-Appendix B - Analog IO List

12.2 Procedure

The Electrical Technician will change the value of each Analog Input from 4mA, 12mA, and 20mA. The PLC Technician will verify the signal is being received in accordance with Appendix B - Analog IO List. This includes verifying that the correct value is being displayed on the HMI, as well as the Alarm and Trip setpoints

The PLC Technician will change the value of each Analog Output from 0%, 50%, and 100%. The Electrical Technician will verify that the signal is being received at the device in accordance with Appendix B - Analog IO List.

Procedure	Verified
1. Verify each line in Appendix B - Analog IO List has been verified and signed off.	✓

12.3 Section Sign-Off

Comments/Notes:	
Test Section is: <input checked="" type="checkbox"/> Passed <input type="checkbox"/> Failed	Deficiencies: None
Test Executed By (Initial & Date): SL Nov 18, 15	Test Witnessed By (Initial & Date): JPB 18 Nov 2015

13. Data Transfer Points

13.1 Appendix Referenced



-Appendix C - Data Transfer Points Summary

13.2 Procedure

Confirm devices communicating with the PLC can read/write to data points as specified in the Appendix C - Data Transfer Points Summary document.

Procedure	Verified
1. Verify each IO point listed in Appendix C - Data Transfer Points Summary has been verified and signed off	✓

13.3 Section Sign-Off

Comments/Notes:	
Test Section is: <input checked="" type="checkbox"/> Passed () Failed	Deficiencies: None
Test Executed By (Initial & Date):  Nov 13, 15	Test Witnessed By (Initial & Date):  13 Nov. 2015

14. Function Test - Discrete Alarms

14.1 Appendix Referenced

-Appendix D - Function List

14.2 Procedure

Verify that Discrete Alarm functions as specified in the Appendix D - Function List.

Procedure	Verified
1. Verify each function in Appendix D - Function List – Section 22.1 – Discrete Alarms has been verified and signed off	✓

14.3 Section Sign-Off

Comments/Notes:	
Test Section is: <input checked="" type="checkbox"/> Passed <input type="checkbox"/> Failed	Deficiencies: None
Test Executed By (Initial & Date): GH Nov 13, 15	Test Witnessed By (Initial & Date): JD 13 Nov 2015

15. Function Test - Transmitters

15.1 Appendix Referenced

-Appendix D - Function List

15.2 Procedure

Verify that each transmitter functions as specified in the Appendix D - Function List.

Procedure	Verified
1. Verify each function in Appendix D - Function List – Section 22.2 – Transmitters has been verified and signed off	✓

15.3 Section Sign-Off

Comments/Notes:	
Test Section is: <input checked="" type="checkbox"/> Passed <input type="checkbox"/> Failed	Deficiencies: <i>None</i>
Test Executed By (Initial & Date): <i>[Signature]</i> <i>18 Nov 15</i>	Test Witnessed By (Initial & Date): <i>[Signature]</i> <i>18 Nov 2015</i>


16. Function Test – SIL Units

16.1 Appendix Referenced

-Appendix D - Function List

16.2 Procedure

Verify that each SIL Unit functions as specified in the Appendix D - Function List.

Procedure	Verified
1. Verify each function in Appendix D - Function List – Section 22.3 – SIL Units has been verified and signed off	

16.2 Section Sign-Off

Comments/Notes:	
Test Section is: <input checked="" type="checkbox"/> Passed <input type="checkbox"/> Failed	Deficiencies: <i>None</i>
Test Executed By (Initial & Date): <i>SH Nov 13.</i>	Test Witnessed By (Initial & Date): <i>JD 13 Nov 2015</i>


17. Function Test – Control Loop

17.1 Appendix Referenced

-Appendix D - Function List

17.2 Procedure

Verify that each heater functions as specified in the Appendix D - Function List.

Procedure	Verified
1. Verify each function in Appendix D - Function List – Section 22.4 – Control Loops has been verified and signed off	

17.3 Section Sign-Off

Comments/Notes:	
Test Section is: <input checked="" type="checkbox"/> Passed <input type="checkbox"/> Failed	Deficiencies: <i>None</i>
Test Executed By (Initial & Date): <i>JL Nov 13</i>	Test Witnessed By (Initial & Date): <i>JL 13 Nov 2015</i>

18 Deficiency Log

See External Log

Item	Section Ref	Description	Responsible Party	Resolved	Verified	Date Corrected
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

19 Appendix A - Discrete IO List

19.1 Discrete Inputs

Tag	Address	Description	HMI Screen	NO/NC	Verified
XI21601C1	R2:1.0 ✓	UPS-21601D1 AC Failure	Overview	NO	✓
XI21601D1	R2:1.1 ✓	UPS-21601D1 DC Low	Overview	NO	✓
XIB21601A1	R2:1.2 ✓	CP-21601 Common Alarm	Overview	NO	✓
XIS21602A1	R2:1.3 ✓	CP-21602 Common Alarm	Overview	NC	✓
XI21601A1	R2:1.4 ✓	HVAC Common Alarm	Overview	NC	✓
HZS-21601A/2A/3A	R2:1.5 ✓	Emergency Shutdown	Overview	NC	✓
XI21603A1	R2:1.6 ✓	Heater Common Alarm	Overview	NC	✓
XI21602C1	R2:1.7 ✓	Smoke Detector Alarm	Overview	NC	✓
XI21602D1	R2:1.8 ✓	Loss Of Power To Beacons + Horn	Overview	NC	✓

19.2 Discrete Outputs

Tag	Address	Description	NO/NC	Verified
XV8071A1 ✓	R2:2.0 ✓	Common Alarm	NC	✓
XV8071B1 ✓	R2:2.1 ✓	Skid Trip Alarm	NC	✓
XV21601A1	R2:2.2 ✓	HVAC Common Alarm	NC	✓
XV21601B1	R2:2.3 ✓	Building Temperature Alarm	NC	✓
XV21602A1	R2:2.4 ✓	LEL Common Alarm	NC	✓
XV21602B1	R2:2.5 ✓	Flame Common Alarm	NC	✓
SDV08071A	R2:2.6 ✓	Emergency Valve Open	NC	✓
XY21602A1	R2:2.7 ✓	Beacon/Horn Test	NO	✓
XY21602A2	R2:3.0 ✓	Silence Horn	NO	✓
XY21602A3	R2:3.1 ✓	Smoke Detector Reset	NC	✓
XY21602A4	R2:3.2 ✓	ESD Trip Reset	NC	✓

20 Appendix B - Analog IO List

20.1 Analog Inputs

Tag	Address	Description	HMI Screen	Eng Units	Eng Max	Eng Min	HH SP	H SP	SP	L SP	LL SP	Signal Verified
TT08071A1	R1:4.0	Outlet Gas Temperature	Process	deg C	100	-50		60	25	18		✓
FT08071A1	R1:4.1	Outlet Gas Flow	Process	Sm ³ /d	2000	0						✓
ZT08070A	R1:4.2	Shutdown Valve Position	Overview	%	100	0						✓
TT21601A	R1:4.3	Building Temperature	Process	deg C	50	-50				0		✓
TZT08071A	R1:5.0	Natural Gas Heater Temperature Transmitter	Process	deg C	100	-50	72.6					✓
TZT08071B	R1:5.1	Gas Outlet Temp. Transmitter	Process	deg C	100	-50					-10	✓
PZT08071A	R1:5.2	Heater H-08071 Gas Outlet Pressure	Process	Kpag	12,000	0	8270					✓
PZT08071B	R1:5.3	1st Stage Reduction Gas Pressure	Pressure Control Valves	Kpag	5515.8	0	3760					✓
PZT08071C	R1:6.0	2nd Stage Reduction Gas Pressure	Pressure Control Valves	Kpag	5515.8	0	1127					✓
PZT08071D	R1:6.1	Stream 2 PIT (ignore) 3rd Stage	Pressure Control Valves	Kpag	1034.2	0	563					✓
UZT21601A	R1:6.2	Natural Gas Heater Room Combustible Gas Detection	Overview	%	100	0	40	20				✓
YZT21601A	R1:6.3	Natural Gas Heater Room Fire Detection	Overview	mA	20	4	16					✓
UZT21601B	R1:7.0	Natural Gas Heater Room Combustible Gas Detection	Overview	%	100	0	40	20				✓

Unable to simulate flow

20.2 Analog Outputs

Tag	Address	Description	HMI Screen	Eng Units	4mA	12mA	20mA	Verified
H08071	R1:8.1	Natural Gas Heater	Process	%				

Unable to test heater due to no flow of process gas

21 Appendix C - Data Transfer Points Summary

TAG	DESCRIPTION	AREA_NAME	Min Eng	Max Eng	Units	Modbus/Ethernet I/P address	COMMENTS	IP ADDRESS	SUBNET MASK	Verified
TZT-08071A	Natural Gas Heater Temp	CMT	-50	100	deg C	HMI_INPUT_REAL[0]		10.32.254.83	255.255.255.192	✓
PZT-08071A	Heater H-08071 Gas Outlet Pressure	CMT	0	12000	kPa	HMI_INPUT_REAL[1]		10.32.254.83	255.255.255.192	✓
PZT-08071B	Heater H-08071 Gas Outlet Pressure	CMT	0	5515.8	kPa	HMI_INPUT_REAL[2]		10.32.254.83	255.255.255.192	✓
PZT-08071C	Heater H-08071 Gas Outlet Pressure	CMT	0	5515.8	kPa	HMI_INPUT_REAL[3]		10.32.254.83	255.255.255.192	✓
PZT-08071D	Heater H-08071 Gas Outlet Pressure	CMT	0	1034.2	kPa	HMI_INPUT_REAL[4]		10.32.254.83	255.255.255.192	✓
TZT-08071B	Gas Outlet Temp	CMT	-50	100	deg C	HMI_INPUT_REAL[5]		10.32.254.83	255.255.255.192	✓
FT-08071A1	Outlet Gas Flow	CMT	0	2000	Sm3/d	HMI_INPUT_REAL[6]		10.32.254.83	255.255.255.192	✓
TT-08071A1	Gas Outlet Temp	CMT	-50	100	deg C	HMI_INPUT_REAL[7]		10.32.254.83	255.255.255.192	✓
ZT-08071A	Shutdown Valve Position	CMT	0	100	%	HMI_INPUT_REAL[8]		10.32.254.83	255.255.255.192	✓
TT-21601A	SHELTER TEMPERATURE	CMT	-50	50	deg C	HMI_INPUT_REAL[9]		10.32.254.83	255.255.255.192	✓
XZY-08071A XIS-21601A1	SIL PANEL TRIP	CMT				HMI_INPUT_BOOL[0].0	Common SIL Panel Trip, no individual inputs	10.32.254.83	255.255.255.192	✓
HZS-21601/2A	ESD STRING TRIP	CMT				HMI_INPUT_BOOL[0].1	Common ESD Trip, no individual inputs	10.32.254.83	255.255.255.192	✓
YZT-21601A	Natural Gas Heater Room FLAME	CMT				HMI_INPUT_BOOL[0].2		10.32.254.83	255.255.255.192	✓
UZT-21601A	Natural Gas Heater Room LEL	CMT				HMI_INPUT_BOOL[0].3		10.32.254.83	255.255.255.192	✓
UZT-21601B	Natural Gas Heater Room LEL	CMT				HMI_INPUT_BOOL[0].4		10.32.254.83	255.255.255.192	✓

22 Appendix D - Function List

22.1 Discrete Alarms				
	Cause	Tag	Effect	Effect Verified
22.1.1	UPS AC Failure	XI-21601C1	Notify (Alarm) to HMI	(✓)
22.1.2	UPS DC Low	XI-21601D1	Notify (Alarm) to HMI	✓
22.1.3	Common Alarm Input	XI-B-21601A1	Notify (Alarm) to HMI	✓
			Open Output R1:02:00 Common Alarm	✓
22.1.4	Common Alarm Input	XI-S-21602A1	Notify (Alarm) to HMI	✓
			Open Output R1:02:00 Common Alarm	✓
22.1.5	HVAC Alarm	XI-21601A1	Notify (Alarm) to HMI	✓
			Open Output R1:02:02 HVAC Alarm	✓
22.1.6	Skid ESD	ESD	Notify (Alarm) to HMI	✓
			Open Output R1:02:01 Skid Trip	✓
			Close SDV-08071A	✓
22.2 Transmitters				
22.2.1 TT-08071A1				
	Cause	Tag	Effect	Effect Verified
22.2.1.1	Temperature Transmitter Fail	TAX-08071A1	Notify (Alarm) to HMI	(✓)
22.2.1.2	Temperature Low Alarm	TAL-08071A1	Notify (Alarm) to HMI	✓
22.2.1.3	Temperature High Alarm	TAH-08071A1	Notify (Alarm) to HMI	✓
22.2.2 FT-08071A1				
	Cause	Tag	Effect	Effect Verified
22.2.2.2	Flow Totalizer	FQIT-08071A1	Display on HMI	(✓)
	Flow Transmitter Fail			✓
22.2.3 PZT-08071A				
	Cause	Tag	Effect	Effect Verified
22.2.3.1	Pressure Transmitter Fail	PAX-08071A1	Notify (Alarm) to HMI	(✓)
22.2.3.2	Pressure High High Alarm	PZH-08071A1	Notify (Alarm) to HMI	✓

Signal notifies on HMI. Unable to simulate DC Low other than forced signal

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22.2.4 PZT-08071B				
	Cause	Tag	Effect	Effect Verified (✓)
22.2.4.1	Pressure Transmitter Fail	PAX-08071B1	Notify (Alarm) to HMI	✓
22.2.4.2	Pressure High High Alarm	PZH-08071B1	Notify (Alarm) to HMI	✓
22.2.5 PZT-08071C				
	Cause	Tag	Effect	Effect Verified (✓)
22.2.5.1	Pressure Transmitter Fail	PAX-08071C1	Notify (Alarm) to HMI	✓
22.2.5.2	Pressure High High Alarm	PZH-08071C1	Notify (Alarm) to HMI	✓
22.2.6 PZT-08071D				
	Cause	Tag	Effect	Effect Verified (✓)
22.2.6.1	Pressure Transmitter Fail	PAX-08071D1	Notify (Alarm) to HMI	✓
22.2.6.2	Pressure High High Alarm	PZH-08071D1	Notify (Alarm) to HMI	✓
22.2.7 ZT-08071A				
	Cause	Tag	Effect	Effect Verified (✓)
22.2.7.1	Shutdown Valve Transmitter Fail	ZAX-08071A	Notify (Alarm) to HMI	✓
22.2.7.2	Shutdown Valve Closed Alarm	ZALL-08071A	Notify (Alarm) to HMI	✓
			Move TIC-08071A1 to Manual	✓
			Set TIC-08071A1 Manual Setpoint to 0 <i>Output</i>	✓
22.2.8 TT-21601A				
	Cause	Tag	Effect	Effect Verified (✓)
22.2.8.1	Temperature Transmitter Fail	TAX-21601A	Notify (Alarm) to HMI	✓
22.2.8.2	Temperature Low Alarm	TAL-21601A	Notify (Alarm) to HMI	✓
			Open Output R1:02:02 Building Temperature Alarm	✓
22.2.9 TZT-08071A				
	Cause	Tag	Effect	Effect Verified (✓)
22.2.9.1	Temperature Transmitter Fail	TZX-08071A	Notify (Alarm) to HMI	✓

22.2.9.2	Temperature High Alarm	TZH-08071A	Notify (Alarm) to HMI	✓
22.2.10	TZT-08071B			
	Cause	Tag	Effect	Effect Verified (✓)
22.2.10.1	Temperature Transmitter Fail	TZX-08071B	Notify (Alarm) to HMI	✓
22.2.10.2	Temperature Low Alarm	TZL-08071B	Notify (Alarm) to HMI	✓
22.2.11	UZT-21601A			
	Cause	Tag	Effect	Effect Verified (✓)
22.2.11.1	LEL Transmitter Fail	UZX-21601A	Notify (Alarm) to HMI	✓
22.2.11.2	LEL High Alarm	UZH-21601A	Notify (Alarm) to HMI	✓
			Open Output R1:02:03 LEL Alarm	✓
22.2.12	UZT-21601B			
	Cause	Tag	Effect	Effect Verified (✓)
22.2.12.1	LEL Transmitter Fail	UZX-21601B	Notify (Alarm) to HMI	✓
22.2.12.2	LEL High Alarm	UZH-21601B	Notify (Alarm) to HMI	✓
			Open Output R1:02:03 LEL Alarm	✓
22.2.13	YZT-21601A			
	Cause	Tag	Effect	Effect Verified (✓)
22.2.13.1	Fire Transmitter Fail	YZX-21601A	Notify (Alarm) to HMI + Trip Skid	✓
22.2.13.2	Fire High Alarm	YZH-21601A	Notify (Alarm) to HMI + Trip Skid	✓
			Open Output R1:02:04 Fire Alarm	✓
22.3	SIL Units			
	Cause	Tag	Effect	Effect Verified (✓)
22.3.1	Gas Temperature High High	TZH08071A	Shut Down Inlet ESD Valve	✓
			Shut Down Heater H-08071	✓
			Activate R1:01:03 Common Alarm R1:02:01	✓
22.3.2	Gas Temperature Low Low	TZL08071B	Shut Down Inlet ESD Valve	✓
			Shut Down Heater H-08071	✓

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			Activate R1-01-03 Common Alarm R1:02:01	✓
22.3.3	Gas Pressure High High	PZH08071A	Shut Down Inlet ESD Valve	✓
			Shut Down Heater H-08071	✓
			Activate R1-01-03 Common Alarm R1:02:01	✓
22.3.4	Gas Pressure High High	PZH08071B	Shut Down Inlet ESD Valve	✓
			Shut Down Heater H-08071	✓
			Activate R1-01-03 Common Alarm R1:02:01	✓
22.3.5	Gas Pressure High High	PZH08071C	Shut Down Inlet ESD Valve	✓
			Shut Down Heater H-08071	✓
			Activate R1-01-03 Common Alarm R1:02:01	✓
22.3.6	Gas Pressure High High	PZH08071D	Shut Down Inlet ESD Valve	✓
			Shut Down Heater H-08071	✓
			Activate R1-01-03 Common Alarm R1:02:01	✓
22.3.7	LEL 2oo2 Alarm	UZH21601A	Shut Down Inlet ESD Valve	✓
			Shut Down Heater H-08071	✓
			Activate R1-01-03 Common Alarm R1:02:01	✓
			Activate Fan C-08174	✓
22.3.8	Fire High High	YZH21601A	Shut Down Inlet ESD Valve	✓
			Shut Down Heater H-08071	✓
			Activate R1-01-03 Common Alarm R1:02:01	✓

22.4	Control Loops			
22.4.1	TIC-08071A1			
	Cause	Tag	Effect	Effect Verified (✓)
22.4.1.1	Control Loop AutoMan	TIC-08071A1	Prove Control Loop AutoMan Operation	✓
22.4.1.2	Control Loop In Auto		Prove Control Loop Auto Operation	✓
22.4.1.3	Control Loop In Manual		Prove Control Loop Manual Operation	✓
22.4.1.4	Control Loop Control	H-08071A	Output Matches Control Loop Command	✓

Material Test Certificates

Skid MTRs

Customer Name

Customer PO#

Shipper No

Heat Number

ROLLFAB INDUSTRIES LTD.

14 003814

741930

59057252



U.S.-MIL. MIDLOTHIAN
300 WARD ROAD
MIDLOTHIAN, TX 76065
USA

CERTIFIED MATERIAL TEST REPORT

CUSTOMER PURCHASE ORDER NUMBER CY:969249	BILL OF LADING 1327-000080095	DATE 10/31/2013	CUSTOMER SHIP TO VARSTEEL LTD 55 DUFFERIN PL. SE CALGARY, AB T2C 4W3 Canada	CUSTOMER BIL. TO VARSTEEL LTD 220 4TH ST S LETHBRIDGE, AB T1J 4J7 Canada	GRADE 992572-50	SHAPE / SIZE Wide Flange Beam / 4 X 13# / 100 X 19.3	LENGTH 40'00"	WEIGHT 23,400 LB	HEAT / BATCH 59057252/02
CUSTOMER MATERIAL N°			SPECIFICATION / DATE OF REVISION A572/A572M-07 A992/A992M-11 ASTM A6-66/A6M-11						

CHEMICAL COMPOSITION																									
C	0.08	Mn	0.90	P	0.012	S	0.023	Si	0.23	Co	0.25	N	0.08	Cr	0.18	Mo	0.032	Sb	0.008	V	0.002	Nb	0.012	NI	0.004

CHEMICAL COMPOSITION Chem A6									
0.3									

MECHANICAL PROPERTIES									
YS	KSI	UTS	KSI	YS	MPa	UTS	MPa	G.L.	G.L.
572	71.6	72.0	71.6	398	496	494	8,000	inch	mm
57.7				39.4			8,000		200.0

MECHANICAL PROPERTIES									
Elong.	Y/Tell								
21.20	0.801								
21.20	0.799								

COMMENTS / NOTES

The above figures are certified chemical and physical test records as contained in the permanent records of company. This material, including the billers, was melted and manufactured in the USA. CMTR complies with EN 10204 3.1.

Mackay
BHASKAR VALAMANGILI
QUALITY DIRECTOR

Tom Harrington
TOM HARRINGTON
QUALITY ASSURANCE MGR

Customer Name

ROLLFAB INDUSTRIES LTD.

Customer PO#

14 003814

Shipper No

741930

Heat Number

59057252



US-ML-MIDLOTHIAN
300 WARD ROAD
MIDLOTHIAN, TX 76065
USA

CUSTOMER SHIP TO VARSTEEL LTD 2191 ALBERT ST N REGINA, SK S4P 3E1 Canada	CUSTOMER BILL TO VARSTEEL LTD 230 4TH ST S LETHBRIDGE, AB T1J 4J7 Canada
SALES ORDER 572992-000090	CUSTOMER MATERIAL N°

CUSTOMER PURCHASE ORDER NUMBER RE:968787	BILL OF LADING 1327-000080326	DATE 11/01/2013
---	----------------------------------	--------------------

GRADE 992.572.50	SHAPE / SIZE Wide Flange Beam / 4 X 13# / 100 X 19.3
LENGTH 40'00"	WEIGHT 15,600 LB
HEAT BATCH 5905725202	
SPECIFICATION / DATE of REVISION A572.A572M-07 A992.A992M-11 ASTM A6.A6M-11	

CHEMICAL COMPOSITION																																						
C	%	0.08	Mn	%	0.90	P	%	0.012	S	%	0.023	Si	%	0.23	Cu	%	0.25	Ni	%	0.08	Cr	%	0.18	Mo	%	0.032	Sb	%	0.008	V	%	0.002	Nb	%	0.012	Al	%	0.004

CHEMICAL COMPOSITION											
CE:0.06											
0.3											

MECHANICAL PROPERTIES																				
YS	KSI	71.6	UTS	KSI	72.0	YS	MPa	398	UTS	MPa	494	G.L	Inch	8.900	G.L	mm	200.6	G.L	mm	200.6
57.2			71.6			398			494			8.900			200.6			200.6		

MECHANICAL PROPERTIES											
Flange	%	21.20	Y-Ten	%	0.801	Flange	%	21.20	Y-Ten	%	0.799

COMMENTS / NOTES

CERTIFIED MATERIAL TEST REPORT

The above figures are certified chemical and physical test records as contained in the permanent records of company. This material, including the bill(s), was melted and manufactured in the USA. CMTR complies with EN 10204 3.1.

Mackay
BHASKAR VALAMANGI HILL
QUALITY DIRECTOR

Don Stewart
TOM HARRINGTON
QUALITY ASSURANCE MGR

Customer Name

Customer PO#

Shipper No

Heat Number

ROLLFAB INDUSTRIES LTD.

14 003814

741930

59057252



CERTIFIED MATERIAL TEST REPORT

US-ML-MIDLOTHIAN
300 WARD ROAD
MIDLOTHIAN, TX 76065
USA

CUSTOMER SHIP TO VARSTEEL LTD 2607 WENTZ AVE SASKATOON, SK S7N 3J1 Canada	CUSTOMER BILL TO VARSTEEL LTD 220 4TH ST S LETHBRIDGE, AB T1J 4J7 Canada	GRADE 992.S72.50	SHAPE / SIZE Wide Flange Beam / 4 X 13# / 100 X 19.3
SALES ORDER 587502-000030	CUSTOMER MATERIAL No	LENGTH 40'00"	WEIGHT 7,800 LB
CUSTOMER PURCHASE ORDER NUMBER ST-969126	BILL OF LADING 1327-0000080294	DATE 11/01/2013	HEAT / BATCH 59057252/02
		SPECIFICATION / DATE OF REVISION A572.A572M-07 A992.A992M-11 ASTM A6.A6M-11	

CHEMICAL COMPOSITION											
C	%	Mn	%	P	%	S	%	Si	%	Cr	%
0.08		0.90		0.012		0.023		0.23		0.25	
CHEMICAL COMPOSITION CE ₉₉ A6 0.3											

MECHANICAL PROPERTIES						MECHANICAL PROPERTIES					
YS	KSI	UTS	YS	MPa	UTS	YS	MPa	UTS	MPa	G/L	G/L
57.2		71.6		398		496		8,000		200.0	200.0
57.2		72.0		394		494		8,000			

MECHANICAL PROPERTIES		Y-Tenil	
Elong	%	0.801	
	%	0.799	

COMMENTS / NOTES

The above figures are certified chemical and physical test records as contained in the permanent records of company. This material, including the billets, was melted and manufactured in the USA. CMTI complies with EN 10204 3.1.

Maskey

BHASKAR VAI AMANG BHIL
QUALITY DIRECTOR

Tom Harrington

TOM HARRINGTON
QUALITY ASSURANCE MGR

Customer Name

Customer PO#

Shipper No

Heat Number

ROLLFAB INDUSTRIES LTD.

14 003814

741930

P73685



MILL TEST CERTIFICATE

CHJA3442 STAR ATLANTIC

Order No. : 3003575715
PO No. : LSC201406006
Commodity : CHANNEL
Specification : ASTM A572-50/CSA 300W/350W

Supplier : DONGKUK INTERNATIONAL INC
Customer : SALZGITTER
Certificate No. : PSS-2-140729-017-001
Date of Issue : Jul 29, 2014

Dimension	Product No	Quant Qty B/D PCS	Weight kg	Heat No.	Tensile Test		Chemical Composition(%)											Remarks					
					Y	R	C	Si	Mn	P	S	Cr	Ni	Cu	Mo	Nb	V						
C 6 x 8.2 401	P736830-008.010.011	3	4.470	P73683	Y	423	553	22	L	0.15	0.21	1.26	0.021	0.012	0.082	0.059	0.248	0.013	0	0	0.023		
		90																					
	Sub Total (20)	3	13.410																				
C 6 x 8.2 401	P736830-013.014.015	3	4.470	P73683	Y	418	547	23	L	0.15	0.21	1.26	0.021	0.012	0.082	0.059	0.249	0.013	0	0	0.023		
		90																					
	Sub Total (20)	3	13.410																				
C 6 x 8.2 501	P736850-016.017.018.019. 020.021	6	4.464	P73685	Y	422	560	23	L	0.15	0.21	1.28	0.024	0.015	0.072	0.104	0.32	0.012	0	0	0.022		
		144																					
	Sub Total (30)	6	26.784																				
C 6 x 10.5 401	P736740-074.075.076.077	4	4.584	P73674	Y	375	527	27	L	0.15	0.25	1.27	0.026	0.009	0.096	0.065	0.263	0.014	0.031	0.022			
		96																					
	Sub Total (50)	4	18.336																				

We hereby certify that this material has been made and satisfactorily tested in accordance with above specification requirement called for by the above order. If the amount of C, Si, Cu, Mo, Ni or S is blank, the heat analysis for that element is less than 0.02% and/or of Nb, V is blank, it is less than 0.008%. * Inspector documents: According to EN 10204 Type 3.1

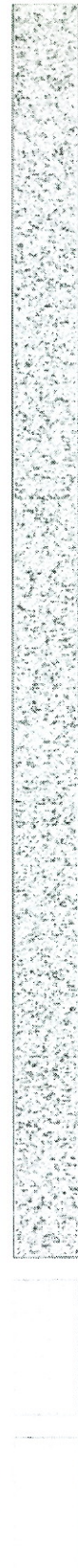
When using the ordered product for other uses, rather than the above specification use, product damage and safety accidents may be caused.

Specimen No. : a-Tension
Position : 1-Top, 2-Middle, 3-Bottom
Direction : L-Longitudinal, P-Product Analysis
Sub(Side Size, Real Value, mm) : Blank-Full Size, 1-7.5-10, 2-5.0-10
G(L Gauge Length, mm) : 1-200, 2-100, 3-80, 4-70, 5-50, 6-5 BSA
7-50, 8-40, 9-30
T(S) : A- Total(Soluble) A, *Tr: Trace
NRI Result : G-No Break, B-Break
TTF(Through Thickness Position) : 1-Surface, 2-1/4T, 3-1/2T

원본인증 방법 : 동국제강 물품이지점 (www.dongkuk.co.kr) → e비즈니스 물품(물품이지점) → 검사정명서 원본검출물품 → 정보입력후 검색

Inspector to : _____ Surveyor to : _____
Chief of Quality Control Team : *Y/Bm*

TEL: Cheongjeongdaero 153, Songjeong-ro, Daejeong-myeon, Nam-gu, Pohang-si, Republic of Korea. TEL: 054-271-5882, Res. TEL: 054-271-5481 Page: 1/5



Customer Name

ROLLFAB INDUSTRIES LTD.

Customer PO#

14-3852

Shipper No

744462

Heat Number

59062875



US-ML-MIDLOTHIAN
300 WARD ROAD
MIDLOTHIAN, TX 76065
USA

CUSTOMER SHIP TO		CUSTOMER BILL TO		GRADE	SHAPE / SIZE	WEIGHT	HEAT / BATCH
VARSTEEL LTD 55 DUFFERIN PL SE CALGARY, AB T2C 4W3 Canada		VARSTEEL LTD 220 4TH ST S LETHBRIDGE, AB T1J 4J7 Canada		A992/A572-50	Wide Flange Beam / 10 X 22# / 250 X 32.7	6,600 LB	59062875/02
SALES ORDER 1334033/000030		CUSTOMER MATERIAL #		SPECIFICATION / DATE OF REVISION			
BILL OF LADING 1327-0000127941		DATE 18/07/2014		A572/A572M-07 A992/A992M-11 ASTM A6/A6M-11			

CERTIFIED MATERIAL TEST REPORT

CHEMICAL COMPOSITION							
C	Mn	P	S	Si	Co	Ni	Cr
%	%	%	%	%	%	%	%
0.09	0.83	0.010	0.024	0.23	0.26	0.09	0.12
CHEMICAL COMPOSITION							
CE: P: A6							
0.28							

MECHANICAL PROPERTIES			
YS	UTS	YS	UTS
KSI	KSI	MPa	MPa
54.7	71.1	377	490
56.2	72.5	388	500

MECHANICAL PROPERTIES			
UTS	Elong.	V/T: rati	G/L
mm	%	%	Inch
200.0	24.10	0.769	8.000
200.0	24.30	0.775	8.000

COMMENTS: NOTES

The above figures are certified chemical and physical test records as contained in the permanent records of company. We certify that these data are correct and in compliance with specified requirements. This material, including the billets, was melted and manufactured in the USA. CMTR complies with EN 10204 3.1.

Maskery

BRASCAK VALMANN/III
QUALITY DIRECTOR

Don Idonif

TON HARRINGTON
QUALITY ASSURANCE MGR

ROLLFAB INDUSTRIES LTD.

14-3852

744462

59059823



US-ML-MIDLOTHIAN
300 WARD ROAD
MIDLOTHIAN, TX 76065
USA

CUSTOMER SHIP TO
VARSTEEL LTD
55 DEFFERIN PL SE
CALGARY, AB T2C 4W3
Canada

CUSTOMER BILL TO
VARSTEEL LTD
220 4TH ST S
LETHBRIDGE, AB T1J 4J7
Canada

GRADE
992572-50

SHAPE / SIZE
Wide Flange Beam / 10 X 22# / 250 X 327

WEIGHT
9,680 LB

HEAT / BATCH
5905982304

CUSTOMER MATERIAL N°
8722137000030

SPECIFICATION / DATE OF REVISION
A572/A575M-07
A992/A993M-11
ASTM A6/A6M-11

CUSTOMER PURCHASE ORDER NUMBER
CY-975875

BILL OF LADING
1327-0800102854

DATE
04/22/2014

CHEMICAL COMPOSITION		C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Sn	V	Nb	Al
		%	%	%	%	%	%	%	%	%	%	%	%	%
		0.08	0.91	0.012	0.023	0.22	0.30	0.13	0.16	0.031	0.007	0.002	0.012	0.003

CHEMICAL COMPOSITION		CE	CA
		%	%
		0.3	

MECHANICAL PROPERTIES		YS	UTS	EL	ELONG	Y/T RATIO
		ksi	ksi	%	%	%
		57.4	73.2	39.6	72.6	0.784
		56.8	72.6	39.2	500	0.782

MECHANICAL PROPERTIES		ELONG	Y/T RATIO
		%	%
		28.60	0.784
		25.70	0.782

COMMENTS / NOTES

CERTIFIED MATERIAL TEST REPORT

The above figures are certified chemical and physical test records as contained in the permanent records of company. This material, including the billers, was melted and manufactured in the USA. CMTR complies with EN 10204 3.1.

Maskey

BIHASKAR VALAMANI BHIL
QUALITY DIRECTOR

Tom Harrington

TOM HARRINGTON
QUALITY ASSURANCE MGR

Customer Name

ROLLFAB INDUSTRIES LTD.

Customer PO#

13-1339

Shipper No

589026

Heat Number

59057257



US-MIL-MIDLOTHIAN
300 WARD ROAD
MIDLOTHIAN, TX 76065
USA

CUSTOMER SHIP TO VARSTEEL LTD 55 DUFFERIN PL SE CALGARY, AB T2C 4W3 Canada	CUSTOMER BILL TO VARSTEEL LTD 220 4TH ST S LETHBRIDGE, AB T1J 4J7 Canada	GRADE 992/572-50	SHAPE / SIZE Wide Flange Beam / 10 X 33# / 250 X 49.1
SALES ORDER 542744/000040	CUSTOMER MATERIAL #	LENGTH 50'00"	WEIGHT 14,850 LB
CUSTOMER PURCHASE ORDER NUMBER CY-968081	BILL OF LADING 1327-0000076531	DATE 10/08/2013	SPECIFICATION / DATE OF REVISION A572/A572M-07 A992/A992M-11 ASTM A660M-11
		HEAT / BATCH 59057257/05	

CHEMICAL COMPOSITION	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Sb	V	Nb	Al
%	0.10	0.89	0.010	0.011	0.27	0.34	0.11	0.16	0.041	0.012	0.003	0.021	0.004

CHEMICAL COMPOSITION	CEq/A6	%	0.3
MECHANICAL PROPERTIES	YS	UTS	UTS
	KSI	KSI	MPa
	56.3	74.5	514
	57.3	73.6	308

MECHANICAL PROPERTIES	Elong %	Y/T mft %
	25.70	0.765
	25.50	0.769

COMMENTS / NOTES

The above figures are certified chemical and physical test records as contained in the permanent records of company. This material, including the billets, was melted and manufactured in the USA. CMTR complies with EN 10204 3.1.

Shackery
BHASKAR YALAMANCHILI
QUALITY DIRECTOR

Tom Harrington
TOM HARRINGTON
QUALITY ASSURANCE MGR.

Spool MTRs

Heat No	Description
A1253	2" bleed ring adjustment NP 338716BLEEDRING2 338716
A1253	2" bleed ring
58962	2x1/2 Olet
59443	2 90 Ell
59530	1 90 Ell
59653	1 90 Ell
59783	2x3/4 Olet
74347	1/2 Flg RFSW
330592	3/4 Pipe
569936	1 Pipe incorrect 569934
569936	1" Pipe
1424374	2 Nipple
4677159	3/4 Flg RFSW
4803135	2.5 x 1/2 hub flange incorrect 4806135
10_33034	1/2 Flg RFSW
10_72711	1.5 Flg RFSW
1089V2	1/2 Flg RFSW incorrect 1089V4
1121V3	1/2 Flg RFSW
1126277V	2" Pipe
1126526V	2" Pipe
12_103914	3/4 Nipple
12_1703	3/4 Flg RFSW
12_34232	3 Hub Flg RF
12_35059	2 Flg RFWN
12_35060	2 Flg Blind RF
12_70354	1/2 Flg RFSW
12G_11814	2x1.5 Red Tee
13_30305	2 Flg RFWN
13_38954	3 Flg RFWN
13_39017	1.5 Flg RFWN
13_76390	3 Flg Blind RF
13_77263	1 Flg RFSW
13_77325	2 Flg RFWN
13_78156	2 Flg RFWN
14_30992	1.5 Flg RFWN
14_31364	2 Flg Blind RF
14_33854	2 Flg RFWN
14_70198	3/4 Flg RFSW
14_70420	2" Flg RFWN
14_71409	1 Flg RFSW
14H01013	90 Ell
14H5594	2x2 Tee
1640V3	1" 150# Flg SW
18Z	
1J2564	2x1.5 Red Tee
23Z	3/4 90 Ell

630SS	3/4 Flg RFSW
719SS	3/4 Flg RFSW
7Z	1 90 Ell
B20A4	1/2 Flg RFSW
B20V4	1 Flg RFSW
3E7959	2 Weld Cap
H00125	1 Nipple
H00204	2x1.5 Swage Conc
H00934	2x1 Swage Conc
H2327	2x1/2 Swage Conc
K2848	1x1/2 Swage Conc
P455	3/4 Manifold
RSF53	3x2 Red Conc
T3	1/2 x 1/2 Tee SW
TL10009352	3/4 Flg RFSW
TL10010271	1 Flg RFSW
TM7	1x1 Tee also 1x3/4 & 1x1/2 Tees
TP3	1x1 Tee
UL7	1 Check Valve
UL7	1 Gate Valve
UL8	3/4" Gate Valve
UL8	1/2 Gate Valve
UP9	1 Ball Valve
UR9	1/2 Ball Valve
W11306329	1/2 Pipe
Y046	1/2 90 Ell
Y046	1/2 90 Ell incorrect Y048
YT13523	3/4 Pipe adjustments
Z71	3/4 90 Ell

PURCHASER : TRANS AM
 STANDARD : ASTM A420 WPL6-07
 ASME SA420 WPL6-04



INSPECTION CERTIFICATE
RIGID INDUSTRIES CO., LTD.

8 MEL-CHUNG RD. NIAO-SONG,
 KAHSIUNG HSIEN, 83301 TAIWAN
 TEL: 886-77310527-8
 FAX: 886-77315887

ORDER NO: 7004702/C11486
 P.I. NO: 1H02-2
 CERTIFI. NO: 632

DATE: 2011 - 12 - 19
 PURCHASER : TRANS AM
 STANDARD : ASTM A420 WPL6-07
 ASME SA420 WPL6-04
 MATERIALS : ASTM A333-6 (SEAMLESS PIPE)
 INSP. SPEC. : ASME B16.9 - 03
 ACCORDING TO EN10204/DIN50049/3.1

ITEM NO.	PRODUCT & SIZE	QUANTITY PCS	MFG NO.	VISUAL & DIMENSIONAL INSPECTION	HARDNESS MAX 197 HB	HEAT TREATMENT (NOTE)	MAGNETIC PARTICLE EXAMINATION	IMPACT TEST (J)								
									C	Si	Mn	P	S	Cu	Ni	Cr
2	RED-TEE 2X1.12"WPL6 XH		1J2564	GOOD	138 — 153	N	GOOD	10 X 2.5 X 2V AT -45°C 32.0 31.6 30.4 31.33								
2	JDL1064	30	15	60	35	8	40	30	12	5	20	45.8	63.6	40	50	32

(NOTE): A: HOT FORMED WITH FINAL TEMPERATURE BETWEEN 620°C-980°C, AIR COOLING.
 N: NORMALIZING AT TEMPERATURE 880°C X 0.5 HR, AIR COOLING.
 NACE MR-01-75-03/ISO 15156.2 & NACE MR 0103-03 : SATISFACTORY
 WE HEREBY CERTIFY THAT THE PRODUCT DESCRIBED HEREIN HAS BEEN MANUFACTURED IN ACCORDANCE WITH THE SPECIFICATIONS CONCERNED AND ALSO WITH THE PURCHASER'S REQUIREMENTS AND THAT THE TEST RESULTS SHOWN HEREIN ARE CORRECT.

Qu E Pan
 MANAGER OF Q.A. DEPT.

2" XH BW CAP A420-WPL6

National Process PO# 3846673 Item# 6
 Heat Number: 3E7959
 Trans Am Piping Products Ltd. ; Rev'd By: SB
 Shipment/Seq #: 14 - 1360



INSPECTION CERTIFICATE

RIGID INDUSTRIES CO., LTD.

PURCHASER : SEYBOLD INTL CORP.
 STANDARD : ASTM A420 WPL6-13
 ASME SA420 WPL6-04
 CSA Z245.11-13 Gr.241 CAT II Sour Service
 MATERIALS : ASTM A516 GR.70
 INSP. SPEC. : ASME B16.9 -12

8. MEI-CHUNG RD. NIAO-SONG,
 KAOHSIUNG 83301, TAIWAN
 TEL: 886-77310527-8
 FAX: 886-77315887

DATE: 2014-05-27

ORDER NO: 7008556/CI-14-307

P.I. NO: 14E01-1

CERTIFI. NO: 14E11-1

ACCORDING TO EN10204/DIN50049/3.1

ITEM NO.	PRODUCT & SIZE	QUANTITY PCS	MFG NO.	VISUAL & DIMENSIONAL INSPECTION	HARDNESS MAX 197 HB	HEAT TREATMENT (NOTE)	MAGNETIC PARTICLE EXAMINATION	IMPACT TEST (J)									
18	CAP 2"WPL6 XH		3E7959	GOOD	119-125	N		10 x 5.0 x 2V AT -45 °C 32.6 33.5 33.9									
ITEM NO.	MATERIAL CHARGE NO.	CHEMICAL COMPOSITION %											* PHYSICAL TEST				
		C x100	Si x100	Mn x100	P x1000	S x1000	Cu x100	Ni x100	Cr x100	Mo x100	V x100	Nb x1000	Y S KSI	T S KSI	E %	**	C.E. X100
		MIN.	15	60									35.0	60.0	16.5		
18	2MT40	21	25	105	10	1	2	1	2	<1	<1	16	45.5	69.0	31.3	T	39


(NOTE):A:HOT FORMED WITH FINAL TEMPERATURE BETWEEN 620°C -980°C ,AIR COOLING.
 N:NORMALIZING AT TEMPERATURE 880°C X0.5HR,AIR COOLING.
 NACE MR-01-75-09/ISO15156.2 ,NACE MR 0103-12:SATISFACTORY

WE HEREBY CERTIFY THAT THE PRODUCT DESCRIBED HEREIN HAS BEEN MANUFACTURED IN ACCORDANCE WITH THE SPECIFICATIONS CONCERNED AND ALSO WITH THE PURCHASER'S REQUIREMENTS AND THAT THE TEST RESULTS SHOWN HEREIN ARE CORRECT.

* TYPE OF SPECIMEN:STRIP(WIDTH:1 in./GAUGE LENGTH:2 in.) ** SAMPLING DIRECTION:L=LONGITUDINAL T=TRANSVERSE


Ou L Lan

MANAGER OF Q.A. DEPT.

 I.M.L. - INDUSTRIA MECCANICA LIGURE S.P.A. Via Giancarlo Farina, 25 - 16030 Casarza Ligure - GE - ITALY Tel. +39 0185 467681 - Fax +39 0185 468510 - E-mail quality.lmi@farinagroup.com MATERIAL TEST DEPARTMENT		COMPANY WITH QUALITY SYSTEM ISO 9001: 2008 CERTIFIED BY RINA CERT. N° 23/91/S																																											
INSPECTION CERTIFICATE EN 10204:2004 / 3.1		Nr ^{A03} 2014-C_IML-25961	Data / Dated 28.11.2014 ^{Z02}																																										
TRANS AM PIPING PRODUCTS LTD. 9335 Endeavor Drive S.E. Calgary, Alberta T3S 0A1		Ordine / PO Item DDT / Delivery note Packing List Fattura / Invoice Ns. rif. / Our ref.	CI-14-584 65 2014-2E301-0001404 2014-2E301-0001404 2014-2E401-0001329 2014-2E201-0001250-0065																																										
Dest. TRANS AM PIPING PRODUCTS LTD. 9335 - Endeavor Drive S.E. Calgary, Alberta T3S 0A1																																													
Cod. colata ^{B07} Heat Code 7Z	Nr. colata ^{B07} Heat Nr 14/79532	Descrizione ^{B01 - (B08 - B11)} Description FITTING 90 ELB. SW 3M 1" A350/LF2																																											
Mat. In acc. a / Mat. In acc. to ^{B02} ASME SA ASTM A350-13 Gr. LF2 cl.1 NACE MR.0175 - ISO 15156 Ed. 2009 / NACE MR 0103 Ed. 2012 P.E.D. 97/23/EC ANNEX 1 PAR. 4.3																																													
Ann. mat. / Mat. remarks ^{B02} MATERIAL FULLY KILLED & FINE GRAIN PRACTICED																																													
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CE LF=C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE SF=C+Mn/6) F1=Cu+Ni+Cr+Mo+V F2=Cr+Mo																																													
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Tratt. Term. / Heat treatment ^{C70} Normalized at 900°C / Air Cool ELECTRIC FURNACE																																													
Dim In acc. a / Dim. acc. to ^{B14} ASME B16.11 Ed.2011 - MSS SP25 Ed.2013																																													
Marcatura in acc. ^{B06} Marking In acc. to	MSS SP25 Ed. 2013	Vis. & Dim.	Satisfactory																																										
		Origina Origin of Steel	EUROPEAN UNION																																										


Note / Notes: 100% MANUFACTURED IN ITALY
 SUPPLIED MATERIAL MEETS SPECIFICATIONS AND P.O. REQUIREMENTS

UFFICIO CONTROLLO QUALITA' ^{A05} QUALITY CONTROL DEPARTMENT 	ENTE UFFICIALE DI COLLAUDO ^{Z03} INSPECTION AUTHORITY	MARCHIO PRODUZIONE ^{A04} MANUFACTURER'S SYMBOL IML or 
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 METFAR PRODOTTI INDUSTRIALI SPA 23861 CESANA BRIANZA (LC) - ITALY VIA G. PARINI, 28 PHONE + 39 031 655441 - FAX +39 031 655149 certificate@metalfaritaly.com		A01 COMPANY WITH MANAGEMENT SYSTEM CERTIFIED BY DNV = ISO 9001 = = ISO 14001 =	
INSPECTION CERTIFICATE EN 10204:2004 / 3.1		Nr ^{A03} 2015-C_MFF-01029 Data / Dated 27.02.2015 ^{Z02}	
TRANS AM PIPING PRODUCTS LTD 9335 ENDEAVOR DRIVE S.E. T3S 0A1 CALGARY, ALBERTA		A05 CA Ordine / PO CI-14-441 Item 140 DDT / Delivery note 2015-3E301-0000804 Packing List 2015-3E401-0000702 Fattura / Invoice 2015-3E401-0000702 Ns. rif. / Our ref. 2014-3E201-0002508-0140	
Dest. TRANS AM PIPING PRODUCTS LTD 9335 - Endeavor Drive S.E. T3S 0A1 Calgary, ALBERTA		A05 CA	
Cod. colata ^{B07} Heat Code	Nr. colata ^{B07} Heat Nr	Quantita' ^{B08} Quantity	Descrizione ^{B01 - (B09 - B11)} Description
	10/72711	5,00	S/W 900/1500 RF 1.1/2" XXS LF2CL1
Mat. In acc. a / Mat. in acc. to ^{B02}			
ASTM/ASME A 350/ISA 350 M - 14 ASME CODE SECT. II, PART A, ED. 2013 ASTM A350-LF2 CL1 NACE MR-0175/2009 ISO 15156 - SOUR SERVICE NACE MR-0103/2012 - SOUR SERVICE CSA Z245.12 GRADE 248 CAT II SOUR SERVICE Q.A.S. IN ACCORD WITH PRESS. EQUIPM. DIRECT. 97/23/EC (PED) ANNEX I, PARAGRAPH 4.3 CERT. 4687-2014-CE-ITA-ACCREDIA			
Elementi / Elements ^(C11 - C12)			
	C	Si	Mn S P Cr Ni Mo Ti Cu V Nb N
LADLE ANALYSIS	0,200	0,210	1,090 0,009 0,015 0,110 0,070 0,020 0,020 0,140 0,003 0,001 0,000
LADLE ANALYSIS	Al		CE LF CE SF F1 F2 PREN
	0,025		0,420 0,882 0,343 0,130 --
CE LF=C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE SF=C+Mn/6 F1=Cu+Ni+Cr+Mo+V F2=Cr+Mo			
Provetta ^{C10} Forma ^{C10} °C ^{C03} Snervamento >0,2% ^{C11} Snervamento >1,0% ^{C11} Rottura ^{C12} Allungamento ^{C13} Contrazione ^{C18}			
Test specimen Shape Yield Strength >0,2% Yield Strength >1,0% Tensile Elongation Reduction of area			
Sez/Sect mm2 L mm 1=O - 2=□ MPa MPa MPa % %			
126,60 50,80 1 20 344,0 - 558,0 32,0 57,0			
DUREZZA / HARDNESS ^{C24} RESILIENZA / IMPACT TEST			
HBW Tipo/Type ^{C40} Provetta / Test Specimen °C ^{C03} 1-Joule ^{C42} 2-Joule ^{C42} 3-Joule ^{C42} Media/Average ^{C43}			
186,0 - 170,0 KV 10x10 mm -46 72 65 66 67,7			
Tratt. Term. / Heat treatment ^{C20} NORMALIZED AT 930° C - COOLED IN STILL AIR ELECTRIC FURNACE			
Dim In acc. a / Dim. acc. to ^{B14} ASME/ANSI B16.5 -2013 ASME/ANSI B36.10M -2004			
Finitura / Roughness 125/250 MICRORINCH AARH			
Marcatura in acc. ^{B06} Marking in acc. to		MSS SP25 Ed. 2013 Vis. & Dim. SATISFACTORY Origine Origin of Steel EUROPEAN UNION	

Note / Notes 100% MANUFACTURED IN ITALY
 MANUFACTURING IN ACCORDANCE WITH ORDER AND SPECIFICATION

A05 UFFICIO CONTROLLO QUALITA' QUALITY CONTROL DEPARTMENT  S. Frigerio	Z03 ENTE UFFICIALE DI COLLAUDO INSPECTION AUTHORITY	A04 MARCHIO PRODUZIONE MANUFACTURER'S SYMBOL 
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	METALFAR PRODOTTI INDUSTRIALI SPA 23861 CESANA BRIANZA (LC) - ITALY VIA G. PARINI, 28 PHONE + 39 031 655441 - FAX +39 031 655149 certificate@metalfaritaly.com	A01	COMPANY WITH MANAGEMENT SYSTEM CERTIFIED BY DNV = ISO 9001 = = ISO 14001 =
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INSPECTION CERTIFICATE EN 10204:2004 / 3.1	A02	Nr ^{A03} 2015-C_MFF-01451	Data / Dated 19.03.2015 ²⁰²
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TRANS AM PIPING PRODUCTS LTD 9335 ENDEAVOR DRIVE S.E. T3S 0A1 CALGARY, ALBERTA	A06	Ordine / PO	CI-14-750	A07
	CA	Item	058	
		DDT / Delivery note	2015-3E301-0001162	
		Packing List	2015-3E401-0001003	
		Fattura / Invoice	2015-3E401-0001003	A08
		Na. rif. / Our ref.	2014-3E201-0003640-0054	

Dest. TRANS AM PIPING PRODUCTS LTD 9335 - Endeavor Drive S.E. T3S 0A1 Calgary, ALBERTA	A06	CA
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Cod. colata ^{B07}	Nr. colata ^{B07}	Quantita ^{B08}	Descrizione ^{B01 - (B08 - B11)}
Heat Code	Heat Nr	Quantity	Description
	12/34232	25,00	BOSSED 150 RF 3" LF2CL1

Mat. in acc. a / Mat. in acc. to ^{B09} ASTM/ASME A 350/SA 350 M - 14 ASME CODE SECT. II, PART A, ED. 2013
 ASTM A350 LF2 CL1
 NACE MR-0175/2009 ISO 15156 - SOUR SERVICE
 NACE MR-0103/2012 - SOUR SERVICE
 CSA Z245.12 GRADE 248 CAT II SOUR SERVICE
 Q.A.S. IN ACCORD WITH PRESS. EQUIPM. DIRECT. 97/23/EC (PED) ANNEX I, PARAGRAPH 4.3
 CERT. 4687-2014-CE-ITA-ACCREDIA

Elementi / Elements ^(C01, C02)	C	SI	Mn	S	P	Cr	NI	Mo	Ti	Cu	V	Nb	N
LADLE ANALYSIS	0,190	0,220	0,930	0,010	0,006	0,110	0,040	0,010	0,017	0,120	0,002	0,001	0,000
LADLE ANALYSIS	0,026								0,380	0,345	0,282	0,120	--

CE LF=C+(Mn/6)
 CE SF=C+(Mn/6)
 F1=Cu+Ni+Cr+Mo+V
 F2=Cr+Mo

Provetta ^{C10}	Forma ^{C10}	Snervamento >0,2% ^{C11}	Snervamento >1,0% ^{C11}	Rottura ^{C12}	Allungamento ^{C13}	Contrazione ^{C15}
Test specimen	Shape	Yield Strength >0,2%	Yield Strength >1,0%	Tensile	Elongation	Reduction of area
Sez/Sect mm ²	L mm	MPa	MPa	MPa	%	%
126,60	50,80	335,0	--	510,0	31,0	59,0

DUREZZA / HARDNESS ^{C22}		RESILIENZA / IMPACT TEST					
HBW	Tipo/Type ^{C40}	Provetta / Test Specimen	°C ^{C03}	1-Joule ^{C42}	2-Joule ^{C42}	3-Joule ^{C42}	Media/Average ^{C43}
153,0 - 158,0	KV	10x10 mm	-46	68	70	67	68,3

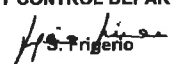

Tratt. Term. / Heat treatment ^{C20}	NORMALIZED AT 930° C - COOLED IN STILL AIR	ELECTRIC FURNACE
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Dim in acc. a / Dim. acc. to ^{B14}	ASME/ANSI B16.5 -2013
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Finitura / Roughness	125/250 MICRORINCH AARH
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Marcatura in acc. ^{B06} Marking in acc. to	MSS SP26 Ed. 2013	Vis. & Dim.	SATISFACTORY	Origine ^{B05} Origin of Steel	EUROPEAN UNION
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Note / Notes
 100% MANUFACTURED IN ITALY
 MANUFACTURING IN ACCORDANCE WITH ORDER AND SPECIFICATION

UFFICIO CONTROLLO QUALITA' ^{A05} QUALITY CONTROL DEPARTMENT 	ENTE UFFICIALE DI COLLAUDO ^{Z03} INSPECTION AUTHORITY	MARCHIO PRODUZIONE ^{A04} MANUFACTURER'S SYMBOL 
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METALFAR
PRODOTTORE ITALIANO DI ACCIAIO
SALDA PROVE E ANALISI MATERIALI / MATERIAL TEST DEPARTMENT

22001 CANTIERI SERRAVALLO - 1007
Via S. Paolo, 20
Tel. 0431 381554
Fax 0431 381555
QUALITÀ CERTIFICATA
CERTIFIED BY DNV
= ISO 9001 =

COMPANY WITH
QUALITY SYSTEM
CERTIFIED BY DNV
= ISO 9001 =


CERTIFICATO DI COLLAUDO SECONDO EN 10204 - 3.1 INSPECTION CERTIFICATE
Caric. N. 5760 Dated/Caric. N. 0
DDT / Ddt Note N. 0 Dated/Caric. N. 0
9335 ENDEAVOR DRIVE S.E. CA
T3S 0A1 CALGARY, ALBERTA

COD. COL. HEAT	POS. ITEM	VS. ORDINE YOUR REFERENCE	Q.T.A. Q.LTY	DESCRIZIONE DESCRIPTION	DIM. ACC. A DIM. ACCORDANCE TO	VISIVO E DIMENS. VIS. & DIMENS.
12/35059			148,00	W/N 1500 RF 2" XS LF2CL1	ASME/ANSI B16.5 - 2013	SATISFACTORY
MATERIALE / MATERIAL						
ASTM A350 LF2 CL1/2 (LADLE)		C% 0,200 S% 0,230 Mn% 0,960 P% 0,010 Cr% 0,110 Ni% 0,050 Mo% 0,010 Ti% 0,017 Cu% 0,110 V% 0,002 Nb% 0,002 N% 0,009 Al% 0,026 C.E.% 0,395				
PROVETA / TEST SPECIMEN	FORMA SHAPE 1-Ø-2-D	SERRAMENTO YIELD POINT Minval >=0,2% 361,0	ROTTURA TENSILE TENSILE STRENGTH Minval >= 522,0	ALLUNGAMENTO ELONGATION % 31,0	CONTRAZIONE REDUCTION OF AREA % 61,0	DUREZZA HARDNESS HBW 159,0 - 183,0
126,60	50,80	1				
MATERIALE IN ACCORDO A / MATERIAL IN ACC. TO						
ASTM/ASME A 350/SA 350 M - 12 ASME CODE SECT. II, PART A, ED. 2010 ADD.				TRATTAMENTO TERMICO / HEAT TREATMENT	FORNO / FURNACE	ORIGINE / ORIGIN OF STEEL
2011a				NORMALIZED AT 930 C - COOLED IN STILL AIR	ELECTRIC FURNACE	EUROPEAN UNION
CSA Z245.12 GRADE 248 CAT.II SOUR SERVICE						

COD. COL. HEAT	POS. ITEM	VS. ORDINE YOUR REFERENCE	Q.T.A. Q.LTY	DESCRIZIONE DESCRIPTION	DIM. ACC. A DIM. ACCORDANCE TO	VISIVO E DIMENS. VIS. & DIMENS.
12/35059			91,00	BLIND 160 RF 6" LF2CL1	ASME/ANSI B16.5 - 2013	SATISFACTORY
MATERIALE / MATERIAL						
ASTM A350 LF2 CL1/2 (LADLE)		C% 0,200 S% 0,230 Mn% 0,960 P% 0,010 Cr% 0,110 Ni% 0,050 Mo% 0,010 Ti% 0,017 Cu% 0,110 V% 0,002 Nb% 0,002 N% 0,009 Al% 0,026 C.E.% 0,395				
PROVETA / TEST SPECIMEN	FORMA SHAPE 1-Ø-2-D	SERRAMENTO YIELD POINT Minval >=0,2% 361,0	ROTTURA TENSILE TENSILE STRENGTH Minval >= 522,0	ALLUNGAMENTO ELONGATION % 31,0	CONTRAZIONE REDUCTION OF AREA % 61,0	DUREZZA HARDNESS HBW 159,0 - 183,0
126,60	50,80	1				
MATERIALE IN ACCORDO A / MATERIAL IN ACC. TO						
ASTM/ASME A 350/SA 350 M - 12 ASME CODE SECT. II, PART A, ED. 2010 ADD.				TRATTAMENTO TERMICO / HEAT TREATMENT	FORNO / FURNACE	ORIGINE / ORIGIN OF STEEL
2011a				NORMALIZED AT 930 C - COOLED IN STILL AIR	ELECTRIC FURNACE	EUROPEAN UNION
CSA Z245.12 GRADE 248 CAT.II SOUR SERVICE						

NOTE 100% MANUFACTURED IN ITALY NOTES MANUFACTURING IN ACCORDANCE WITH ORDER AND SPECIFICATION MATERIAL IN ACCORDANCE WITH NACE MR-01752/009 ISO 15156-2/009 - SOUR SERVICE MATERIAL IN ACCORDANCE WITH NACE MR-0103/2012 - SOUR SERVICE	UFFICIO CONTROLLO QUALITÀ QUALITY CONTROL DEPARTMENT <i>Angela...</i>	ENTE UFFICIALE DI COLLAUDO INSPECTION AUTHORITY	MARCHIO PRODUZIONE MANUFACTURER'S SYMBOL
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National Heat Treatment
Number
Order
Price
\$12.00
100013
0518
0918
3862961
11687
1
Rev'd By: SB

	METALFAR PRODOTTI INDUSTRIALI SPA 23861 CESANA BRIANZA (LC) - ITALY VIA G. PARINI, 28 PHONE +39 031 655441 - FAX +39 031 655149 quality.mff@farmas.com	A01	COMPANY WITH MANAGEMENT SYSTEM CERTIFIED BY DNV = ISO 9001 = = ISO 14001 =
	INSPECTION CERTIFICATE EN 10204:2004 / 3.1		

Nr ^{A03} 2014-C_MFF-03063 Data / Dated 17.08.2014 ^{Z02}	A02
TRANS AM PIPING PRODUCTS LTD 9335 ENDEAVOR DRIVE S.E. T3S 0A1 CALGARY, ALBERTA	A08 CA

Cod. colata ^{B07} Heat Code	Nr. colata ^{B07} Heat Nr.	808	Descrizione ^{B01 - (B09 - B11)} Description
	12/35060		BLIND 1500 RF 2" LF2CL1

Mat. in acc. a / Mat. in acc. to^{B02} ASTM/ASME A 350/SA 350 M - 13 ASME CODE SECT. II, PART A, ED. 2013
 ASTM A350 LF2 CL1
 NACE MR-0175/2009 ISO 15156 - SOUR SERVICE
 NACE MR-0103/2012 - SOUR SERVICE
 Q.A.S. IN ACCORD WITH PRESS. EQUIPM. DIRECT. 97/23/EC (PED) ANNEX I, PARAGRAPH 4.3
 CERT. 4687-2014-CE-ITA-ACCREDIA
 CSA Z245.12 GRADE 248 CAT. II SOUR SERVICE

Elementi / Elements ^(C71 - C92)	C	Si	Mn	S	P	Cr	Ni	Mo	Ti	Cu	V	Nb	N
LADLE ANALYSIS	0,200	0,220	0,970	0,010	0,009	0,110	0,050	0,010	0,019	0,120	0,002	0,002	0,010
LADLE ANALYSIS	0,026								0,397	0,362	0,292	0,120	--

CE LF=C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE SF=C+Mn/6 F1=Cu+Ni+Cr+Mo+V F2=Cr+Mo

Provetta ^{C10} Test specimen	Forma ^{C10} Shape	Snervamento ^{C03} Yield Strength	Snervamento ^{C11} Yield Strength	Rottura ^{C12} Tensile	Allungamento ^{C13} Elongation	Contrazione ^{C15} Reduction of area
126,60	1=O - 2=□	MPa	MPa	MPa	%	%
50,80	1	368,0	-	519,0	33,0	64,0

DUREZZA / HARDNESS ^{C22}	RESILIENZA / IMPACT TEST
HBW	Tipo/Type ^{C40}
159,0 - 163,0	KV

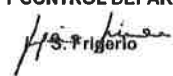
Tratt. Term. / Heat treatment^{C70} NORMALIZED AT 930 C - COOLED IN STILL AIR ELECTRIC FURNACE


Dim In acc. a / Dim. acc. to^{B14} ASME/ANSI B16.5 -2013

Finitura / Roughness 125/250 MICROINCH AARH

Marcatura In acc. ^{B08} Marking in acc. to	MSS SP25 Ed. 2013	Vis. & Dim. SATISFACTORY	Origine Origin of Steel EUROPEAN UNION
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Note / Notes 100% MANUFACTURED IN ITALY
 MANUFACTURING IN ACCORDANCE WITH ORDER AND SPECIFICATION

UFFICIO CONTROLLO QUALITA' ^{A05} QUALITY CONTROL DEPARTMENT 	ENTE UFFICIALE DI COLLAUDO ^{Z03} INSPECTION AUTHORITY	MARCHIO PRODUZIONE ^{A04} MANUFACTURER'S SYMBOL 
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	METALFAR PRODOTTI INDUSTRIALI SPA 23861 CESANA BRIANZA (LC) - ITALY VIA G. PARINI, 28 PHONE + 39 031 655441 - FAX +39 031 655149 quality.mff@farmas.com	A01	COMPANY WITH MANAGEMENT SYSTEM CERTIFIED BY DNV = ISO 9001 = = ISO 14001 =
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INSPECTION CERTIFICATE EN 10204:2004 / 3.1	A02	Nr ^{A03} 2014-C_MFF-06210	Data / Dated 31.07.2014 ^{Z02}
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TRANS AM PIPING PRODUCTS LTD 9335 ENDEAVOR DRIVE S.E. T3S 0A1 CALGARY, ALBERTA	CA	Ordine / PO	CI-13-553	A07
		Item	046	
		DDT / Delivery note	2014-3E301-0003287	
		Packing List	2014-3E401-0002921	
		Fattura / Invoice	2014-3E401-0002921	A08
		Ns. rif. / Our ref.	2013-3E201-0003027-0046	

Dest. TRANS AM PIPING PRODUCTS LTD 9335 - Endeavor Drive S.E. T3S 0A1 Calgary, ALBERTA	A06	CA
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Cod. colata ^{B07}	Nr. colata ^{B07}			Descrizione ^{B01-(B09-B11)}
Heat Code	Heat Nr			Description
	12/70354			S/W 600 RF 1/2" 80 LF2CL1

Mat. in acc. a / Mat. in acc. to^{B02} ASTM/ASME A 350/SA 350 M - 13 ASME CODE SECT. II, PART A, ED. 2013
 ASTM A350 LF2 CL1
 NACE MR-0175/2009 ISO 15156 - SOUR SERVICE
 NACE MR-0103/2012 - SOUR SERVICE
 Q.A.S.IN ACCORD WITH PRESS.EQUIPM.DIRECT.97/23/EC(PED) ANNEX I, PARAGRAPH 4.3
 CERT.4687-2014/CE-ITA-ACCREDIA
 CSA Z245.12 GRADE 248 CAT.II SOUR SERVICE

Elementi / Elements ^(C71-C82)	C	Si	Mn	S	P	Cr	Ni	Mo	Ti	Cu	V	Nb	N
LADLE ANALYSIS	0,185	0,210	1,020	0,010	0,011	0,080	0,060	0,010	0,021	0,160	0,003	0,002	0,000
	AI												
LADLE ANALYSIS	0,027								0,388	0,366	0,313	0,090	--
CE LF=C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15		CE SF=C+Mn/6)		F1=Cu+Ni+Cr+Mo+V		F2=Cr+Mo							

Provetta	Forma ^{C10}	°C ^{C03}	Sneramento>0,2% ^{C11}	Sneramento>1,0% ^{C11}	Rottura ^{C12}	Allungamento ^{C13}	Contrazione ^{C15}
Test specimen	Shape		Yield Strength>0,2%	Yield Strength>1,0%	Tensile	Elongation	Reduction of area
Sez/Sect mm ²	L. mm	1=0 2=□	MPa	MPa	MPa	%	%
126,60	50,80	1	20	335,0	530,0	31,0	58,0

DUREZZA / HARDNESS ^{C22}		RESILIENZA / IMPACT TEST					
HBW	Tipo/Type ^{C40}	Provetta / Test Specimen	°C ^{C03}	1-Joule ^{C42}	2-Joule ^{C42}	3-Joule ^{C42}	Media/Average ^{C43}
159,0 - 163,0	KV	10x10 mm	-46	69	70	66	68,3

Tratt. Term. / Heat treatment ^{C70}	NORMALIZED AT 930 C - COOLED IN STILL AIR	ELECTRIC FURNACE
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Dim in acc. a / Dim. acc. to ^{B13}	ASME/ANSI B16.5 -2013 ASME/ANSI B36.10M -2004
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Finitura / Roughness	125/250 MICROINCH AARH
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Marcatura in acc. ^{B06} Marking in acc. to	MSS SP25 Ed. 2013	Vis. & Dim.	SATISFACTORY	Origine ^{B08}	EUROPEAN UNION
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Nota / Notes 100% MANUFACTURED IN ITALY
 MANUFACTURING IN ACCORDANCE WITH ORDER AND SPECIFICATION

UFFICIO CONTROLLO QUALITA' ^{A05} QUALITY CONTROL DEPARTMENT 	ENTE UFFICIALE DI COLLAUDO ^{Z03} INSPECTION AUTHORITY	MARCHIO PRODUZIONE ^{A04} MANUFACTURER'S SYMBOL 
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	METALFAR PRODOTTI INDUSTRIALI SPA 23861 CESANA BRIANZA (LC) - ITALY VIA G. PARINI, 28 PHONE + 39 031 655441 - FAX +39 031 655149 certificate@metalfaritaly.com	A01	COMPANY WITH MANAGEMENT SYSTEM CERTIFIED BY DNV = ISO 9001 = = ISO 14001 =
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INSPECTION CERTIFICATE EN 10204:2004 / 3.1		A02	Nr ^{A03} 2015-C_MFF-01029	Data / Dated 27.02.2015	Z02
TRANS AM PIPING PRODUCTS LTD 9335 ENDEAVOR DRIVE S.E. T3S 0A1 CALGARY, ALBERTA	CA	A08	Ordine / PO Item DDT / Delivery note Packing List Fattura / Invoice Ns. rif. / Our ref.	Cl-14-441 069 2015-3E301-0000804 2015-3E401-0000702 2015-3E401-0000702 2014-3E201-0002508-0069	A07 A08

Dest. TRANS AM PIPING PRODUCTS LTD 9335 - Endeavor Drive S.E. T3S 0A1 Calgary, ALBERTA	CA	A08
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Cod. colata Heat Code	Nr. colata Heat Nr		Descrizione Description	B01 - (B09 - B11)
	13/39017		W/N 900/1500 RF 1.1/2" XS LF2CL1	

Mat. in acc. a / Mat. in acc. to ^{B02} ASTM/ASME A 350/SA 350 M - 14 ASME CODE SECT. II, PART A, ED. 2013
 ASTM A350 LF2 CL1
 NACE MR-0175/2009 ISO 15156 - SOUR SERVICE
 NACE MR-0103/2012 - SOUR SERVICE
 CSA Z245.12 GRADE 248 CAT. II SOUR SERVICE
 Q.A.S. IN ACCORD WITH PRESS EQUIP. DIRECT. 97/23/EC (PED) ANNEX I, PARAGRAPH 4.3
 CERT 4687-2014-CE-ITA-ACCREDIA

Elementi / Elements	C	SI	Mn	S	P	Cr	Ni	Mo	Ti	Cu	V	Nb	N
LADLE ANALYSIS	0,185	0,230	0,960	0,010	0,013	0,130	0,060	0,010	0,015	0,140	0,002	0,002	0,008
LADLE ANALYSIS	0,026												

CE LF=C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15		CE SF=C+Mn/6	F1=Cu+Ni+Cr+Mo+V	F2=Cr+Mo		
Provetta Test specimen	Forma Shape	Snervamento > 0,2% Yield Strength > 0,2%	Snervamento > 1,0% Yield Strength > 1,0%	Rottura Tensile	Allungamento Elongation	Contrazione Reduction of area
Spz/Sect-mm ² L mm	1=O - 2=□	MPa	MPa	MPa	%	%
126,60 50,80	1	347,0	--	519,0	32,0	61,0

DUREZZA / HARDNESS		RESILIENZA / IMPACT TEST					
HBW	Tipo/Type	Provetta / Test Specimen	°C	1-Joule	2-Joule	3-Joule	Media/Average
154,0 - 158,0	KV	10x10 mm	-46	71	67	66	68,0

Tratt. Term. / Heat treatment	NORMALIZED AT 930° C - COOLED IN STILL AIR	ELECTRIC FURNACE
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Dim in acc. a / Dim. acc. to	ASME/ANSI B16.5 -2013 ASME/ANSI B36.10M -2004
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Finitura / Roughness	125/250 MICRORINCH AARH
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Marcatura in acc. Marking in acc. to	MSS SP25 Ed. 2013	Vis. & Dim.	SATISFACTORY	Origine Origin of Steel	EUROPEAN UNION
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Note / Notes
 100% MANUFACTURED IN ITALY
 MANUFACTURING IN ACCORDANCE WITH ORDER AND SPECIFICATION

UFFICIO CONTROLLO QUALITA' QUALITY CONTROL DEPARTMENT 	ENTE UFFICIALE DI COLLAUDO INSPECTION AUTHORITY	MARCHIO PRODUZIONE MANUFACTURER'S SYMBOL 
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METALFAR
PRODOTTORE INDUSTRIALI S.P.A.

22951 CASALVA BIANZANO (LO) - Italy
Via G. Pavesi, 28
Tel. +39 035 855441
Fax +39 035 855442
E-mail: info@metalfar.com

COMPANY WITH
QUALITY SYSTEM
CERTIFIED BY DNV
= ISO 9001 =

CERTIFICATO DI COLLAUDO SECONDO EN 10204 - 3.1 INSPECTION CERTIFICATE

Certif. N. 5551	Delivered 17/10/2013	Factory / Invoice N. 3816	Delivered 17/10/2013
DOT / Dot Note N. 4383	Delivered 17/10/2013	No. Ord. / Ord. ref. N. 0	Delivered
FORGED FLANGES & FITTINGS LTD (DE)		Dest.: F.F. de WAREHOUSE	
CASTLE HOUSE - STATION ROAD ENS 1PE NEW BARRETHERTFORD ..		Bergmannstrasse 170 45896 GELSENKIRCHEN	
GB	DE	Page 15 - 29	


SAVA PROVE E ANALISI MATERIALI / MATERIAL TEST DEPARTMENT

COD. COL.	COLATA	POS.	VS. ORDINE	Q.TA.	DESCRIZIONE	DIM. ACC. A	VISIVO E DIMENS.										
HEAT CODE	HEAT	ITEM	YOUR REFERENCE	Q.TY	DESCRIPTION	DIM. ACCORDANCE TO	VIS. & DIMENS.										
13/76390	012	3995/STK GER	100,00	BLIND 600 RF 3"	LF2CL1	ASME/ANSI B16.5-2013	SATISFACTORY										
MATERIALE / MATERIAL																	
ASTM A350 LF2 CL 1/2 (LADLE)			C% 0,185	Si% 0,250	Mn% 0,860	S% 0,009	P% 0,015	Cr% 0,150	Ni% 0,080	Mo% 0,010	Ti% 0,030	Cu% 0,150	V% 0,002	Nb% 0,001	N% 0,000	A% 0,028	C.E.% 0,376
PROVETA / TEST SPECIMEN	FORMA	SERVIZIO	RETTURA	ALLUNGAMENTO	CONTRAZIONE	DUREZZA											
SEZ. SPES. / SECT. SPEC.	LIBERT. mm	1-Ø 2-Ø	YIELD POINT	TENSILE STRENGTH	ELONGATION	REDUCTION OF AREA	HARDNESS										
125,60	50,80	1	308,0	512,0	32,0	60,0	152,0 - 156,0										
MATERIALE IN ACCORDO A / MATERIAL IN ACC. TO								TRATTAMENTO TERMICO / HEAT TREATMENT									
ASTM/ASME A 350/SA 350 M - 12 ASME CODE SECT. II, PART A, ED. 2010 ADD.								NORMALIZED AT 830 C - COOLED IN STILL AIR									
2011a								EUROPEAN UNION									

National Procurement / International Procurement / Shipments / ...
Item# 5
Rev'd By: SJ

NOTE	100% MANUFACTURED IN ITALY	UFFICIO CONTROLLO QUALITA'	ENTE UFFICIALE DI COLLAUDO	MARCHIO PRODUZIONE
NOTES	MANUFACTURING IN ACCORDANCE WITH ORDER AND SPECIFICATION	QUALITY CONTROL DEPARTMENT	INSPECTION AUTHORITY	MANUFACTURER'S SYMBOL
	LF2 CHAMPY TEST SPECIMEN RESULT AS 10X10	<i>[Signature]</i>		
	Q.A.S. IN ACCORD. WITH PRESS. EQUIPMENT DIRECT 97/23/CE (PED) ANNEX I, PARAGRAPH 4.3			
	CERT. MIL. 0531016/01			
	MATERIAL IN ACCORDANCE WITH NACE MR-0175/2009 ISO 15156-2:2009			
	MATERIAL IN ACCORDANCE WITH NACE MR-0103/2012			

VERIFIED TRUE COPY
OF ORIGINAL
FORGED FLANGES & FITTINGS
LIMITED

	METALFAR PRODOTTI INDUSTRIALI SPA 23861 CESANA BRIANZA (LC) - ITALY VIA G. PARINI, 28 PHONE + 39 031 655441 - FAX +39 031 655149 quality.mff@farmas.com	A01	COMPANY WITH MANAGEMENT SYSTEM CERTIFIED BY DNV = ISO 9001 = = ISO 14001 =
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INSPECTION CERTIFICATE EN 10204:2004 / 3.1	A02	Nr ^{A03} 2014-C_MFF-06976 Data / Dated 27.09.2014 ²⁰²
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TRANS AM PIPING PRODUCTS LTD 9335 ENDEAVOR DRIVE S.E. T3S 0A1 CALGARY, ALBERTA	A06	Ordine / PO CI-13-553 ^{A07} Item 048 DDT / Delivery note 2014-3E301-0003943 Packing List 2014-3E401-0003501 Fattura / Invoice 2014-3E401-0003501 ^{A08} Ns. rif. / Our ref. 2013-3E201-0003027-0048
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Dest. TRANS AM "PROJECT" Warehouse 1711 - 68 Avenue T6P 1Y9 Edmonton, ALBERTA	A08	CA
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Cod. colata ^{B07} Heat Code	Nr. colata ^{B07} Heat Nr	13/77263	S/W 600 RF 1" 80. LF2CL1	Descrizione Description	B01 - (B09 - B11)
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Mat. in acc. a / Mat. in acc. to ^{B02} ASTM/ASME A 350/SA 350 M - 13 ASME CODE SECT. II, PART A, ED. 2013
 ASTM A350-LF2-CL1
 NACE MR-0175/2009 ISO 15156 - SOUR SERVICE
 NACE MR-0103/2012 - SOUR SERVICE
 Q.A.S. IN ACCORD WITH PRESS.EQUIPM.DIRECT.97/23/EC (PED) ANNEX I, PARAGRAPH 4.3
 CERT.4687-2014-CE-ITA-ACCREDIA
 CSA Z245.12 GRADE 248 CAT. II SOUR SERVICE

Elementi / Elements ^{C01, C02}	C	Si	Mn	S	P	Cr	Ni	Mo	Ti	Cu	V	Nb	N			
LADLE ANALYSIS	0,195	0,210	0,880	0,008	0,012	0,150	0,080	0,020	0,025	0,180	0,005	0,002	0,000			
LADLE ANALYSIS											Al	CE, LF	CE, SF	F1	F2	PREN
											0,025	0,894	0,342	0,435	0,170	-

CE, LF=C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE, SF=C+Mn/6) F1=Cu+Ni+Cr+Mo+V F2=Cr+Mo

Provetta	Forma ^{C10}	°C ^{C03}	Snervamento > 0,2% ^{C11}	Snervamento > 1,0% ^{C11}	Rottura ^{C12}	Allungamento ^{C13}	Contrazione ^{C15}	
Test specimen	Shape		Yield Strength > 0,2%	Yield Strength > 1,0%	Tensile	Elongation	Reduction of area	
Sez/Sect mm ²	L mm	1=□, 2=□	MPa	MPa	MPa	%	%	
126,80	50,80	1	20	327,0	-	519,0	34,0	58,0

DUREZZA / HARDNESS ^{C04}	RESILIENZA / IMPACT TEST						
HBW	Tipo/Type ^{C40}	Provetta / Test Specimen	°C ^{C03}	1-Joule ^{C42}	2-Joule ^{C42}	3-Joule ^{C42}	Media/Average ^{C43}
152,0 - 154,0	KV	10x10 mm	-46	72	70	66	69,3

Tratt. Term. / Heat treatment ^{C70}	NORMALIZED AT 930 C - COOLED IN STILL AIR	ELECTRIC FURNACE
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Dim in acc. a / Dim. acc. to ^{B14}	ASME/ANSI B16.5 - 2013 ASME/ANSI B36.10M - 2004
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Finitura / Roughness	125/250 MICROINCH AARH
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Marcatura in acc. ^{B06} Marking in acc. to	MSS-SP25 Ed. 2013	Vis. & Dim.	SATISFACTORY	Origine ^{B08} Origin of Steel	EUROPEAN UNION
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Note / Notes 100% MANUFACTURED IN ITALY
 MANUFACTURING IN ACCORDANCE WITH ORDER AND SPECIFICATION

UFFICIO CONTROLLO QUALITA' ^{A05} QUALITY CONTROL DEPARTMENT 	ENTE UFFICIALE DI COLLAUDO ^{Z03} INSPECTION AUTHORITY	MARCHIO PRODUZIONE ^{A04} MANUFACTURER'S SYMBOL 
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METALFAR
 PRODOTTI INDUSTRIALI S.P.A.
 Via G. Perini, 28
 Tel. +39 031 65541
 Fax. +39 031 655149
 email: info@metalfar.com

SEDE AMMINISTRATIVA E DIREZIONE:
 23061 ORSANA BFIANZA (LC) - Italy

COMPANY WITH
 QUALITY SYSTEM
 CERTIFIED BY DNV
 = ISO 9001 =

SALA PROVE E ANALISI MATERIALI / MATERIAL TEST DEPARTMENT

CERTIFICATO DI COLLAUDO SECONDO EN 10204 - 3.1 INSPECTION CERTIFICATE


Certif. N. 6049	Del/Dated 14.11.2013	Fattura / Invoice N. 4114	Del/Dated 13.11.2013
DDT / Del Note N. 4719	Del/Dated 13.11.2013	No.Ord. / Our ref. N. 0	Del/Dated 13.11.2013
TRANS AM PIPING PRODUCTS LTD		Dest.: TRANS AM PIPING PRODUCTS LTD	
9335 ENDEAVOR DRIVE S.E.		9335 - Endeavor Drive S.E.	
T3S 0A1 CALGARY, ALBERTA		T3S 0A1 Calgary, ALBERTA	
CA		CA	

Pag. 7 - 21

COD. COL. HEAT	COLATA ITEM	POS.	VS. ORDINE YOUR REFERENCE	Q.TA DESCRIPTION	DESCRIZIONE	DIM. IN ACC. A DIM. ACCORDANCE TO	VISIVO E DIMENS. VIS. & DIMENS.							
1377325	005		CI-12-476	454,00 W/N 150 RF 2" XS	LF2CL1	ASME/ANSI B16.5-2013	SATISFACTORY							
MATERIALE / MATERIAL														
ASTM A350 LF2 CL1/2 (LADLE)														
C%	Si%	Mn%	S%	P%	C%	Ni%	Mo%	Ti%	Cu%	V%	Nb%	N%	Al%	C.E.%
0,180	0,210	0,880	0,010	0,012	0,150	0,080	0,020	0,025	0,200	0,004	0,002	0,000	0,028	0,380
PROVETA / TEST SPECIMEN	FORMA SECONDO EN 10204	SERVIZIAMENTO YIELD POINT Min/Max	ROTTURA TENSILE STRENGTH Min/Max	ALLUNGAMENTO ELONGATION %	CONTRAZIONE REDUCTION OF AREA %	DUREZZA HARDNESS HBW	RESILIEZZA / IMPACT TEST - JOULE/ft.lbm	TPO / TYPE 10x10mm	KV	FORNO / FURNACE	ORIGINE / ORIGIN OF STEEL			
126,60	50,80	1	312,0	504,0	32,0	60,0	152,0 - 154,0		-46	1 74 2 78 3 73	EUROPEAN UNION			
MATERIALE IN ACCORDO A / MATERIAL IN ACC. TO														
ASTM/A530 A 350/SA 350 M - 13 ASME CODE SECT. II, PART A, ED. 2013														
CSA Z245.12 GRADE 248 CAT.II SOUR SERVICE														

COD. COL. HEAT	COLATA ITEM	POS.	VS. ORDINE YOUR REFERENCE	Q.TA DESCRIPTION	DESCRIZIONE	DIM. IN ACC. A DIM. ACCORDANCE TO	VISIVO E DIMENS. VIS. & DIMENS.							
13389680	013		CI-12-476	13,00 W/N 300 RF 3" STD	LF2CL1	ASME/ANSI B16.5-2013	SATISFACTORY							
MATERIALE / MATERIAL														
ASTM A350 LF2 CL1/2 (LADLE)														
C%	Si%	Mn%	S%	P%	C%	Ni%	Mo%	Ti%	Cu%	V%	Nb%	N%	Al%	C.E.%
0,195	0,220	0,950	0,007	0,009	0,100	0,070	0,010	0,016	0,150	0,003	0,001	0,009	0,025	0,391
PROVETA / TEST SPECIMEN	FORMA SECONDO EN 10204	SERVIZIAMENTO YIELD POINT Min/Max	ROTTURA TENSILE STRENGTH Min/Max	ALLUNGAMENTO ELONGATION %	CONTRAZIONE REDUCTION OF AREA %	DUREZZA HARDNESS HBW	RESILIEZZA / IMPACT TEST - JOULE/ft.lbm	TPO / TYPE 10x10mm	KV	FORNO / FURNACE	ORIGINE / ORIGIN OF STEEL			
126,60	50,80	1	325,0	512,0	31,0	80,0	154,0 - 156,0		-46	1 70 2 68 3 70	EUROPEAN UNION			
MATERIALE IN ACCORDO A / MATERIAL IN ACC. TO														
ASTM/A530 A 350/SA 350 M - 13 ASME CODE SECT. II, PART A, ED. 2013														
CSA Z245.12 GRADE 248 CAT.II SOUR SERVICE														

NOTE 100% MANUFACTURED IN ITALY	UFFICIO CONTROLLO QUALITA' QUALITY CONTROL DEPARTMENT	ENTE UFFICIALE DI COLLAUDO INSPECTION AUTHORITY	MARCHIO PRODUZIONE MANUFACTURER'S SYMBOL
NOTES MANUFACTURING IN ACCORDANCE WITH ORDER AND SPECIFICATION			
MATERIAL IN ACCORDANCE WITH NACE MR-0175/2009 ISO 15156-2009 - SOUR SERVICE			
MATERIAL IN ACCORDANCE WITH NACE MR-0103/2012 - SOUR SERVICE			

 METALFAR PRODOTTI INDUSTRIALI SPA 23881 CESANA BRIANZA (LC) - ITALY VIA G. PARINI, 28 PHONE + 39 031 655441 - FAX +39 031 655149 quality.mff@farmas.com	A01	COMPANY WITH MANAGEMENT SYSTEM CERTIFIED BY DNV = ISO 9001 = = ISO 14001 =

INSPECTION CERTIFICATE EN 10204:2004 / 3.1		Nr ^{A03} 2014-C_MFF-07998	Data / Dated 20.11.2014 ²⁰²
TRANS AM PIPING PRODUCTS LTD 9335 ENDEAVOR DRIVE S.E. T3S 0A1 CALGARY, ALBERTA	CA	Ordine / PO	CI-14-441
		Item	015
		DDT / Delivery note	2014-3E301-0004810
		Packing List	2014-3E401-0004291
		Fattura / Invoice	2014-3E401-0004291
		Na. rif. / Our ref.	2014-3E201-0002508-0015

Dest. TRANS AM PIPING PRODUCTS LTD
 9335 - Endeavor Drive S.E.
 T3S 0A1 Calgary, ALBERTA

Cod. colata ^{B07} Heat Code	Nr. colata ^{B07} Heat Nr		Descrizione Description
	13/78156	W/N, 150 RF 2" XS	LF2CL1

Mat. in acc. a / Mat. in acc. to^{B02} ASTM/ASME A 350/SA 350 M - 14 ASME CODE SECT. II, PART A, ED. 2013
 ASTM A350-LF2-CL1
 NACE MR-0175/2009 ISO 15156 - SOUR SERVICE
 NACE MR-0103/2012 - SOUR SERVICE
 Q.A.S. IN ACCORD WITH PRESS. EQUIPM. DIRECT. 97/23/EC (PED) ANNEX I, PARAGRAPH 4.3
 CERT. 4687-2014-CE-ITA-ACCREDIA
 CSA 2245.12 GRADE 248 CAT. II SOUR SERVICE

Elementi / Elements ^{C01-C02}	C	Si	Mn	S	P	Cr	Ni	Mo	Ti	Cu	V	Nb	N
LADLE ANALYSIS	0,200	0,230	0,910	0,010	0,015	0,160	0,100	0,020	0,022	0,190	0,002	0,003	0,000
LADLE ANALYSIS	AI	0,030							CE LF	CE SF	F1	F2	PREN
									0,407	0,352	0,472	0,180	-

CE LF=C+Mn/6+(Cr+Mo*V)/5+(Ni+Cu)/15	CE SF=C+Mn/6)	F1=Cu+Ni+Cr+Mo+V	F2=Cr+Mo
Provetta ^{C10}	Forma ^{C10}	Snervamento>0,2% ^{C11}	Snervamento>1,0% ^{C11}
Test specimen	Shape	Yield Strength>0,2%	Yield Strength>1,0%
Sez/Sect mm ²	L mm	MPa	MPa
126,60	50,80	330,0	--
			Rottura ^{C12}
			Tensile
			MPa
			527,0
			Allungamento ^{C13}
			Elongation
			%
			33,0
			Contrazione ^{C15}
			Reduction of area
			%
			60,0

DUREZZA / HARDNESS ^{C29}	RESILIENZA / IMPACT TEST			
HBW	Tipo/Type ^{C40}	Provetta / Test Specimen	°C ^{C03}	1-Joule ^{C42}
154,0 - 158,0	KV	10x10 mm	-46	67
			74	74
			3-Joule ^{C42}	70
			Media/Average ^{C40}	70,3
			ELECTRIC FURNACE	

Tratt. Term. / Heat treatment^{C70} NORMALIZED AT 930° C - COOLED IN STILL AIR


Dim in acc. a / Dim. acc. to^{B14} ASME/ANSI B16.5 -2013
 ASME/ANSI B36.10M -2004

Finitura / Roughness 125/250 MICRONS AARH

Marcatura in acc. ^{B06} Marking in acc. to	MSS SP25 Ed. 2013	Vis. & Dim.	SATISFACTORY	Origine Origin of Steel	EUROPEAN UNION
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Note / Notes
 100% MANUFACTURED IN ITALY
 MANUFACTURING IN ACCORDANCE WITH ORDER AND SPECIFICATION

UFFICIO CONTROLLO QUALITA' QUALITY CONTROL DEPARTMENT 	ENTE UFFICIALE DI COLLAUDO INSPECTION AUTHORITY	MARCHIO PRODUZIONE MANUFACTURER'S SYMBOL 
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 METALFAR PRODOTTI INDUSTRIALI SPA 23861 CESANA BRIANZA (LC) - ITALY VIA G. PARINI, 28 PHONE + 39 031 655441 - FAX +39 031 655149 certificate@metalfaritaly.com		A01		COMPANY WITH MANAGEMENT SYSTEM CERTIFIED BY DNV = ISO 9001 = = ISO 14001 =											
INSPECTION CERTIFICATE EN 10204:2004 / 3.1			A02	Nr ^{A03} 2015-C_MFF-01029	Data / Dated 27.02.2015 ^{Z02}										
TRANS AM PIPING PRODUCTS LTD 9335 ENDEAVOR DRIVE S.E. T3S 0A1 CALGARY, ALBERTA		CA	A05	Ordine / PO CI-14-441 Item 033 DDT / Delivery note 2015-3E301-0000804 Packing List 2015-3E401-0000702 Fattura / Invoice 2015-3E401-0000702 Ns. rif. / Our ref. 2014-3E201-0002508-0033	A07 A08										
Dest. TRANS AM PIPING PRODUCTS LTD 9335 - Endeavor Drive S.E. T3S 0A1 Calgary, ALBERTA		CA	A08												
Cod. colata ^{B07} Heat Code	Nr. colata ^{B07} Heat Nr			Descrizione Description											
	14/30992			W/N 300 RF 1.1/2" XS LF2CL1											
Mat. in acc. a / Mat. in acc. to ^{B02} ASTM/ASME A 350/SA 350 M - 14.ASME CODE SECT. II, PART A, ED. 2013 ASTM A350 LF2 CL1 NACE MR-0175/2009 ISO 15156 - SOUR SERVICE NACE MR-0103/2012 - SOUR SERVICE GSA Z245.12 GRADE 248 CAT. II SOUR SERVICE Q.A.S. IN ACCORD WITH PRESS. EQUIPM. DIRECT. 97/23/EC (PED) ANNEX I, PARAGRAPH 4.3 CERT. 4687-2014-CE-ITA-ACCREDIA															
Elementi / Elements ^{C11, C12}		C	Si	Mn	S	P	Cr	Ni	Mo	Ti	Cu	V	Nb	N	
LADLE ANALYSIS		0,190	0,220	0,950	0,010	0,012	0,130	0,070	0,010	0,016	0,160	0,001	0,001	0,009	
LADLE ANALYSIS		0,027								CE LF	CE SF	F1	F2	PREN	
CE LF=C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15		CE SF=C+Mn/6)		F1=Cu+Ni+Cr+Mo+V		F2=Cr+Mo									
Provetta ^{C10} Test specimen		Forma ^{C10} Shape	C ^{C03}	Snervamento>0,2% ^{C11} Yield Strength>0,2%		Snervamento>1,0% ^{C11} Yield Strength>1,0%		Rottura ^{C12} Tensile	Allungamento ^{C13} Elongation	Contrazione ^{C15} Reduction of area					
Sez/Sect mm ² L mm		1=0 - 2=□	20	MPa		MPa		MPa	%	%					
126,60		50,80	1	347,0		-		519,0	33,0	62,0					
DUREZZA / HARDNESS ^{C22}		RESILIENZA / IMPACT TEST													
HBW		Tipo/Type ^{C40}	Provetta / Test Specimen		°C ^{C03}	1-Joule ^{C42}	2-Joule ^{C42}	3-Joule ^{C42}	Media/Average ^{C43}						
154,0 - 158,0		KV	10x10 mm		-46	76	80	70	75,3						
Tratt. Term. / Heat treatment ^{C20}		NORMALIZED AT 930° C - COOLED IN STILL AIR										ELECTRIC FURNACE			
Dim in acc. a / Dim. acc. to ^{B14}		ASME/ANSI B16.5 -2013 ASME/ANSI B36.10M -2004													
Finitura / Roughness		125/250 MICRORINCH AARH													
Marcatura in acc. ^{B06} Marking in acc. to		MSS SP25 Ed. 2013	Vis. & Dim.	SATISFACTORY		Origine Origin of Steel		EUROPEAN UNION							

Note / Notes
 - 100% MANUFACTURED IN ITALY
 MANUFACTURING IN ACCORDANCE WITH ORDER AND SPECIFICATION

UFFICIO CONTROLLO QUALITA' QUALITY CONTROL DEPARTMENT 	ENTE UFFICIALE DI COLLAUDO INSPECTION AUTHORITY	MARCHIO PRODUZIONE MANUFACTURER'S SYMBOL 
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	METALFAR PRODOTTI INDUSTRIALI SPA 23861 GESANA BRIANZA (LC) - ITALY VIA G. PARINI, 28 PHONE + 39 031 655441 - FAX +39 031 655149 quality.mff@farmas.com	A01 COMPANY WITH MANAGEMENT SYSTEM CERTIFIED BY DNV = ISO 9001 = = ISO 14001 =
	INSPECTION CERTIFICATE EN 10204:2004 / 3.1	

Nr ^{A03} 2014-C_MFF-06604 Data / Dated 09.09.2014 ^{Z02}	
TRANS AM PIPING PRODUCTS LTD 9335 ENDEAVOR DRIVE S.E. T3S 0A1 CALGARY, ALBERTA	A06 CA Ordine / PO CI-14-441 Item 097 DDT / Delivery note 2014-3E301-0003628 Packing List 2014-3E401-0003256 Fattura / Invoice 2014-3E401-0003256 Ns. rif. / Our ref. 2014-3E201-0002508-0097

Dest. TRANS AM "PROJECT" Warehouse 1711 - 66 Avenue T6P 1Y9 Edmonton, ALBERTA	A06 CA
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Cod. colata ^{B07} Heat Code	Nr. colata ^{B07} Heat Nr	B08 BLIND 600 RF 2" LF2CL1	Descrizione Description	B01 - (B06 - B11)
14/31364	AI			

Mat. in acc. a / Mat. in acc. to^{B07} ASTM/ASME A 350/SA 350 M - 13 ASME CODE SECT. II, PART A, ED. 2013
 ASTM A350 LF2 CL1
 NACE MR-0175/2009 ISO 15156 - SOUR SERVICE
 NACE MR-0103/2012 - SOUR SERVICE
 Q.A.S. IN ACCORD. WITH PRESS. EQUIPM. DIRECT. 97/23/EC (PED) ANNEX I, PARAGRAPH 4.3
 CERT. 4687-2014-CE-ITA-ACCREDIA
 CSA Z245.12 GRADE 248 CAT. II SOUR SERVICE

Elementi / Elements ^{C11-C03}	C	SI	Mn	S	P	Cr	NI	Mo	TI	Cu	V	Nb	N
LADLE ANALYSIS	0,185	0,230	0,970	0,008	0,009	0,100	0,050	0,010	0,015	0,120	0,001	0,002	0,009
LADLE ANALYSIS	0,025								0,380	0,347	0,281	0,110	-

CE LF=C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE SF=C+Mn/6 F1=Cu+Ni+Cr+Mo+V F2=Cr+Mo

Provetta / Test specimen	Forma / Shape ^{C10}	Snervamento > 0,2% / Yield Strength > 0,2% ^{C03}	Snervamento > 1,0% / Yield Strength > 1,0% ^{C11}	Rottura / Tensile ^{C12}	Allungamento / Elongation ^{C13}	Contrazione / Reduction of area ^{C15}
Sez/Sect mm ²	L mm	MPa	MPa	MPa	%	%
126,60	50,80	337,0	--	508,0	33,0	60,0

DUREZZA / HARDNESS ^{C22}		RESILIENZA / IMPACT TEST					
HBW	Tipo/Type ^{C40}	Provetta / Test Specimen	°C ^{C03}	1-Joule ^{C42}	2-Joule ^{C42}	3-Joule ^{C42}	Media/Average ^{C43}
152,0 - 156,0	KV	10x10 mm	-46	68	72	63	67,7



Tratt. Term. / Heat treatment ^{C20}	NORMALIZED AT 930 C - COOLED IN STILL AIR	ELECTRIC FURNACE
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Dim. in acc. a / Dim. acc. to ^{B19}	ASME/ANSI B16.5 - 2013
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Finitura / Roughness	125/250 MICRQINCH AARH
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Marcatura in acc. ^{B06} Marking in acc. to	MSS SP25 Ed. 2013	Vis. & Dim.	SATISFACTORY	Origine / Origin of Steel	EUROPEAN UNION
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Note / Notes: 100% MANUFACTURED IN ITALY
 MANUFACTURING IN ACCORDANCE WITH ORDER AND SPECIFICATION

UFFICIO CONTROLLO QUALITA' QUALITY CONTROL DEPARTMENT 	ENTE UFFICIALE DI COLLAUDO INSPECTION AUTHORITY	MARCHIO PRODUZIONE MANUFACTURER'S SYMBOL 
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	METALFAR PRODOTTI INDUSTRIALI SPA 23861 CESANA BRIANZA (LC) - ITALY VIA G. PARINI, 28 PHONE +39 031 655441 - FAX +39 031 655149 quality.mff@farnas.com	A01	COMPANY WITH MANAGEMENT SYSTEM CERTIFIED BY DNV = ISO 9001 = = ISO 14001 =
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INSPECTION CERTIFICATE EN 10204:2004 / 3.1	A02	Nr ^{A03} 2014-C_MFF-07559	Data / Dated 28.10.2014	Z02
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TRANS AM PIPING PRODUCTS LTD 9335 ENDEAVOR DRIVE S.E. T3S 0A1 CALGARY, ALBERTA	CA	Ordine / PO CI-14-441 Item 034 DDT / Delivery note 2014-3E301-0004446 Packing List 2014-3E401-0003967 Fattura / Invoice 2014-3E401-0003967 Ns. rif. / Our ref. 2014-3E201-0002508-0034	A06	A07	A08
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Dest. TRANS AM PIPING PRODUCTS LTD 9335 - Endeavor Drive S.E. T3S 0A1 Calgary, ALBERTA	CA	A05
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Cod. colore Heat Code	Nr. colore Heat Nr	Descrizione Description
14/33854		W/N 300 RF 2" XS LF2CL1

Mat. in acc. a / Mat. in acc. to: ASTM/ASME A 350/SA 350 M - 13 ASME CODE SECT. II, PART A, ED. 2013
 ASTM A350 LF2 CL1
 NACE MR-0175/2009 ISO 15156 - SOUR SERVICE
 NACE MR-0103/2012 - SOUR SERVICE
 G.I.S. IN ACCORD WITH PRESS. EQUIP. DIRECT. 97/23/EC (PED) ANNEX I; PARAGRAPH 4.3
 CERT. 4687-2014-CE-ITA-ACCREDIA
 CSA Z245.12 GRADE 248 CAT. II SOUR SERVICE

Elementi / Elements	C	SI	Mn	S	P	Cr	NI	Mo	Ti	Cu	V	Nb	N
LADLE ANALYSIS	0,200	0,220	0,940	0,010	0,010	0,090	0,050	0,020	0,016	0,110	0,003	0,001	0,010
LADLE ANALYSIS	AI	0,025							CE LF	CE SF	F1	F2	PREN
									0,390	0,357	0,273	0,110	-

Provetta / Test specimen	Forma / Shape	C ^{C03}	Snervamento > 0,2% ^{C11}	Snervamento > 1,0% ^{C11}	Rottura ^{C13}	Allungamento ^{C13}	Contrazione ^{C15}	
Spz/Sect mm ²	L mm	1=0-2=□	Yield Strength > 0,2%	Yield Strength > 1,0%	Tensile	Elongation	Reduction of area	
MPa	MPa	MPa	%	%	%			
126,60	50,80	1	20	341,0	-	516,0	32,0	60,0

DUREZZA / HARDNESS ^{C22}	RESILIENZA / IMPACT TEST					
HBW	10x10 mm	°C ^{C03}	1-Joule ^{C42}	2-Joule ^{C42}	3-Joule ^{C42}	Media/Average ^{C43}
KV	-46	74	74	68	72,0	
154,0 - 158,0						

Tratt. Term. / Heat treatment	NORMALIZED AT 930° C - COOLED IN STILL AIR	ELECTRIC FURNACE
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Dim in acc. a / Dim. acc. to	ASME/ANSI B16.5 -2013 ASME/ANSI B36.10M -2004
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Finitura / Roughness	125/250 MICRORINCH AARH
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Marcatura in acc. / Marking in acc. to	MSS SP25 Ed. 2013	Vis. & Dim.	SATISFACTORY	Origine / Origin of Steel	EUROPEAN UNION
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Note / Notes: 100% MANUFACTURED IN ITALY
 MANUFACTURING IN ACCORDANCE WITH ORDER AND SPECIFICATION

UFFICIO CONTROLLO QUALITA' QUALITY CONTROL DEPARTMENT 	ENTE UFFICIALE DI COLLAUDO INSPECTION AUTHORITY	MARCHIO PRODUZIONE MANUFACTURER'S SYMBOL 
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 METALFAR PRODOTTI INDUSTRIALI SPA 23861 CESANA BRIANZA (LC) - ITALY VIA G. PARINI, 28 PHONE +39 031 655441 - FAX +39 031 655149 certificate@metalfaritaly.com		A01		COMPANY WITH MANAGEMENT SYSTEM CERTIFIED BY DNV = ISO 9001 = = ISO 14001 =									
INSPECTION CERTIFICATE EN 10204:2004 / 3.1			A02	Nr ^{A03} 2014-C MFF-08653 Data / Dated 23.12.2014 ^{Z02}									
TRANS AM PIPING PRODUCTS LTD 9335 ENDEAVOR DRIVE S.E. T3S 0A1 CALGARY, ALBERTA		CA	Ordine / PO CI-14-441 ^{A07} Item 128 DDT / Delivery note 2014-3E301-0005371 Packing List 2014-3E401-0004796 Fattura / Invoice 2014-3E401-0004796 ^{A08} Ns. rif. / Our ref. 2014-3E201-0002508-0128										
Dest. TRANS AM PIPING PRODUCTS LTD 9335 - Endeavor Drive S.E. T3S 0A1 Calgary, ALBERTA		CA	A08										
Cod. colata ^{B07} Heat Code	Nr. colata ^{B07} Heat Nr		Descrizione Description		B01 - (B06 - B11)								
	14/70198		SAW 150 RF 3/4" 80 LF2CL1										
Mat. in acc. a / Mat. in acc. to ^{B02} ASTM/ASME A 350/SA 350 M - 14 ASME CODE SECT. II, PART A, ED. 2013 ASTM A350 LF2 CL1 NACE MR-0175/2009 ISO 15156 - SOUR SERVICE NACE MR-0103/2012 - SOUR SERVICE Q.A.S. IN ACCORD WITH PRESS. EQUIPM. DIRECT. 97/23/EC (PED) ANNEX I, PARAGRAPH 4.3 CERT. 4687-2014-CE-ITA-ACCREDIA CSA Z245.12 GRADE 248 CAT. II SOUR SERVICE													
Elementi / Elements ^{(C1) (C62)}													
LADLE ANALYSIS	C	Si	Mn	S	P	Cr	Ni	Mo	Ti	Cu	V	Nb	N
	0,200	0,220	0,910	0,007	0,013	0,110	0,050	0,010	0,017	0,180	0,002	0,002	0,000
LADLE ANALYSIS	Al								CE LF	CE SF	F1	F2	PREN
	0,026								0,391	0,352	0,352	0,120	--
CE LF=C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE SF=C+Mn/6 F1=Cu+Ni+Cr+Mo+V F2=Cr+Mo													
Provetta ^{C10} Forma ^{C10} Snervamento ^{>0,2% C11} Snervamento ^{>1,0% C11} Rottura ^{C12} Allungamento ^{C13} Centrazione ^{C15}													
Test specimen Shape		Yield Strength ^{>0,2%} Yield Strength ^{>1,0%}		Tensile Elongation Reduction of area									
Sez/Sect mm2	L mm	1=0-2=□	MPa	MPa	MPa	%	%	%					
126,60	50,80	1	330,0	-	527,0	34,0		62,0					
DUREZZA / HARDNESS ^{C22} RESILLENZA / IMPACT TEST													
HBW Tipo/Type ^{C40} Provetta / Test Specimen °C ^{C03} 1-Joule ^{C42} 2-Joule ^{C42} 3-Joule ^{C42} Media/Average ^{C43}													
154,0 - 158,0		KV		10x10 mm		-46 70 64 66		66,7					
Tratt. Term. / Heat treatment ^{C16}			NORMALIZED AT 930° C - COOLED IN STILL AIR			ELECTRIC FURNACE							
Dim in acc. a / Dim. acc. to ^{B14}			ASME/ANSI B 16.5 - 2013 ASME/ANSI B 36.10M - 2004										
Finitura / Roughness			125/250 MICROINCH AARH										
Marcatura in acc. / Marking in acc. to ^{B06}		MSS SP25 Ed. 2013	Vis. & Dim.	SATISFACTORY	Origine / Origin of Steel	EUROPEAN UNION							

Note / Notes
 100% MANUFACTURED IN ITALY
 MANUFACTURING IN ACCORDANCE WITH ORDER AND SPECIFICATION


UFFICIO CONTROLLO QUALITA' ^{A05} QUALITY CONTROL DEPARTMENT 	ENTE UFFICIALE DI COLLAUDO ^{Z03} INSPECTION AUTHORITY	MARCHIO PRODUZIONE ^{A04} MANUFACTURER'S SYMBOL 
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 METALFAR PRODOTTI INDUSTRIALI SPA 23861 CESANA BRIANZA (LC) - ITALY VIA G. PARINI, 28 PHONE + 39 031 655441 - FAX +39 031 655149 certificate@metalfaritaly.com		A01		COMPANY WITH MANAGEMENT SYSTEM CERTIFIED BY DNV = ISO 9001 = = ISO 14001 =																																																									
INSPECTION CERTIFICATE EN 10204:2004 / 3.1			A02	Nr ^{A03} 2015-C_MFF-00293 Data / Dated 22.01.2015 ^{Z02}																																																									
FORGED FLANGES & FITTINGS LTD CASTLE HOUSE - STATION ROAD EN5 1PE NEW BARNET/HERTFORDSHIRE			A05	Ordine / PO FFF 4121/C Item 174 DDT / Delivery note 2015-3E301-0000224 Packing List 2015-3E401-0000168 Fattura / Invoice 2015-3E401-0000168 No. rif. / Our ref. 2014-3E201-0003578-0174																																																									
Dest. F.F.F UK LTD - Canadian Branch TRADING AS - FFF CANADA 1811-86th Avenue, NW T6P 1M5 EDMONTON, ALBERTA (GST 80104-9834 RT0001)			A06	CA																																																									
Cod. colata ^{B07} Heat Code	Nr. colata ^{B07} Heat Nr. 14/70420	Quantità ^{B08} Quantity 260,00	Descrizione ^{B01 - (B09 - B11)} Description W/N 600 RF 2" XS LF2CL1																																																										
Mat. in acc. a / Mat. in acc. to ^{B02} ASTM/ASME A 350/SA 350 M - 14 ASME CODE SECT. II, PART A, ED. 2013 ASTM A350 LF2 CL1 NACE MR-0175/2009 ISO 15156 - SOUR SERVICE NACE MR-0103/2012 - SOUR SERVICE CSA Z245.12 GRADE 248 CAT.II SOUR SERVICE Q.A.S.IN ACCORD.WITH PRESS.EQUIPM.DIRECT.97/23/EC(PED) ANNEX I,PARAGRAPH 4.3 CERT.4687-2014-CE-ITA-ACCREDIA																																																													
<table border="1"> <thead> <tr> <th>Elementi / Elements ^(C17 - C22)</th> <th>C</th> <th>SI</th> <th>Mn</th> <th>S</th> <th>P</th> <th>Cr</th> <th>NI</th> <th>Mo</th> <th>TI</th> <th>Cu</th> <th>V</th> <th>Nb</th> <th>N</th> </tr> </thead> <tbody> <tr> <td>LADLE ANALYSIS</td> <td>0,180</td> <td>0,240</td> <td>0,860</td> <td>0,009</td> <td>0,015</td> <td>0,110</td> <td>0,070</td> <td>0,010</td> <td>0,015</td> <td>0,200</td> <td>0,003</td> <td>0,001</td> <td>0,000</td> </tr> <tr> <td>LADLE ANALYSIS</td> <td>0,025</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>CE LF</td> <td>CE SF</td> <td>F1</td> <td>F2</td> <td>PREN</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>0,366</td> <td>0,323</td> <td>0,393</td> <td>0,120</td> <td>--</td> </tr> </tbody> </table> <p>CE LF=C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE SF=C+Mn/6 F1=Cu+Ni+Cr+Mo+V F2=Cr+Mo</p>						Elementi / Elements ^(C17 - C22)	C	SI	Mn	S	P	Cr	NI	Mo	TI	Cu	V	Nb	N	LADLE ANALYSIS	0,180	0,240	0,860	0,009	0,015	0,110	0,070	0,010	0,015	0,200	0,003	0,001	0,000	LADLE ANALYSIS	0,025								CE LF	CE SF	F1	F2	PREN										0,366	0,323	0,393	0,120	--
Elementi / Elements ^(C17 - C22)	C	SI	Mn	S	P	Cr	NI	Mo	TI	Cu	V	Nb	N																																																
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									0,366	0,323	0,393	0,120	--																																																
<table border="1"> <thead> <tr> <th>Provetta ^{C10}</th> <th>Forma ^{C10}</th> <th>Snervamento >0,2% ^{C09}</th> <th>Snervamento >1,0% ^{C11}</th> <th>Rottura ^{C12}</th> <th>Allungamento ^{C13}</th> <th>Contrazione ^{C15}</th> </tr> <tr> <th>Test specimen</th> <th>Shape</th> <th>Yield Strength >0,2%</th> <th>Yield Strength >1,0%</th> <th>Tensile</th> <th>Elongation</th> <th>Reduction of area</th> </tr> <tr> <th>Sez/Sect mm2</th> <th>L mm</th> <th>MPa</th> <th>MPa</th> <th>MPa</th> <th>%</th> <th>%</th> </tr> </thead> <tbody> <tr> <td>126,60</td> <td>50,80</td> <td>1</td> <td>20</td> <td>319,0</td> <td>--</td> <td>513,0</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td>33,0</td> <td>62,0</td> </tr> </tbody> </table>						Provetta ^{C10}	Forma ^{C10}	Snervamento >0,2% ^{C09}	Snervamento >1,0% ^{C11}	Rottura ^{C12}	Allungamento ^{C13}	Contrazione ^{C15}	Test specimen	Shape	Yield Strength >0,2%	Yield Strength >1,0%	Tensile	Elongation	Reduction of area	Sez/Sect mm2	L mm	MPa	MPa	MPa	%	%	126,60	50,80	1	20	319,0	--	513,0						33,0	62,0																					
Provetta ^{C10}	Forma ^{C10}	Snervamento >0,2% ^{C09}	Snervamento >1,0% ^{C11}	Rottura ^{C12}	Allungamento ^{C13}	Contrazione ^{C15}																																																							
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126,60	50,80	1	20	319,0	--	513,0																																																							
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<table border="1"> <thead> <tr> <th colspan="2">DUREZZA / HARDNESS ^{C22}</th> <th colspan="4">RESILIENZA / IMPACT TEST</th> </tr> <tr> <th>HBW</th> <th>Tipo/Type ^{C40}</th> <th>Provetta / Test Specimen</th> <th>°C ^{C03}</th> <th>1-Joule ^{C42}</th> <th>2-Joule ^{C42}</th> <th>3-Joule ^{C42}</th> <th>Media/Average ^{C43}</th> </tr> </thead> <tbody> <tr> <td>154,0 - 158,0</td> <td>KV</td> <td>10x10 mm</td> <td>-46</td> <td>78</td> <td>70</td> <td>72</td> <td>73,3</td> </tr> </tbody> </table>						DUREZZA / HARDNESS ^{C22}		RESILIENZA / IMPACT TEST				HBW	Tipo/Type ^{C40}	Provetta / Test Specimen	°C ^{C03}	1-Joule ^{C42}	2-Joule ^{C42}	3-Joule ^{C42}	Media/Average ^{C43}	154,0 - 158,0	KV	10x10 mm	-46	78	70	72	73,3																																		
DUREZZA / HARDNESS ^{C22}		RESILIENZA / IMPACT TEST																																																											
HBW	Tipo/Type ^{C40}	Provetta / Test Specimen	°C ^{C03}	1-Joule ^{C42}	2-Joule ^{C42}	3-Joule ^{C42}	Media/Average ^{C43}																																																						
154,0 - 158,0	KV	10x10 mm	-46	78	70	72	73,3																																																						
Tratt. Term. / Heat treatment ^{C70} NORMALIZED AT 930° C - COOLED IN STILL AIR ELECTRIC FURNACE																																																													
Dim in acc. a / Dim. acc. to ^{B14} ASME/ANSI B16.5 -2013 ASME/ANSI B36.10M -2004																																																													
Finitura / Roughness 125/250 MICRORINCH AARH																																																													
Marcatura in acc. ^{B09} Marking in acc. to		MSS SP25 Ed. 2013	Vis. & Dim.	SATISFACTORY	Origine ^{B01} Origin of Steel	EUROPEAN UNION																																																							

Note / Notes: 100% MANUFACTURED IN ITALY
 MANUFACTURING IN ACCORDANCE WITH ORDER AND SPECIFICATION

VERIFIED TRUE COPY
 OF ORIGINAL
 FORGED FLANGES & FITTINGS
 LIMITED

UFFICIO CONTROLLO QUALITA' ^{A05} QUALITY CONTROL DEPARTMENT 	ENTE UFFICIALE DI COLLAUDO ^{Z03} INSPECTION AUTHORITY	MARCHIO PRODUZIONE ^{A04} MANUFACTURER'S SYMBOL 
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	METALFAR PRODOTTI INDUSTRIALI SPA 23861 CESANA BRIANZA (LC) - ITALY VIA G. PARINI, 28 PHONE + 39 031 655441 - FAX +39 031 655149 quality.mff@farmas.com	A01	COMPANY WITH MANAGEMENT SYSTEM CERTIFIED BY DNV = ISO 9001 = = ISO 14001 =
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INSPECTION CERTIFICATE EN 10204:2004 / 3.1	A02	Nr ^{A03} 2014-C_MFF-08181	Data / Dated 01.12.2014 ²⁰²
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TRANS AM PIPING PRODUCTS LTD 9335 ENDEAVOR DRIVE S.E. T3S 0A1 CALGARY, ALBERTA	CA	Ordine / PO CI-14-441 Item 132 DDT / Delivery note 2014-3E301-0004974 Packing List 2014-3E401-0004438 Fattura / Invoice 2014-3E401-0004438 Ns. rif. / Our ref. 2014-3E201-0002508-0132	A06 A07 A08
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Dest. TRANS AM PIPING PRODUCTS LTD 9335 - Endeavor Drive S.E. T3S 0A1 Calgary, ALBERTA	CA
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Cod. colata ^{B07} Heat Code	Nr. colata ^{B07} Heat Nr	B08	Descrizione ^{B01 - (B08 - B11)} Description
	14/71409		SAW 300 RF 1" 80 LF2CL1

Mat. In acc. a / Mat. in acc. to^{B02} ASTM/ASME A 350/SA 350 M - 14 ASME CODE SECT. II, PART A, ED. 2013
 ASTM A350 LF2 CL1
 NACE MR-0175/2009 ISO 15156 - SOUR SERVICE
 NACE MR-0103/2012 - SOUR SERVICE
 Q.A.S. IN ACCORD WITH PRESS. EQUIPM. DIRECT. 97/23/EC (PED) ANNEX I PARAGRAPH 4.3
 CERT-4687-2014-CE-ITA-ACCREDIA
 CSA Z245.12 GRADE 248 CAT. II SOUR SERVICE

Elementi / Elements ^(C01 - C02)	C	Si	Mn	S	P	Cr	Ni	Mo	Ti	Cu	V	Nb	N
LADLE ANALYSIS	0,190	0,220	0,880	0,010	0,014	0,150	0,060	0,010	0,018	0,200	0,002	0,003	0,000
LADLE ANALYSIS	AI	0,026							CE LF	CE SF	F1	F2	PREN
									0,386	0,337	0,422	0,160	--

CE LF=C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE SF=C+Mn/6 F1=Cu+Ni+Cr+Mo+V F2=Cr+Mo

Provetta ^{C10} Test specimen	Forma ^{C10} Shape	Snervamento > 0,2% ^{C11} Yield Strength > 0,2%	Snervamento > 1,0% ^{C11} Yield Strength > 1,0%	Rottura ^{C12} Tensile	Allungamento ^{C13} Elongation	Contrazione ^{C15} Reduction of area
Sez/Sect mm ²	L mm	MPa	MPa	MPa	%	%
126,50	50,80	331,0	--	518,0	32,0	60,0

DUREZZA / HARDNESS ^{C22}		RESILIENZA / IMPACT TEST				
HBW	Tipo/Type ^{C40}	Provetta / Test Specimen	°C ^{C03}	1-Joule ^{C42}	2-Joule ^{C42}	3-Joule ^{C42} Media/Average ^{C43}
152,0 - 156,0	KV	10x10 mm	-46	74	70	76 73,3

Tratt. Term. / Heat treatment ^{C70}	NORMALIZED AT 830° C - COOLED IN STILL AIR	ELECTRIC FURNACE
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Dim In acc. a / Dim. acc. to ^{B14}	ASME/ANSI B16.5 - 2013 ASME/ANSI B36.10M - 2004
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Finitura / Roughness	125/250 MICROROUGH AARH
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Marcatura In acc. to ^{B06} Marking In acc. to	MSS SP25 Ed. 2013	Vis. & Dim.	SATISFACTORY	Origine Origin of Steel	EUROPEAN UNION
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Note / Notes

100% MANUFACTURED IN ITALY
 MANUFACTURING IN ACCORDANCE WITH ORDER AND SPECIFICATION

UFFICIO CONTROLLO QUALITA' ^{A05} QUALITY CONTROL DEPARTMENT 	ENTE UFFICIALE DI COLLAUDO ²⁰³ INSPECTION AUTHORITY	MARCHIO PRODUZIONE ^{A04} MANUFACTURER'S SYMBOL 
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3846673 Item# 13
 Rev'd By: SB
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INSPECTION CERTIFICATE
INDUSTRIES CO., LTD.

PURCHASER : SEYBOLD INTL CORP.
 STANDARD : ASTM A420 WPL6-14
 MATERIALS : ASTM A333-6
 INSP. SPEC. : ASME B16.9 -12

8. MEI-CHUNG RD. NIAO-SONG,
 KAOSHUNG 83301, TAIWAN
 TEL: 886-77310527-8
 FAX: 886-77315887


DATE: 2015-01-29
 ORDER NO: 7009075/CI-14-503
 P.I. NO: 14102-3
 CERTIF. NO: 15A13-4

ACCORDING TO EN10204/DIN50049/3.1

ITEM NO.	PRODUCT & SIZE	QUANTITY PCS	MFG NO.	VISUAL & DIMENSIONAL INSPECTION	HARDNESS MAX 197 HB	HEAT TREATMENT (NOTE)	MAGNETIC PARTICLE EXAMINATION	IMPACT TEST (J)											
									CHEMICAL COMPOSITION %										
ITEM NO.	MATERIAL CHARGE NO.	STANDARD	MIN	MAX	C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	Y S	T S	E	C.E.
					x100	x100	x100	x1000	x1000	x100	x100	x100	x100	x100	x100	x1000	KSI	KSI	%
3	TEE 2"WPL6 XH				14H5594	GOOD	138-144	N	GOOD	10 x 2.5 x 2V AT -45 °C	45.3 42.6 43.5 43.8								
3	J3LA394		11	29	60	135	129	35	4	40	3	30	12	5	20	43.4	68.9	31.9	50 35


(NOTE):A:HOT FORMED WITH FINAL TEMPERATURE BETWEEN 620°C-980°C AIR COOLING.
 N:NORMALIZING AT TEMPERATURE 880°C X0.5HR AIR COOLING.
 NACE MR-01-75-09/ISO15156.2 NACE MR 0103-12:SATISFACTORY
 WE HEREBY CERTIFY THAT THE PRODUCT DESCRIBED HEREIN HAS BEEN MANUFACTURED IN ACCORDANCE WITH THE SPECIFICATIONS CONCERNED AND ALSO WITH THE PURCHASER'S REQUIREMENTS AND THAT THE TEST RESULTS SHOWN HEREIN ARE CORRECT.
 * TYPE OF SPECIMENS:STRIP(WIDTH:1 in./GAUGE LENGTH:2 in.) ** SAMPLING DIRECTION:L=LONGITUDINAL T=TRANSVERSE

Qu E Dam
 MANAGER OF Q.A. DEPT.



 I.M.L. - INDUSTRIA MECCANICA LIGURE S.P.A. Via Giancarlo Farina, 25 - 16030 Casarza Ligure - GE - ITALY Tel. +39 0185 467661 - Fax +39 0185 466510 - E-mail quality.Impl@farinagroup.com MATERIAL TEST DEPARTMENT		COMPANY WITH QUALITY SYSTEM ISO 9001: 2008 CERTIFIED BY RINA CERT. N°23/91/S																																																									
INSPECTION CERTIFICATE EN 10204:2004 / 3.1		Nr ^{A03} 2014-C. IML-25800	Data / Dated 21.10.2014 ^{Z02}																																																								
TRANS AM PIPING PRODUCTS LTD. 9335 Endeavor Drive S.E. Calgary, Alberta T3S 0A1		CA	Ordine / PO Item CI-14 - 573 253 DDT / Delivery note 2014-2E301-0001197 Packing List 2014-2E401-0001123 Fattura / Invoice 2014-2E401-0001123 Ns. rif. / Our ref. 2014-2E201-0001229-0253																																																								
Dest. TRANS AM PIPING PRODUCTS LTD. 9335 - Endeavor Drive S.E. Calgary, Alberta T3S 0A1		CA																																																									
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Note / Notes 100% MANUFACTURED IN ITALY
 SUPPLIED MATERIAL MEETS SPECIFICATIONS AND P.O. REQUIREMENTS

UFFICIO CONTROLLO QUALITA' QUALITY CONTROL DEPARTMENT 	ENTE UFFICIALE DI COLLAUDO INSPECTION AUTHORITY	MARCHIO PRODUZIONE MANUFACTURER'S SYMBOL IML or 
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 I.M.L. - INDUSTRIA MECCANICA LIGURE S.P.A. Via Giancarlo Farina, 25 - 16030 Casarza Ligure - GE - ITALY Tel. +39 0185 467661 - Fax +39 0185 466510 - E-mail quality.impl@farinagroup.com MATERIAL TEST DEPARTMENT		A01 COMPANY WITH QUALITY SYSTEM ISO 9001: 2008 CERTIFIED BY RINA CERT. N° 23/91/S																																																											
INSPECTION CERTIFICATE EN 10204:2004 / 3.1		A02 Nr ^{A03} 2015-C_IML-26327 Data / Dated 23.02.2015 ^{Z02}																																																											
TRANS AM PIPING PRODUCTS LTD. 9335 Endeavor Drive S.E. Calgary, Alberta T3S 0A1		A06 CA Ordine / PO CI-15 - 201 ^{A07} Item 53 DDT / Delivery note 2015-2E301-0000252 Packing List Fattura / Invoice ^{A08} Ns. rif. / Our ref. 2015-2E201-0000194-0053																																																											
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 SUPPLIED MATERIAL MEETS SPECIFICATIONS AND P.O. REQUIREMENTS

UFFICIO CONTROLLO QUALITA' ^{A05} QUALITY CONTROL DEPARTMENT Boris Fizzotti - Q.C. Manager 	ENTE UFFICIALE DI COLLAUDO ^{Z03} INSPECTION AUTHORITY	MARCHIO PRODUZIONE ^{A04} MANUFACTURER'S SYMBOL IML or 
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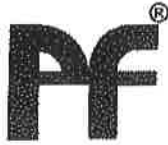
Calgary WH
#1, 7408 - 40 St SE
Calgary, Alberta, Canada
T2C2L6
Phone : 4032362216

To:

Document Summary Page

The MTRs are printed in the following order:

#	Heat	Item # / SKU	Description
1	719SS	34300RFSW86	3/4" 300# RF SW SCH 80S F316/L 02



PARAMOUNT FORGETM

MANUFACTURERS OF : FORGED FLANGES & FITTINGS

ISO 900
2008

TEST CERTIFICATE

TYPE EN10204:2004 3.1

CUSTOMER: M/S. UNIFIED ALLOYS, CANADA	PF/TC:32761	DATE:12/06/2014
P O. NO & DATE: CP-65439 DTD. 13/02/2014	INSPECTION AGENCY: -	

P.O. SR.NO.	DESCRIPTION	SIZE	DIMENSION	MATERIAL	HEAT NO.	QTY (Nos)
11	SCRD RF (NPT) FLANGES 150#	1 1/2" NPS	ASME B16.5 2009	ASTM/ASME A/SA182F316/316L 2013	719SS	40
12	SCRD RF (NPT) FLANGES 300#	1" NPS	ASME B16.5 2009	ASTM/ASME A/SA182F316/316L 2013	719SS	40
13	SCRD RF (NPT) FLANGES 150#	1 1/2" NPS	ASME B16.5 2009	ASTM/ASME A/SA182F304/304L 2013	626S	25
14	SWRF FLANGES 300# SCH.40S	1" NPS	ASME B16.5 2009	ASTM/ASME A/SA182F316/316L 2013	719SS	15
15	SWRF FLANGES 300# SCH.80S	3/4" NPS	ASME B16.5 2009	ASTM/ASME A/SA182F316/316L 2013	719SS	25

CHEMICAL COMPOSITION %

HEAT NO.	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	N	Ti	C
719SS	0.023	1.72	0.031	0.013	0.36	--	10.10	16.55	2.10	--	0.096	--	--
719SS	0.023	1.72	0.031	0.013	0.36	--	10.10	16.55	2.10	--	0.096	--	--
626S	0.020	1.87	0.036	0.015	0.51	--	8.14	18.06	--	--	0.086	--	--
719SS	0.023	1.72	0.031	0.013	0.36	--	10.10	16.55	2.10	--	0.096	--	--
719SS	0.023	1.72	0.031	0.013	0.36	--	10.10	16.55	2.10	--	0.096	--	--




PHYSICAL PROPERTIES

HEAT NO.	UTS	Y.S	%EL	RED. IN	HARDNESS	CHARPY V IMPACT TEST				
	MPa	MPa	-	AREA %		TEMP.	1	2	3	AVC
719SS	585.61	381.92	56.00	69.38	<22 HRC	--	--	--	--	--
719SS	585.61	381.92	56.00	69.38	<22 HRC	--	--	--	--	--
626S	586.08	307.19	56.80	70.64	<22 HRC	--	--	--	--	--
719SS	585.61	381.92	56.00	69.38	<22 HRC	--	--	--	--	--
719SS	585.61	381.92	56.00	69.38	<22 HRC	--	--	--	--	--

HEAT NO.	HEAT TREATMENT	HEAT TREATMENT TEMP.	LAB REF NO.
719SS	SOLUTION ANNEALED	1060 °C & WATER QUENCHED	E3/06/016
719SS	SOLUTION ANNEALED	1060 °C & WATER QUENCHED	E3/06/016
626S	SOLUTION ANNEALED	1060 °C & WATER QUENCHED	E3/03/040
719SS	SOLUTION ANNEALED	1060 °C & WATER QUENCHED	E3/06/016
719SS	SOLUTION ANNEALED	1060 °C & WATER QUENCHED	E3/06/016

REMARKS:

100% PMI TEST & FOUND SATISFACTORY.
 ASTM A262 IGC PRACTICE 'E' TEST SATISFACTORY.
 GEIGER - MULLER TEST SATISFACTORY- NIL RADIOACTIVITY.
 ALL MATERIAL CONFIRMS TO NACE MR0175 (2009), NACE MR0103 (2012) & ISO 15156.

Signature/Seal Of Surveyor		766070	PARAMOUNT FORGE  MANAGER QC 

Registered Office : 3, Guru Himmat Bldg., 140, Dr. Mascarenhas Road, Mazgaon, Mumbai - 400 010.
 ☎ : 91-22-2373 2656 / 6657 0979 / 2378 0007 Fax : 91-22-2373 2657

Factory : 99/100, 260/263, Jawahar Industrial Estate, Kamothe - 410 209, Panvel, (Dist. Raigadh) : 91-22-2743 0301, 2743 5058
 Fax : 91-22-2743 0802 ✉ : qaqc@paramountforge.org / pforge@bom5.vsnl.net.in Website : www.paramountforge.com

We Certify that all items herein conform to the applicable standards and customer requirements

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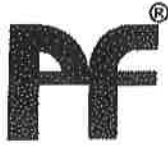
Calgary WH
#1, 7408 - 40 St SE
Calgary, Alberta, Canada
T2C2L6
Phone : 4032362216

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Document Summary Page

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PARAMOUNT FORGE™

MANUFACTURERS OF : FORGED FLANGES & FITTINGS

ISO 900
2008

TEST CERTIFICATE

TYPE EN10204:2004 3.1

CUSTOMER: M/S. UNIFIED ALLOYS, CANADA	PF/TC:32761	DATE:12/06/2014
P O. NO & DATE: CP-65439 DTD. 13/02/2014	INSPECTION AGENCY: -	

P.O. SR.NO.	DESCRIPTION	SIZE	DIMENSION	MATERIAL	HEAT NO.	QTY (Nos)
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12	SCRD RF (NPT) FLANGES 300#	1" NPS	ASME B16.5 2009	ASTM/ASME A/SA182F316/316L 2013	719SS	40
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CHEMICAL COMPOSITION %

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719SS	585.61	381.92	56.00	69.38	<22 HRC	--	--	--	--	--
626S	586.08	307.19	56.80	70.64	<22 HRC	--	--	--	--	--
719SS	585.61	381.92	56.00	69.38	<22 HRC	--	--	--	--	--
719SS	585.61	381.92	56.00	69.38	<22 HRC	--	--	--	--	--

HEAT NO.	HEAT TREATMENT	HEAT TREATMENT TEMP.	LAB REF NO.
719SS	SOLUTION ANNEALED	1060 °C & WATER QUENCHED	E3/06/016
719SS	SOLUTION ANNEALED	1060 °C & WATER QUENCHED	E3/06/016
626S	SOLUTION ANNEALED	1060 °C & WATER QUENCHED	E3/03/040
719SS	SOLUTION ANNEALED	1060 °C & WATER QUENCHED	E3/06/016
719SS	SOLUTION ANNEALED	1060 °C & WATER QUENCHED	E3/06/016

REMARKS:

100% PMI TEST & FOUND SATISFACTORY.
 ASTM A262 IGC PRACTICE 'E' TEST SATISFACTORY.
 GEIGER - MULLER TEST SATISFACTORY- NIL RADIOACTIVITY.
 ALL MATERIAL CONFIRMS TO NACE MR0175 (2009), NACE MR0103 (2012) & ISO 15156.

Signature/Seal Of Surveyor 	PARAMOUNT FORGE 766070 Manager QC 
---	--

Registered Office : 3, Guru Himmat Bldg., 140, Dr. Mascarenhas Road, Mazgaon, Mumbai - 400 010.
 ☎ : 91-22-2373 2656 / 6657 0979 / 2378 0007 Fax : 91-22-2373 2657

Factory : 99/100, 260/263, Jawahar Industrial Estate, Kamothe - 410 209, Panvel, (Dist. Raigadh) : 91-22-2743 0301, 2743 5058
 Fax : 91-22-2743 0802 ✉ : qaqc@paramountforge.org / pforge@bom5.vsnl.net.in Website : www.paramountforge.com

We Certify that all items herein conform to the applicable standards and customer requirements

CLIENTE / Customer / Client
TRANS AM PIPING PRODUCTS LTD.
 9335 ENDEAVOR DRIVE S.E.
 CALGARY, ALBERTA T3S 0A1
 CANADA

CERTIFICADO DE INSPECCION
 Inspection Certificate - Certificat de Réception

DIN EN 10204 / 3.1
 ISO 10474 / 3.1

FECHA: 02/06/2014
 N.º: 165161
 HOJA: 1
 Page: 1



Management Systems certified by LRSQE

PRODUCTO: FLANGES
 Article - Produit: SU PEDIDO N.º: PO# CI-14 - 283
 Your Order No.: Votrs Cde. N.º:

DE: - de 29/04/2014

Certified acc. PED 97/23/EC+AD2000-WO
 by TÜV Rheinland
 N.º 01 202 EIQ 02 7443

Bº Zubillaga, 3 - Apdo. 14
 20550 ONATI (Gipuzkoa) SPAIN
 Tel.: 34 - 943 780552
 Fax: 34 - 943 781808
 E-mail: ulma@ulmapiping.com

NORMAS APLICABLES: ASME B16.5-13
 Requirements - Normes Applicables

MATERIAL CORRESPONDIENTE: ASME SA350LF2CL-13, ASTM A350LF2CL-13
 Material Correspondant - Matière: NACE MR0175/ISO15156-2-08 & MR0103-12
 MODQ DE FUSION (?): Clause 7.2.1.4, Annex A.2 and SSC Region 3.
 Steel Making - Elaboration de l'acier: CSA-Z245.12-13 GR248 CAT II -SS (WN & BLIND FLANGES ONLY)
 E = Elec. Y = Oxígeno básico

MARCA DEL FABRICANTE: ULMA
 Mark of factory: ULMA
 Marque du fabricant: ULMA



DEPARTAMENTO: QUALITY ASSURANCE
 Section: Département

Packing List 109888

PARTIDA Item Poste	CANTIDAD Quantity	DESCRIPCION Description	LOTE	OBSERVACIONES Remarks Observations (?)	COLADA N.º Heat No N.º Coudée	T.Strength Resist Tensile N/mm2	Y.Strength Elongation 0.2 % N/mm2	ALARGAM. Elongation Lc. 4 d %	ESTRICCION Red Area Section %	RESILIENCIA Impact test Joules	CHARPY V 10x10mm Average C	DUREZA Hardness HBW			
2		WN 24 150LB STD/20 RF A350LF2	02A14	NE	A33V4	493	301	32,20	61,30	35	42	54	44	-50	145 160
2		WN 24 150LB STD/20 RF A350LF2	15F14	NE	A33V4	494	302	31,70	60,60	35	43	55	44	-50	145 160
3		WN 1 150LB XS/80 RF A350LF2	15F2	NE	54ZV1	504	307	35,00	65,50	39	59	48	45	-50	145 155
5		WN 24 150LB XS RF A350LF2	01A14	NE	A34V4	527	325	25,80	60,50	61	66	52	60	-50	149 159
5		WN 24 150LB XS RF A350LF2	03A14	NE	A34V4	513	311	31,40	69,00	49	64	66	56	-50	145 159
5		WN 24 150LB XS RF A350LF2	04F14	NE	D10V3	514	319	32,80	57,80	60	55	71	62	-50	163 169
6		WN 12 150LB S80 RF A350LF2	21Y14	NE	A86V4	505	315	30,10	58,60	53	59	58	57	-50	149 149
14		THR 3/4 150LB RF A350LF2	22Y14	NE	A86V4	521	322	26,80	55,50	57	63	74	65	-50	157 160
19		SW 1 150LB XS/80 RF A350LF2	2333	NE	A86V4	541	377	27,40	58,10	97	96	90	94	-50	153 160
20		SW 1 150LB XS/80 RF A350LF2	16E14T	NE	1640V3	527	323	28,40	47,60	66	74	71	70	-50	153 158

COMPOSICION QUIMICA - STEEL MAKERS LADLE ANALYSIS - ANALYSE CHIMIQUE

COLADA N.º Heat No N.º Coudée	C %	Si %	Mn %	P %	S %	Cr %	Ni %	Mo %	Nb %	V %	Cu %	Al %	Ti %	CEq %
1640V3	0,180	0,170	1,140	0,015	0,013	0,150	0,070	0,010	0,008	0,019	0,140	0,024	0,025	0,420
54ZV1	0,210	0,230	0,840	0,008	0,004	0,140	0,060	0,010	0,001	0,001	0,150	0,024	0,000	0,394
783M2	0,170	0,245	1,220	0,006	0,002	0,027	0,020	0,010	0,006	0,085	0,021	0,029	0,012	0,385
A33V4	0,160	0,230	0,910	0,007	0,004	0,120	0,099	0,034	0,001	0,000	0,281	0,039	0,001	0,388
A34V4	0,190	0,230	0,950	0,010	0,003	0,106	0,096	0,027	0,000	0,000	0,287	0,038	0,002	0,399
A86V4	0,190	0,200	1,040	0,009	0,004	0,060	0,060	0,010	0,005	0,002	0,160	0,035	0,000	0,392
A86V4	0,190	0,230	1,100	0,011	0,003	0,080	0,100	0,010	0,010	0,005	0,170	0,030	0,005	0,410
D10V3	0,200	0,240	1,000	0,011	0,004	0,107	0,096	0,041	0,001	0,002	0,226	0,026	0,002	0,418

(?) OBSERVACIONES: N.º NORMALIZED AT 900 C AND ALLOWED TO COOL IN STILL AIR
 Remarks Observations

EL INSPECTOR
 Works Inspector - L'inspecteur

ULMA FORJAS S.COOP.
 Dpto. de Garantía de calidad
 Quality Assurance Dept.

- Las dimensiones y la condición superficial se hallan satisfactorias.
- Dimension and surface condition were found acceptable.
- Les dimensions et états de surface sont satisfaisants.
- Los materiales citados cumplen las normas aplicables.
- Manufacturing requirements are satisfied.
- Les normes applicables sont respectées.



Manufacturer of Piping and Pressure Vessel Components
 4404 Haygood St - Houston, TX 77022
 Phone: 713-695-3633 Fax: 713-695-3528
 A Bonney Forge Company

Sold To: TRANS AM PIPING
 PRODUCTS LTD
 9335 ENDEAVOR DRIVE S.E.
 CALGARY AB T3S 0A1

MTR #: 287,434

PO #: CI-14 - 697

Sales Order #: C001416390

Date: 11/21/2014

This product has not come in direct contact with mercury or any of its compounds, nor with any mercury-containing device employing a single boundary of containment. No welding performed.

Certified Material Test Report

Heat Code: 58962

We certify that the contents of this report are correct and accurate, and that all test results and operations performed by WFI or its subcontractors are in compliance with the material specification and requirements of the referenced code or standard, and that the material conforms to the dimensional requirements of the order. This document is in accordance with EN10204 3.1.

Material: A/SA350 00a LF2 CL1

Item	Description
37	36 - 3/4 X 1/2 3M SWP A350LF2 CL1

Chemical Composition

Ladle	C	CR	CU	MN	MO	NB	NI	P
	0.200	0.04	0.07	1.05	0.005	0.012	0.02	0.009
	S	SI	V					
	0.019	0.20	0.004					
Carbon Equivalency:	Ladle			0.39				

Product	Tensile PSI	Yield PSI	Elong %	RA %	Hardness	
Charpy V-Notch Properties:	79,000	47,700	28.00	63.00	159 BHN	163 BHN
			Test Temperature:		-50 F	
FT LBS: 49/43/29		% Shear: NB/NB/NB			MLE: NB/NB/NB	

Normalized

1. IN ACCORDANCE WITH NACE MR0175 / ISO 15156-2009

Marie Dehmer
 Quality Assurance Representative



Manufacturer of Piping and Pressure Vessel Components
 4404 Haygood St - Houston, TX 77022
 Phone: 713-695-3633 Fax: 713-695-3528
 A Bonney Forge Company

Sold To: TRANS AM PIPING
 PRODUCTS LTD
 9335 ENDEAVOR DRIVE S.E.
 CALGARY AB T3S 0A1

MTR #: 284,228

PO #: CI-14-539

Sales Order #: C001413977

Date: 09/26/2014

This product has not come in direct contact with mercury or any of its compounds, nor with any mercury-containing device employing a single boundary of containment. No welding performed.

Certified Material Test Report

Heat Code: 59443

We certify that the contents of this report are correct and accurate, and that all test results and operations performed by WFI or its subcontractors are in compliance with the material specification and requirements of the referenced code or standard, and that the material conforms to the dimensional requirements of the order. This document is in accordance with EN10204 3.1.

Material: A/SA350 12 LF2 CL1

Item	Description
34	2 1/2 - 1 1/4 X 1 3M THP A350LF2 CL1
42	2 1/2 - 1 1/4 X 1 3M SWP A350LF2 CL1

Chemical Composition

Ladle	C	CR	CU	MN	MO	NB	NI	P
	0.200	0.03	0.06	1.02	0.006	0.014	0.02	0.006
	S	SI	V					
	0.021	0.21	0.004					
Carbon Equivalency:	Ladle		0.38					

Product	Tensile PSI	Yield PSI	Elong %	RA %	Hardness
	72,673	49,216	36.10	59.94	132 BHN
Charpy V-Notch Properties:			Test Temperature:	-50 F	
FT LBS: 25/23/24	% Shear: NB/NB/NB		MLE: NB/NB/NB		

Normalized

1. IN ACCORDANCE WITH NACE MR0175 / ISO 15156-2009

CERTIFIED MILL TEST REPORT



LOG NO. F0000000065680 Page 10 of 13

BONNEY FORGE CORPORATION
 P.O. BOX 330 • 14496 CROGHAN PIKE • MOUNT UNION, PA 17066-0330
 (814) 542-2545 • (800) 345-7546 • FAX (814) 542-4906
 www.bonneyforge.com

CUSTOMER: CCTF CORPORATION

DATE 11/11/2014

CUSTOMER ORDER NO.: 4896236-00

BONNEY ORDER NO. B000177105

SHIP TO: CCTF CORPORATION (EDMONTON)
 5407 - 53RD AVE.
 EDMONTON AB T6B 3G2
 Canada

ITEM	QUANTITY	LOT NO.	GRADE OR SPECIFICATION NO.	CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS:
19 7680031		59357	3/4 3000 LF2 90EL S	SA/A350 LF2 CL1 Al 0.035 C 0.200 Co 0.005 Cr 0.040 Cu 0.130 Mn 1.010 Mo 0.007 N 0.003 Nb 0.013 Ni 0.020 P 0.006 S 0.020 Si 0.210 V 0.004 CE(Long Formula) = 0.39 T/S(PSI) 74,055 Y/S(PSI) 49,090 EL(%) 34.40 RA(%) 59.71 Brinell 130 BHN 130 BHN Charpy -50 F 33/30/33 (Ft-Lbs) Average 32.00
20 7680032		59530	1 3000 LF2 90EL S	SA/A350 LF2 CL1 Al 0.030 C 0.200 Cb 0.000 Co 0.003 Cr 0.060 Cu 0.070 Mn 1.050 Mo 0.006 Nb 0.015 Ni 0.030 P 0.012 S 0.020 Si 0.190 V 0.005 CE(Long Formula) = 0.40 T/S(PSI) 73,351 Y/S(PSI) 51,967 EL(%) 37.00 RA(%) 68.57 Brinell 135 BHN 137 BHN Charpy -50 F 43/58/57 (Ft-Lbs) Average 52.70
22 7680166		59344	1 6000 LF2 90EL S	SA/A350 LF2 CL1 Al 0.028 C 0.200 Co 0.005 Cr 0.050 Cu 0.110 Mn 1.010 Mo 0.006 N 0.004 Nb 0.012 Ni 0.030 P 0.013 S 0.019 Si 0.230 V 0.004 CE(Long Formula) = 0.39 T/S(PSI) 76,343 Y/S(PSI) 51,191 EL(%) 36.75 RA(%) 62.94 Brinell 132 BHN 130 BHN Charpy -50 F 26/23/17 (Ft-Lbs) Average 22.00

We certify that the data on this sheet is a true copy taken from our records of material furnished us by the production mill, or as obtained by additional laboratory checks.

by Kylee Ruiz
 Kylee Ruiz
 QUALITY PROCESS MANAGER

CMTR: REV2

CERTIFIED MILL TEST REPORT



LOG NO. F0000000065680

Page 13 of 13

BONNEY FORGE CORPORATION

P.O. BOX 330 • 14496 CROGHAN PIKE • MOUNT UNION, PA 17066-0330

(814) 542-2545 • (800) 345-7646 • FAX (814) 542-4906

www.bonneyforge.com

CUSTOMER: CCTF CORPORATION

DATE 11/11/2014

CUSTOMER

BONNEY ORDER NO. B000177105

ORDER NO.: 4896236-00

SHIP TO: CCTF CORPORATION (EDMONTON)

5407 - 53RD AVE.

EDMONTON AB T6B 3G2

Canada

ITEM QUANTITY LOT NO.

GRADE OR SPECIFICATION NO
CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS.

1. THE FITTINGS SUPPLIED ARE IN ACCORDANCE WITH PURCHASE ORDER SPECIFICATIONS.
2. CERTIFYING TO ASTM A350 LF2 07 REVISION.
3. THE MATERIAL OF THE FITTINGS SUPPLIED IS ASTM A350-LF2 BUT MEETS THE REQUIREMENTS OF ASME SA350-LF2.
4. THE CHARPY V-NOTCH IMPACT TEST WAS PERFORMED AT -50 DEGREES FAHRENHEIT IN ACCORDANCE WITH A350-LF2.
5. THE MATERIAL SUPPLIED AS A350 LF2 CL1 MEETS THE REQUIREMENTS OF BOTH NACE MRO103-2007 AND NACE MRO175/ISO 15156-2.
6. THE MATERIAL SUPPLIED WAS NORMALIZED IN ACCORDANCE WITH ASTM A350 HEAT TREATING REQUIREMENTS.
7. THE PRODUCT SUPPLIED WAS INSPECTED IN ACCORDANCE WITH EN 10204:2004 EDITION TYPE 3.1 INSPECTION DOCUMENT. (EUROPEAN STANDARD)
8. THE UNIT OF MEASURE FOR TENSILE AND YIELD (0.2%) STRENGTH ARE REPORTED IN PSI.
9. ELONGATION TEST RESULTS ARE OBTAINED USING STANDARD ROUND SPECIMEN, 2 INCH OR 50 MM GAGE LENGTH.

We certify that the data on this sheet is a true copy taken from our records of material furnished us by the production mill, or as obtained by additional laboratory checks.

by

Kylee Ruiz
QUALITY PROCESS MANAGER

CMTR: REV2



Manufacturer of Piping and Pressure Vessel Components

4404 Haygood St - Houston, TX 77022

Phone: 713-695-3633 Fax: 713-695-3528

A Bonney Forge Company

Sold To: TRANS AM PIPING
 PRODUCTS LTD
 9335 ENDEAVOR DRIVE S.E.
 CALGARY AB T3S 0A1

MTR #: 288,803

PO #: CI-14-798

Sales Order #: C001417290

Date: 12/19/2014

This product has not come in direct contact with mercury or any of its compounds, nor with any mercury-containing device employing a single boundary of containment. No welding performed.

Certified Material Test Report

Heat Code: 59653

We certify that the contents of this report are correct and accurate, and that all test results and operations performed by WFI or its subcontractors are in compliance with the material specification and requirements of the referenced code or standard, and that the material conforms to the dimensional requirements of the order. This document is in accordance with EN10204 3.1.

Material: A/SA105N 11

Item	Description
11	36 - 8 X 2 3M THP A/SA105N

Chemical Composition

Ladle	C	CR	CU	MN	MO	NB	NI	P
	0.2000	0.04	0.06	1.010	0.008	0.009	0.040	0.005
	S	SI	V					
	0.024	0.210	0.003					

Carbon Equivalency: Ladle 0.39

Product	Tensile PSI	Yield PSI	Elong %	RA %	Hardness
	73,027	48,978	36.65	65.37	135 BHN
					135 BHN

Normalized

1. IN ACCORDANCE WITH NACE MR0175 / ISO 15156-2009



Manufacturer of Piping and Pressure Vessel Components
 4404 Haygood St - Houston, TX 77022
 Phone: 713-695-3633 Fax: 713-695-3528
 A Bonney Forge Company

Sold To: TRANS AM PIPING
 PRODUCTS LTD
 9335 ENDEAVOR DRIVE S.E.
 CALGARY AB T3S 0A1

MTR #: 293,791

PO #: CI-15-234

Sales Order #: C001512569

Date: 03/24/2015

This product has not come in direct contact with mercury or any of its compounds, nor with any mercury-containing device employing a single boundary of containment. No welding performed.

Certified Material Test Report

Heat Code: 59783

We certify that the contents of this report are correct and accurate, and that all test results and operations performed by WFI or its subcontractors are in compliance with the material specification and requirements of the referenced code or standard, and that the material conforms to the dimensional requirements of the order. This document is in accordance with EN10204 3.1.

Material: A/SA350 12 LF2 CL1

Item	Description
48	36 - 1 1/2 X 3/4 3M SWP A350LF2 CL1

Chemical Composition

Ladle	C	CR	CU	MN	MO	Nb	NI	P
	0.2200	0.04	0.07	1.060	0.009	0.012	0.030	0.008
	S	SI	V					
	0.015	0.190	0.004					

Carbon Equivalency: Ladle 0.41

Product	Tensile PSI	Yield PSI	Elong %	RA %	Hardness
Charpy V-Notch Properties:	77,778	55,737	36.00	62.65	139 BHN
			Test Temperature:		-50 F
	FT LBS: 81/37/32	% Shear: NB/NB/NB			MLE: NB/NB/NB

Normalized

1. IN ACCORDANCE WITH NACE MR0175 / ISO 15156-2009

National Process PO# 3938456 Item# 5
 Heat Number: 74307 Products Ltd. - Rev'd By: SB
 Trans Am Piping Products Ltd. - Shipm't/Seq #: 13 - 1377
 1/2" CL 600 S/W FLANGE RF XH
 BORE A350-LF2 CL 1



METALFAR
 PRODOTTI INDUSTRIALI S.P.A.

STAMPAGGIO A CALDO DI ACCIAI COMUNI - LEGATI E INOSSIDABILI

SEDE AMMINISTRATIVA E STABILIMENTO:
 23861 CESANA BRIANZA (LC) - Italy
 Via G. Parini, 28
 Tel. +39 031.655441
 Fax +39 031.655149
 quality.mff@farnas.com

COMPANY WITH
 QUALITY SYSTEM
 CERTIFIED BY DNV
 = ISO 9001 =

SALA PROVE E ANALISI MATERIALI / MATERIAL TEST DEPARTMENT

CERTIFICATO DI COLLAUDO SECONDO EN 10204 - 3.1 INSPECTION CERTIFICATE

Certif. N. 3109 DDT / Del Note N. 2436	Del/Dated 31.05.2013 Del/Dated 30.05.2013	Fattura / Invoice N. 2107 No.Ord. / Our ref. N.	Del/Dated 30.05.2013 Del/Dated
TRANS AM PIPING PRODUCTS LTD 9335 ENDEAVOR DRIVE S.E. T3S 0A1 CALGARY, ALBERTA CA		Dest.: F.F.F. c/o TRANS AM PIPING PRODUCTS LTD 9335 Endeavor Drive S.E. T3S 0A1 CALGARY, ALBERTA CA	

Pag. 2 - 32

COD. COL. COLATA HEAT CODE HEAT	POS. ITEM	VS. ORDINE YOUR REFERENCE	Q.TA' Q.TY	DESCRIZIONE DESCRIPTION	DIM. IN ACC. A DIM. ACCORDANCE TO	VISIVO E DIMENS. VIS. & DIMENS.											
74307	062	3755/TRANS AM	20,00	S/W 600 RF 1/2" 80 LF2CL1	ASME/ANSI B16.5 -2009	SATISFACTORY											
MATERIALE / MATERIAL ASTM A350 LF2 CL1/2 (LADLE)		C% 0,180	SI% 0,210	Mn% 1,010	S% 0,011	P% 0,010	Cr% 0,080	Ni% 0,050	Mo% 0,010	Ti% 0,018	Cu% 0,200	V% 0,024	Nb% 0,001	N% 0,000	Al% 0,025	C.E.% 0,387	
PROVETTA / TEST SPECIMEN SEZ. mm2 SECT. mm2	LUNG. mm LENGHT mm	FORMA SHAPE 1= O 2= □	SNERVAMENTO YIELD POINT N/mm2 >=0,2%	ROTTURA TENSILE STRENGHT N/mm2 >=	ALLUNGAMENTO ELONGATION %>=	CONTRAZIONE REDUCTION OF AREA %>=	DUREZZA HARDNESS HBW	REBILLENZA / IMPACT TEST - JOULE/cm2				SNERVAMENTO YIELD POINT N/mm2 >=1,0%	N.R. OUR REF.				
126,60	50,80	1	342,0	552,0	32,0	57,0	166,0 - 170,0	TIPO / TYPE 10x10mm °C				0,0					
MATERIALE IN ACCORDO A / MATERIAL IN ACC. TO ASTM/ASME A 350/SA 350 M - 12 ASME CODE SECT. II, PART A, ED. 2010 ADD.				TRATTAMENTO TERMICO / HEAT TREATMENT NORMALIZED AT 930 C - COOLED IN STILL AIR				FORNO / FURNACE ELECTRIC FURNACE				ORIGINE / ORIGIN OF STEEL EUROPEAN UNION					
CSA Z245.12 GRADE 248 CAT.II SOUR SERVICE																	

COD. COL. COLATA HEAT CODE HEAT	POS. ITEM	VS. ORDINE YOUR REFERENCE	Q.TA' Q.TY	DESCRIZIONE DESCRIPTION	DIM. IN ACC. A DIM. ACCORDANCE TO	VISIVO E DIMENS. VIS. & DIMENS.											
12/30356	164	3804/TRANS AM	30,00	BOSSED 300 RF 1" A105N	ASME/ANSI B16.5 -2009	SATISFACTORY											
MATERIALE / MATERIAL ASTM A105 (LADLE)		C% 0,190	SI% 0,200	Mn% 0,950	S% 0,008	P% 0,006	Cr% 0,060	Ni% 0,040	Mo% 0,010	Ti% 0,017	Cu% 0,080	V% 0,001	Nb% 0,002	N% 0,000	Al% 0,026	C.E.% 0,371	
PROVETTA / TEST SPECIMEN SEZ. mm2 SECT. mm2	LUNG. mm LENGHT mm	FORMA SHAPE 1= O 2= □	SNERVAMENTO YIELD POINT N/mm2 >=0,2%	ROTTURA TENSILE STRENGHT N/mm2 >=	ALLUNGAMENTO ELONGATION %>=	CONTRAZIONE REDUCTION OF AREA %>=	DUREZZA HARDNESS HBW	REBILLENZA / IMPACT TEST - JOULE/cm2				SNERVAMENTO YIELD POINT N/mm2 >=1,0%	N.R. OUR REF.				
126,60	50,80	1	335,0	518,0	31,0	58,0	156,0 - 159,0	TIPO / TYPE 10x10mm °C				0,0					
MATERIALE IN ACCORDO A / MATERIAL IN ACC. TO ASTM/ASME A 105/SA 105 M - 11a ASME CODE SECT. II, PART A, ED. 2010 ADD. 2011a				TRATTAMENTO TERMICO / HEAT TREATMENT NORMALIZED AT 920 C - COOLED IN STILL AIR				FORNO / FURNACE ELECTRIC FURNACE				ORIGINE / ORIGIN OF STEEL EUROPEAN UNION					
CSA Z245.12 GRADE 248 CAT.I SOUR SERVICE																	

NOTE 100% MANUFACTURED IN ITALY NOTES MANUFACTURING IN ACCORDANCE WITH ORDER AND SPECIFICATION MATERIAL IN ACCORDANCE WITH NACE MR-0175/2009 ISO 15156-2009 - SOUR SERVICE MATERIAL IN ACCORDANCE WITH NACE MR-0103/2012 - SOUR SERVICE	UFFICIO CONTROLLO QUALITA' QUALITY CONTROL DEPARTEMENT	ENTE UFFICIALE DI COLLAUDO INSPECTION AUTHORITY	MARCHIO PRODUZIONE MANUFACTURER'S SYMBOL
	<i>S. Erigido</i>		

Material Test Report

EN 10204:2004 3.1
 ISO 10474 3.1

ISO
 9001:2008
 Registered
 Cert.#6H271-156

Customer : UNIFIED ALLOYS
Address : #1 - 7408 - 40 ST. S.E.
CALGARY - ALBERTA T2C 2L6

SOMTR No : 73782
Customer PO : CP-70151
Certificate Date : May 05, 2015

Manufacturer's
 mark

Heat No.	Item	Qty	Description	Material Specification	Heat Treatment
12/1703	1	1	B16 3/4" 1500 RF SW S80S B16	10-ASA182E316/316L	SOLUTION ANNEALED @ 1920°F [1050°C]

Chemical Properties All values in % with minimum and maximum values as indicated

Heat No.	C	Mn	P	S	SI	NI	Cr	Mo	N	J.Fcd	ASME	C Eq.	CSA
Heat Analysis	Max 0.030 Spec. Min 0.000	2.000 0.000	0.045 0.000	0.030 0.000	1.000 0.000	15.000 10.000	18.000 16.000	3.000 2.000	0.100 0.000				
12/1703 Product Analysis	Max 0.021 Spec. Min 0.000	2.430 0.000	0.035 0.000	0.029 0.000	0.430 0.000	10.060 10.000	16.800 16.000	2.030 3.000	0.064 0.100				
12/1703													

Starred values indicate values are not sufficiently present for conformity with another grade, per ASME BPVC-II A.

Physical Properties Values in units indicated, with specification requirements as indicated

Tensile, Yield, Elongation, and Reduction testing & acceptance criteria per ASME BPVC Sec. II, A and B. Grain size to ASTM E112, UT to ASTM A389/A745, LP/DP to ASTM E165, IGC to ASTM A323 practice E, CCR to ASTM G48 method A/D/P to ASTM A923 method C, Fer % to ASTM E562/E1285, Charpy to ASTM A370/A923 method B, longitudinal and full specimen; all acceptance criteria per ASME BPVC Sec. VIII, 1B2. All preceding unless otherwise noted

Heat No.	Tensile ksi / MPa	Yield ksi / MPa	El., % min	Red., % min	BHN	Grain Size	UT	DP	IGC	Bar Ext.	Fer %	Charpy Impact Test per Test, Joules-ft-lb	Avg. J/ft-lb
Spec.	075/517min	030/207min	30	50								0 / 0	0 / 0
12/1703	86 / 592	46 / 317	56	75	177							/	/

-Products and materials comply with NACE MR0175/ISO15156 and MR0103 and are certified free from mercury, alpha particle, radium contamination, and weld repair throughout all phases of manufacturing and shipping. All products marked per MSS SP-25, coating, paint, coding, and tagging per Pro-Flange and customer requirements.
 -Compliance statement: Products supplied are in compliance with the requirements of the order, and with the requirements of all manufacturing, testing, and visual & dimensional examinations of all referenced standards and specifications. All specifications and standards are to the latest published year/revision, unless otherwise stated.




This document is electronically generated and is valid without a signature, as per EN 10204.

Order#: 411524 Seq: 1 PO#: PUR633586 Heat#: 330592 Mill: Salzgitter Mannesmann Line Pipe
 Part#: P .75 XS S3 S P Part Desc: Pipe 3/4 (26.7mm O.D.) EXTRA HEAVY SMLS A/SA333-6 SRL PLAIN END (.154W)

(A01) Salzgitter Mannesmann Rohr Sachsen GmbH Mannesmannstrasse 11 01619 Zeithain	 SALZGITTER MANNESMANN PRECISION <small>A Member of the Salzgitter Group</small>	(A02) (INSPECTION CERTIFICATE 3.1 ACC.TO EN 10204:2004 (A03) No.: 80043700/0000 Page: 1/4 Date: 01.10.2014
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(A06.1) Orderer Vallourec Deutschland GmbH Theodorstraße 109 40472 Düsseldorf	(A08.1) MRS-Order-No. 112565 Item N 000001
(A06.2) Suborderer VALLOUREC TUBES CANADA INC. 5515 NORTH SERVICE ROAD BURLINGTON/ONTARIO L7L 6G4	(A08.2) Orderer-No. 85673777 Item N 1
(A06.3) EDMONTON,AB/CANADA	(A07.2) Suborderer Nr. VM3504 Date

(B01, B02, B04) Description of the product	(B01.1) SELLER:  HOT FINISHED SEAMLESS PIPE FOR LOW TEMPERATURE SERVICE SOUR SERVICE MAX. 10 % SHORT LENGTHS, NOT SHORTER THAN 17 FT TUBE ENDS CLOSED BY PLASTIC PLUGS ENDS PLAIN, SQUARE CUT IN BUNDLES OF MAX. 4000 KG, WITH 6 STEEL BANDS AND 2 SLINGS (NYLON) FOR CONTAINER REPORT ELEMENTS: C, MN, P, S, SI, CR, CU, MO, NI, V, NB, TI, SN, AL, N ASTM A 333 M - 13 ASTM A 999 M - 13 ASME SA 333 M, EDITION 2013 ASME SA 999 M, EDITION 2013 ASME BOILER AND PRESSURE VESSEL CODE, SECTION II, PART A, EDITION 2013 NACE MR 0175/ISO 15156-2:2009/ EN ISO 15156-2:2009, ANNEX A.2.1.2 CSA Z 245.1:2009 NACE STANDARD MR 0103-2010, PARAGRAPH 2.1 SPEC. CCTF-6, REV. 3, DATED MAY 2014 GRADE 6 / GRADE 1 / GRADE 290 (CSA Z245.1, CAT. II) NORMALIZED INSIDE WITHOUT RUST PROTECTION OUTSIDE DRY VARNISH SKU-NO. 2530155 V & M FRANCE NO/ITEM SC0831/01
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(B03) EDDY CURRENT TEST ACC. TO CSA Z 245.1 IMPACT TEST ON CHARPY-V LONGITUDINAL SPECIMENS (UNDER SIZE TEST COUPONS 10 X 2,50)

Order#: 411524 Seq: 1 PO#: PUR633586 Heat#: 330592 Mill: Salzgitter Mannesmann Line Pipe
 Part#: P .75 XS S3 S P Part Desc: Pipe 3/4 (26.7mm O.D.) EXTRA HEAVY SMLS A/SA333-6 SRL PLAIN END (.154W)

(A01) Salzgitter Mannesmann Rohr Sachsen GmbH Mannesmannstrasse 11 01619 Zeithain	 SALZGITTER MANNESMANN PRECISION A Member of the Salzgitter Group	(A02) (INSPECTION CERTIFICATE 3.1 ACC.TO EN 10204:2004 (A03) No.: 80043700/0000 Page: 2/4 Date: 01.10.2014
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(B03)
 AND TEMPERATURE REDUCTION AS PER ASTM A 333)
 WITH REPORT OF LATERAL EXPANSION
 AND FRACTURE APPEARANCE IN % SHEAR,
 TO THE EXTENT SPECIFIED FOR TENSILE TEST
 AT - 45 DEGR. C
 AVERAGE VALUE OF 3 SINGLE SPECIMENS MIN. 6,8 J
 LOWEST SINGLE VALUE MIN. 5,5 J
 HARDNESS HRC MAX. 22
 WITHOUT HIC-TEST:satisfactory

(S201) Item	(S202) Cust. Item	(B14) Item text	(B09) Dimensions	(B10) Single length
1	1	112565	NPS 0,75 X SCHED. 80	FIXED LENGTH 20 FT (6096 MM) SINGLE LENGTH TOLERANCE IN IN +4/-0

(S203) Item	(S204) Cust. Item	(B08) Quantity ST	(B11) Total length m	(B13) Weight kg
1	1	247	1505,72	3326

(C71)
HEAT CHEMICAL ANALYSIS

(B07.1) Heat	(B15) Process	C	Si	Mn	P	S	Al	Cr	Ni	Mo	V	Cu	Ti
		%	%	%	%	%	%	%	%	%	%	%	%
min	-		0,10	0,40									
max	-	0,26	0,50	1,06	0,025	0,025		0,40	0,40	0,15	0,110	0,40	0,110
330592	Oxygen	0,14	0,18	0,95	0,010	0,002	0,029	0,05	0,05	0,01	0,001	0,03	0,006

(B07.1) Heat	(B15) Process	Nb/Cb	B	Sn	N	Co	F3						
		%	%	%	%	%	%						
min	-												
max	-	0,110	0,0010				0,150						
330592	Oxygen	0,001	0,0001	0,002	0,007	0,003	0,008						

Heats fully killed

Order#: 411524 Seq: 1 PO#: PUR633586 Heat#: 330592 Mill: Salzgitter Mannesmann Line Pipe
 Part#: P .75 XS S3 S P Part Desc: Pipe 3/4 (26.7mm O.D.) EXTRA HEAVY SMLS A/SA333-6 SRL PLAIN END (.154W)

(A01) Salzgitter Mannesmann Rohr Sachsen GmbH Mannesmannstrasse 11 01619 Zeithain	 <p>SALZGITTER MANNESMANN PRECISION <small>A Member of the Salzgitter Group</small></p>	(A02) (INSPECTION CERTIFICATE 3.1 ACC.TO EN 10204:2004 (A03) No.: 80043700/0000 Page: 3/4 Date: 01.10.2014
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(A04, B06)
MARKING, IDENTIFICATION

	<p>ACC. TERMS OF DELIVERY/SPEC.</p> <p>PAINT STENCILED ON ONE SIDE DISTANCE FROM END MM 300</p> <p>MANUFACTURER SALZGITTER MANNESMANN ROHR SACHSEN MANUFACTURER'S MARK MRS VALLOUREC LOGO \$\$\$\$</p> <p>SELLER'S NAME VALLOUREC</p> <p>TERMS OF DELIVERY A333/SA333/Z245.1-09 GRADE GRADE6 / 1 / 290 CAT II PROCESS OF MANUFACTURE HFS HEAT-NO. HEAT NO. \$\$\$\$\$\$</p> <p>CUSTOMER DIM. MM 26,7 X 3,91 CUSTOMER DIM. INCH NW 3/4 X SCHED.80 TEST TEMPERATURE CHARPY LT-45 C</p> <p>MARKING TEXT SS TEST PRESSURE BAR \$\$\$\$ BAR TEST PRESSURE PSI \$\$\$\$\$\$ PSI HEAT TREATMENT HN</p> <p>TUBE/PIPE LENGTH MM \$\$\$\$</p> <p>TUBE/PIPE LENGTH FT \$\$\$\$\$\$</p> <p>INSPECTOR'S SIGN WA COUNTRY OF ORIGIN GERMANY CUSTOMER ORDER-NO. VM3504 ORDER-NO. USER 4895245-00</p>
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Order#: 411524 Seq: 1 PO#: PUR633586 Heat#: 330592 Mill: Salzgitter Mannesmann Line Pipe
 Part#: P .75 XS S3 S P Part Desc: Pipe 3/4 (26.7mm O.D.) EXTRA HEAVY SMLS A/SA333-6 SRL PLAIN END (.154W)

(A01) Salzgitter Mannesmann Rohr Sachsen GmbH Mannesmannstrasse 11 01619 Zeithain	 SALZGITTER MANNESMANN PRECISION <small>A Member of the Salzgitter Group</small>	(A02) (INSPECTION CERTIFICATE 3.1 ACC.TO EN 10204:2004)
		(A03) No.: 80043700/0000 Page: 4/4 Date: 01.10.2014

(A04, B06)
MARKING, IDENTIFICATION

	(INSPECTION CERTIFICATE 3.1 ACC.TO EN 10204:2004)
	COLOUR RING ONE SIDE COLOUR(S) YELLOW COLOUR(S) WHITE

The supplied products are in compliance with the requirements of the order.

Date	01.10.2014
Validated by	Inspection representative
	RACZ 
Phone	(03525)-792318
FAX	(03525) 791146
EMAIL	ULRIKE.RACZ@SMP-TUBES.DE
Stamp	

Indication in parentheses correspond to attributes according to EN 10168

This testimonial and certification respectively may neither be modified nor used for other products. Offences are regarded as falsification of documents and will be subject to criminal prosecution.

Benteler Steel/Tube GmbH
Postfach 13 40
33043 Paderborn
Deutschland
Tel.: +49.5254.81-0 Fax: +49.5254.13666

1^{cs}/80 ASTM/ASME A/SA-333 626/45 S69936
A/SA-106 B DUAL

BENTELER 
Steel/Tube

ABNAHMEPRÜFZEUGNIS EN 10204-3.1
INSPECTION CERTIFICATE EN 10204-3.1
CERTIFICAT DE RECEPTION EN 10204-3.1
EN 10204:2005-01

Benteler Steel/Tube GmbH · Postfach 1340 · 33043 Paderborn · Deutschland

SEAMLESS STEEL PIPE LTD.
6771 - 84 STREET S.E.
CALGARY, AB T2C 4T6
CANADA

Dokument-Nr.: 41-698338/001/P

Document No.:
No. du document:

Kunden-Bestell-Nr.: BST 12-5489 / SSP I-12188

Purchase Order No.:
No. de commande du client:

Benteler Auftrags-Nr.: 1573199

Benteler Order No.:
No. de commande Benteler:

Versandanzeigen-Nr.: 4197327

Dispatch Note No.:
No. d'avis d'expédition:

Produkt: NAHTLOSE STAHLROHRE
Product: SEAMLESS STEEL TUBES
Produit: TUBES D'ACIER SANS SOUDURE

Prüf-Nr.:
Inspection No.:
No. du certificat:

Hersteller: Warmrohrwerk/Zieherei
Manufacturer: ISO/TS 16949 (ISO 9001) TÜV CERT 44111090381-002
Producteur: PED 97/23/EC TÜV CERT 07-202-5635 WZ-0606/0H

Herstellerzeichen:
Manufacturer's brand:
Marque du producteur:



Stempel des Abnahmebeauftragten: WA
Stamp of the inspection representative:
Poinçon du contrôleur:

Stahlschmelzungsverfahren: ELEKTROSTAHL
Steelmaking process: ELECTRIC FURNACE
Procédé d'élaboration de l'acier: FOUR ELECTRIQUE

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Lieferbedingungen: ASTM-A 333-2010-HF, ASME SA-333-HF, ASME Section II Part A Edition 2010 Addenda 2011a, CSA Standard
Terms of delivery: Z245.1-07 Category II, Sour Service, ANSI/NACE MRO175/ISO 15156-1: 2009, ANSI/NACE MRO175/ISO
Conditions de livraison: 15156-2: 2009

Maße - Toleranzen: ASME B36.10M-2004, ASME SA-999 ASME Section II Part A Edition 2010, ASTM-A 999-2011
Dimensions-tolerances:
Dimensions-tolérances:

Stahlsorte: GRADE 1, GRADE 290, GRADE 6
Steel grade:

Nuance d'acier:

Lieferzustand: Normalized
Delivery condition:

État de livraison:

Produktkennzeichnung: FS: BENTELER Z.245.1-A/SA333 1/6/290 CAT II CATEGORIE 2 SS HEAT-NO. M45C SMLS HN
Product marking: DIMENSIONS SCHEDULE WA GERMANY I-12188
Marquage du produit:

AEZ = Ätztintenbeschriftung, Etching ink marking, Gravure à l'encre · FK = Farbkennzeichnung, colour marking, marquage par couleur · FS = Farbschablonierung, paint stencilling, marquage par peinture · FSD = Farbstrahldrucker, Colour jet printer, Imprimante à jet d'encre de couleur · LK = Laserkennzeichnung, Laser marking, Marquage laser · PKE = Etikettenkennzeichnung, tag marking, marquage sur étiquette · PS = Prägestempel, die stamp, marquage par poinçonnage · TS = Tintenstrahlkennzeichnung, ink jet spray marking, imprimante à jet

ABNAHMEPRÜFZEUGNIS EN 10204-3.1
 INSPECTION CERTIFICATE EN 10204-3.1
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Pos.	Stück	Maße	Länge	Gewicht	Schmelzen-Nr.	Prüfdruck	Rohr-Nr.-Gruppe	Vielfachlängen
Item	Number	Dimensions	Length	Weight	Heat No.	Test pressure	Tube number group	Multiple lengths
Poste	Nombre	Dimensions	Longueur	Poids	No. de coulée	Pression d'épreuve	Série de no. des tubes	Longueurs multiples
			feet	lbs		PSI		Longueurs multiples
0001	96	1" NPS * Sched. 80 20 FT - 22 FT	1920,01	4542	569936	3000	5	

Schmelzenanalyse [%] / Heat analysis [%] / Analyse sur coulée [%]

Pos.	Schmelzen-Nr.	C	SI	MN	P	S	CR	MO	NI	CU	V	NB	TI	B
Item	Heat No.													
Poste	No. de coulée													
0001	569936	0,140	0,190	0,77	0,006	0,002	0,05	0,03	0,06	0,06	0,001	0,012	0,002	0,0001

- Formel: $CE_{IIW} = C + (Mn/6) + ((Cr + Mo + V)/5) + ((Cu + Ni)/15) \leq 0,42 \%$
- Formel: $CEV = C + F * ((Mn/6) + (Si/24) + (Cu/15) + (Ni/20) + ((Cr + Mo + V + Nb)/5) + (5 * B)) \leq 0,40$
- Formel: $Mn/C > = 3/1$
- Formel: $Cr + Cu + Mo + Ni + V < = 1,00 \%$

Formelergbnisse / Formula results / Résultats des formules

Pos.	Schmelzen-Nr	1. Formel	2. Formel	3. Formel	4. Formel
Item	Heat No.	1. Formula	2. Formula	3. Formula	4. Formula
Poste	No. de coulée	1. Formule	2. Formule	3. Formule	4. Formule
0001	569936	0,293	0,278	5,500	0,201

Produktanalyse [%] / Product analysis [%] / Analyse sur produit [%]

Pos.	Schmelzen-Nr.	C	SI	MN	P	S	CR	MO	NI	CU	V	NB	TI	B
Item	Heat No.													
Poste	No. de coulée													
0001	569936	0,130	0,180	0,76	0,005	0,001	0,05	0,03	0,05	0,06	0,001	0,015	0,001	0,0003

- Formel: $CE_{IIW} = C + (Mn/6) + ((Cr + Mo + V)/5) + ((Cu + Ni)/15) \leq 0,42 \%$
- Formel: $CEV = C + F * ((Mn/6) + (Si/24) + (Cu/15) + (Ni/20) + ((Cr + Mo + V + Nb)/5) + (5 * B)) \leq 0,40$
- Formel: $Mn/C > = 3/1$
- Formel: $Cr + Cu + Mo + Ni + V < = 1,00 \%$

Benteler Steel/Tube GmbH
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Formelergebnisse / Formula results / Résultats des formules

Pos.	Schmelzen-Nr	1. Formel	2. Formel	3. Formel	4. Formel
Item	Heat No.	1. Formula	2. Formula	3. Formula	4. Formula
Poste	No. de coulée	1. Formule	2. Formule	3. Formule	4. Formule
0001	569936	0,280	0,259	5,846	0,191

Prüfergebnisse / Test results / Résultats des essais

Die Rohre sind auf Dichtheit geprüft durch: Hydrostatic test: acc. to CSA Z245.1, holding time min 5 seconds, Test PASSED
 The tubes have been submitted to a leak tightness test by: pressure/Time-record
 Les tubes ont passé un contrôle d'étanchéité par:

Die Rohre wurden zerstörungsfrei geprüft: ET-test: acc. to CSA Z245.1; for imperfections; drilled hole: 3,20 mm PASSED
 The tubes are non destructive tested:
 Les tubes ont passé un essai non destructif:

Augensichtkontrolle: PASSED Biegeversuch: PASSED Maßkontrolle: PASSED
 Visual inspection: Bending test: Dimensions examination:
 Examen visuel: Essai de cintrage: Vérification des dimensions:

Ringfaltversuch: PASSED
 Flattening test:
 Essai d'aplatissement:

Ergebnisse der mechanischen Prüfung / Results of mechanical testing / Résultats des essais mécaniques

Die Probennahme erfolgte an Vielfachlängen.
 The sampling was carried out on multiple lengths.
 L'échantillonnage était réalisé aux longueurs multiples.

Zugversuch längs Vollprobe / Tensile test longitudinal Full section test specimen / Essai de traction longitudinale Eprouvette a section complete

Pos.	Proben-Nr.	Schmelzen-Nr	Probenabmessung	Streckgrenze	Zugfestigkeit	Dehnung	Einschnürung
Item	Specimen No.	Heat No.	Specimen dimensions	Yield strength	Tensile strength	Elongation	Area reduction
Poste	No. de l'éprouvette	No. de coulée	Dimensions de l'éprouv.	Limite élastique	Résistance à la traction	Allongement	Coefficient de striction
Anforderungen				ReH	Rm	A2"	1. Formel
Requirements			mm	N/mm ²	N/mm ²	%	1. Formula
Exigences				290-495	415-625	MIN 35	1. Formule
0001	000001	569936	33,45 X 4,50	304	448	54	
0001	000002	569936	33,45 X 4,50	306	445	56	

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Härteprüfung / Hardness test / Essai de dureté

Pos. Item Poste	Proben-Nr. Specimen No. No. de l'éprouv.	Schmelzen-Nr. Heat No. No. de coulée	Härte Hardness Dureté	HRC	HB	HV	HRB	HBW
Anforderungen Requirements								
Exigences					MAX 200			
0001	000001	569936			132			
0001	000002	569936			131			

Kerbschlagbiegeversuch Notched bar impact test / Essai de flexion par choc (résilience) [1 CHARPY_V]

Pos. Item Poste	Proben-Nr. Specimen No. No. de l'éprouv.	Schmelzen-Nr. Heat No. No. de coulée	Probenabmessung Specimen dimensions Dimensions de l'éprouvette			Probenlage Specimen position Position de l'éprouvette	Prüftemperatur Test temperature Température d'essai	Kerbschlagarbeit Absorbed energy Energie absorbée		Kerbschlagzähigkeit Impact strength Résistance au choc		Verf.-Bruchanteil Shear fracture Rupture ductile
			Länge Length Longueur	Breite Width Largeur	Höhe Height Hauteur	längs (L) longitudinal (L) longitudinal (L)	einzel single individuelle	mittel average moyenne	einzel single individuelle	mittel average moyenne		
Anforderungen Requirements												
Exigences						quer (Q) transversal (Q) transversal (Q)	GRAD °C -45	J MIN 011	J	J/cm² J/cm²	J/cm² J/cm²	
0001	000001	569936	55	4,00	10,00	L	-45	61				
				4,00	10,00			58				
				4,00	10,00			57	59			

Restmagnetismus / Demagnetize / Démagnétiser

demagnetized tubes: 1 measurement per 4 hours on both tube ends Two readings 180° apart around the circumference. Average value max 3.0 Millitesla (24 A/cm), individual value max 3.5 Millitesla (28 A/cm)

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BENTELER 
Steel/Tube

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Vermerk / Remark / Remarque

NACE Standard: Hardness acc. to ANSI/NACE MR0175/ISO 15156: HRC max 22., The material meets the requirements of NACE MR0103;
Certificate remarks: The Material also meets the requirements of ASTM A / ASME SA-106-B, Sour Service, The Material is Aluminium
deoxydized and inclusion shape controlled with Calcium-Silicon treatment, This is to confirm that the seamless linepipe supplied
by Benteler and verified to CSA Standard Z245.1-07 meets the requirement for micro hardness of max. 248 HV 500 gf., No weld
repair has been carried out; Bend test: mandrel diameter 12D; Bending angle: 90 °

Grain size determination: acc. to ASTM-E 112, Grain size 6 and finer: = 10

Verkäufer(in) / Salesman/ woman in charge / Personne chargée : Mrs Schöneweis, Tel.: 05254/81-4234, Fax: 4289


BENTELER
Steel/Tube GmbH

Paderborn Schloß Neuhaus, 06.06.2012, TEL.: 05254.81-1767 FAX: 05254.81-1752

Abnahmebeauftragter
Inspection representative
Contrôleur

THOMAS GOLLAN / TEM

Es wird bestätigt, daß die gelieferten Erzeugnisse den techn. Lieferbedingungen des Auftrages entsprechen. Dieses Dokument wurde mittels EDV erstellt und ist ohne Unterschrift rechtsgültig.
We certify that the supplied products comply with the order specification. This document was prepared by means of electronic data processing and is valid without signature.
Nous attestons que les produits livrés sont conformes aux stipulations de la commande. Ce document a été établi par traitement électronique de l'information et est valide sans signature.

2" S/80 A/SA-333 GR6 HT 1126277V

3

HENGYANG VALIN STEEL
TUBE CO., LTD

MILL TEST REPORT

Add: 10 Dalixincun, Hengyang City, Hunan, P.R. China
P.C.: 421001
Tel and Fax: +86 734 8873739
E-mail: hsiec@hysteeltube.com

(ACCORDING TO EN10204 3.1B)

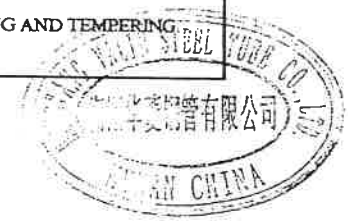
CUSTOMER	CCTF Corporation		CERTIFICATE NO.	C201130739-1	
CONTRACT NO.	2110002130-13	P.O.NO.	DATE:	2011-10-27	PAGE: 1/3
PRODUCT			DELIVERY CONDITION	N	
SPECIFICATION	SEE SPECIFICATION NOTE	HEAT TREATMENT			
GRADE	ASTM/ASME A333-6/SA333-6/NACE MR0175/ISO 15156-2(REGION 3)/MR01103/SS/CSA Z245.1 GRADE 290 CAT II		DIMENSIONS(INCH)	2**0.218**21FT	2860081
TOTAL BUNDLES:	14	TOTAL PIECES:	470	TOTAL LENGTH:	9868.740 FT
				TOTAL WEIGHT:	22.497 MT

NO.	LOT No.	HEAT No.	BUNDLES	PIECES	LENGTH FT	WEIGHT MT	TENSILE TEST ASTM A370					FLATTENING TEST	
							SAMPLE TYPE/ ORIENTATION / SIZE(mm)/GAUGE LENGTH(mm):SV\12.5\50						
Max	Min						TS(MPa)	YS(MPa)	Rp0.2	EL(%)	R.A. (%)	YS/TS	
1	918402319	1125679V	2	77	1616.800	3.686	458/455	320/336		34.5/34.0		0.7/0.7	ACCEPTABLE
2	918402320	1114163V	4	120	2519.680	5.744	448/450	339/341		35.5/34.0		0.8/0.8	ACCEPTABLE
3	919202018	1126277V	8	273	5732.260	13.067	459/461	354/357		36.0/36.0		0.8/0.8	ACCEPTABLE

NO.	IMPACT TEST								NON METALIC INCLUSION	GRAIN SIZE	
	NOTCH TYPE/ORIENTATION/TEMPERATURE/SIZE (mm):										
	V8/L/T1-57/0/3				V8/L/T1-57/0/3						
Max	Min	AK1 (J)	Av. (J)	% SHEAR AREA	LE	AK2 (J)	Av. (J)	% SHEAR AREA	LE		
1		34.0/36.0/34.0	35	70/75/75	//	44.0/48.0/42.0	45		//		
2		36.0/32.0/40.0	36	75/70/80	//	50.0/44.0/42.0	45		//		
3		34.0/44.0/46.0	41	95/90/90	//	34.0/36.0/40.0	37		//		

NOTES:
W1-THEORETICAL WEIGHT SAMPLE ORIENTATION : L-LONGITUDINAL T-TRANSVERSE N-NORMALIZING HE-HOT EXPANDED
W2-ACTUAL WEIGHT SAMPLE TYPE: S-STRIP C- CLUBBED F-FULL-SECTION A-ANNEALING HR-HOT ROLLED
NR-NORMALIZING ROLLED Q&T-QUENCHING AND TEMPERING Av.-AVERAGE N&T-NORMALIZING AND TEMPERING
AK1-ABSORB ENERGY FOR THE FIRST SET AK2-ABSORB ENERGY FOR THE SECOND SET LE-SIDE EXPANSION

ORIGINAL



HENGYANG VALIN STEEL
TUBE CO., LTD

MILL TEST REPORT

Add: 10 Dalixincun, Hengyang
City, Hunan, P. R. China P. C. : 421001
Tel and Fax: +86 734 8873739
E-mail: hsiiec@hysteeltube.com

(ACCORDING TO EN10204 3.1B)

CUSTOMER	CCTF Corporation		CERTIFICATE NO.	C201130739-1	
CONTRACT NO.	2110002130- 13	P. O. NO.	DATE:	2011-10-27	PAGE: 3/3
PRODUCT			DELIVERY CONDITION	N	
SPECIFICATION	SEE SPECIFICATION NOTE	HEAT TREATMENT			
GRADE	ASTM/ASME A333-6/SA333-6/NACE MR0175/ISO 15156-2(REGION 3)/MR01103/SS/CSA Z245.1 GRADE 290 CAT II		DIMENSIONS(INCH)	2"0.218"21FT	
TOTAL BUNDLES: 14	TOTAL PIECES: 470	TOTAL LENGTH: 9868.740 FT	TOTAL WEIGHT: 22.497		

		REMARK :


SPECIFICATION NOTE	ASTM/ASME A333/SA333/NACE
--------------------	---------------------------

We hereby certify that material herein described has been manufactured in accordance with the standards and specifications required in your order and satisfies the corresponding requirements.

This certificate is issued by a computerized system and it is valid with electroic signature. On the original certificate the trade-mark JOINTIME light-green coloured at the bottom of the page is stamped .In case the owner of the certificate would relea

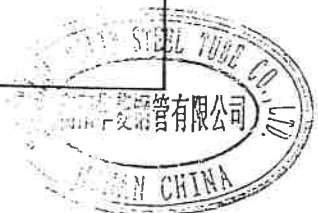
Any alteration and or falsification will be subject to the law.

If you need to assure the authenticity of this certificate ,please do not hesitate to contact Hengyang Valin Steel Tube CO.,LTD, E-mail: hsiiec@hysteeltube.com

Quality Manager: 

Certificate-maker: 曾黎明

ORIGINAL



2" S180 A/SA-333 GR6 15 1126526V

3

HENGYANG VALIN STEEL
TUBE CO., LTD

MILL TEST CERTIFICATE

Add: 10 Dalixincun, Hengyang City, Hunan, P. R. China
P.C.: 421001
Tel and Fax: +86 734 8873739
E-mail: hsiiec@hysteeltube.com

2 XH A333

(ACCORDING TO EN10204 3.1B)

CUSTOMER	CCTF Corporation		CERTIFICATE NO.	C201129608-1	
CONTRACT NO.	2110002205-13	P.O.NO.	DATE:	2011-10-19	PAGE: 1/3
PRODUCT			DELIVERY CONDITION	N	
SPECIFICATION	SEE SPECIFICATION NOTE		HEAT TREATMENT		
GRADE	ASTM/ASME A333-6/SA333-6/NACE MR0175/ISO 15156-2(REGION 3)/MR01103/SS/CSA Z245.1 GRADE 290 CAT II		DIMENSIONS(INCH)	2"0.218**21FT	
TOTAL BUNDLES:	7	TOTAL PIECES:	261	TOTAL LENGTH:	5480.300 FT
				TOTAL WEIGHT:	12.493 MT

2860081

NO.	LOT No.	HEAT No.	BUNDLES	PIECES	LENGTH FT	WEIGHT MT	TENSILE TEST ASTM A370						FLATTENING TEST
							SAMPLE TYPE/ ORIENTATION / SIZE(mm)/GAUGE LENGTH(mm):SUA12.S150						
Max							TS(MPa)	YS(MPa)	Rp0.2	EL(%)	R.A. (%)	YS/TS	ACCEPTABLE
Min													
1	91X200406	1126526V	7	261	5480.300	12.493	466/463	356/351		35.0/34.0		0.8/0.8	

NO.	IMPACT TEST								NON METALLIC INCLUSION	GRAIN SIZE	HARDNESS TEST	
	NOTCH TYPE/ORIENTATION/TEMPERATURE/SIZE (mm): V8/T/L/0/-56/3										NACE MR0175/ISO 15156.2/NACE MR0103	
	AK1 (J)	Av. (J)	% SHEAR AREA	LE	AK2 (J)	Av. (J)	% SHEAR AREA	LE			HRC	
1	8.0/32.0/40.0/33	32/39	86/88/89	//	//					11.0/		

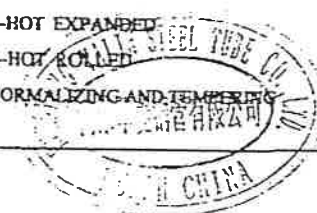
NOTES:

W1-THEORETICAL WEIGHT
W2-ACTUAL WEIGHT
NR-NORMALIZING ROLLED
AK1-ABSORB ENERGY FOR THE FIRST SET

SAMPLE ORIENTATION: L-LONGITUDINAL T-TRANSVERSE
SAMPLE TYPE: S-STRIP C-CLUBBED F-FULL-SECTION
Q&T-QUENCHING AND TEMPERING
AK2-ABSORB ENERGY FOR THE SECOND SET

N-NORMALIZING
A-ANNEALING
Av.-AVERAGE
LE-SIDE EXPANSION

HE-HOT EXPANDED
HR-HOT ROLLED
N&T-NORMALIZING AND TEMPERING



ORIGINAL

HENGYANG VALIN STEEL
TUBE CO., LTD

MILL TEST CERTIFICATE

Add: 10 Dalixincun, Hengyang
City, Hunan, P. R. China P. C. : 421001
Tel and Fax: +86 734 8873739
E-mail: hsiiec@hysteeltube.com

(ACCORDING TO EN10204 3.1B)

CUSTOMER	CCTF Corporation		CERTIFICATE NO.	C201129608-1	
CONTRACT NO.	2110002205- 13	P. O. NO.	DATE:	2011-10-19	PAGE: 3/3
PRODUCT			DELIVERY CONDITION	N	
SPECIFICATION	SEE SPECIFICATION NOTE	HEAT TREATMENT			
GRADE	ASTM/ASME A333-6/SA333-6/NACE MR0175/ISO 15156-2(REGION 3)/MR01103/SS/CSA Z245.1 GRADE 290 CAT II		DIMENSIONS(INCH)	2"0.218"21FT	
TOTAL BUNDLES: 7	TOTAL PIECES: 261	TOTAL LENGTH: 5480.300 FT	TOTAL WEIGHT :	12.493	
		REMARK :			

SPECIFICATION NOTE	ASTM/ASME A333/SA333/NACE
--------------------	---------------------------

We hereby certify that material herein described has been manufactured in accordance with the standards and specifications required in your order and satisfies the corresponding requirements.

This certificate is issued by a computerized system and it is valid with electroic signature. On the original certificate the trade-mark JOINTIME light-green coloured at the bottom of the page is stamped .In case the owner of the certificate would relea

Any alteration and or falsification will be subject to the law.

If you need to assure the authenticity of this certificate ,please do not hesitate to contact Hengyang Valin Steel Tube CO.,LTD. E-mail: hsiiec@hysteeltube.com

CUSTOMER THIRD PARTY

Quality Manager: 



Certificate-maker: 倪小平

ORIGINAL



SEAMLESS STEEL PIPE LTD

NWP INDUSTRIES INC.
4017 - 60 AVENUE
INNISFAIL , ALBERTA
T4G 1S9
1-403-227-4102

CERTIFICATE OF COMPLIANCE

BRINNEL HARDNESS TEST RESULTS
PIN BRINNEL TESTER TO NACE MR0175 / ISO 15156

<u>Heat</u>	<u>Description</u>	<u>BHN</u>
1126526V	2" S/80 (.218") SMLS ASTM /ASME A/SA-333 GR 6	138


JOHN MACRAE

QA rep.

May 7, 2014

Date: _____

Heat No.

1126526V

CARBON EQUIVALENT CALCULATION

2" S/80 (.218") 60.3 mm X 5.54 mm

SMLS ASTM /ASME A/SA-333 GR 6 S R/L B.B.E.

		C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Nb	B	Ti	HARDNESS
A-333 GR 6	MAX	.30	1.06	.025	.025		0.40	0.40	0.30	0.12	0.08	.02			
A-106 B	MAX	.30	1.06	.035	.035		0.40	0.40	0.40	0.15	0.08				
HT	1126526V	H .10	1.04	.012	.0019	.26	.06	.02	.07	.04	.0033	.026	.0002		BHN 138
		P													
	MIN		.29			0.10									

A-333 GR 6 For each reduction of 0.01% carbon below 0.30%, an increase of 0.05% manganese above 1.06% would be permitted to a maximum of 1.35% manganese

A-106 B For each reduction of 0.01% carbon below 0.30%, an increase of 0.06% manganese above 1.06% would be permitted to a maximum of 1.35% manganese

C. E.

H	P
0.30	
0.32	
0.24	0.24
0.36	0.36
0.19	
0.66	

$$1) = C + (Mn/6) + (Cr + Mo + V)/5 + (Ni + Cu)/15$$

$$2) = C + (Mn/6) + .05$$

$$3) = C + F(Mn/6 + Si/24 + Cu/15 + Ni/20 + (Cr + Mo + V + Nb)/5 + 5B)$$

$$4) = C + (Mn/4)$$

$$5) = Cr + Mo + Ni + V + Cu$$

F = Compliance Factor

2" XH A106B
Heat # 1424374

9530075

HENGYANG VALIN
STEEL TUBE CO.,LTD

MILL TEST CERTIFICATE

Add: 10 Dalidacun, Hengyang City, Hunan, P.R. China P.C.: 421001

Tel and Fax: +86 734 8873739

E-mail: hstec@hysteeltube.com

(ACCORDING TO EN10204 3.1B)

CUSTOMER				CERTIFICATE NO.	C201425625-1				
CONTRACT-ITEM NO.	2111001258-05	P.O.NO.	BSC100090		DATE:	2014-8-19	PAGE: 1/3		
PRODUCT	SEAMLESS STEEL LINE PIPE			DELIVERY CONDITION	HR				
SPECIFICATION	SEE SPECIFICATION NOTE		HEAT TREATMENT						
GRADE	B,B/X42,Grade 290		DIMENSIONS		NPS 2 XH 40FT				
TOTAL BUNDLES:	50	TOTAL PIECES:	946	TOTAL LENGTH:	37864.844	ft	TOTAL WEIGHT:	86.335	mt

NO.	BATCH No.	HEAT No.	BUNDLES	PIECES	LENGTH ft	WEIGHT mt	TENSILE TEST ASTM A370					COLD BENDING TEST
							SAMPLE TYPE/ ORIENTATION / SIZE(mm)/GAUGE LENGTH(mm):SLA1950					
							TS(psi)	YS(psi)	RT0.5	EL(%)	R.A. (%)	
1	947300813	1424371	17	320	12808.404	29.204	72935	50605	31.0	0.69	ACCEPTABLE	
2	947300814	1424374	19	356	14249.349	32.490	68585	46400	30.0	0.68	ACCEPTABLE	
3	947300815	1424372	14	270	10807.091	24.641	72210	50605	30.5	0.70	ACCEPTABLE	

NO.	IMPACT TEST								NON METALIC INCLUSION	GRAIN SIZE	HARDNESS TEST	
	NOTCH TYPE/ORIENTATION/TEMPERATURE(C)/SIZE (mm): ///										NACB MR0175	
	AKI (J)	Av.(J)	% SHEAR AREA	LE	AK2 (J)	Av.(J)	% SHEAR AREA	LE			HV10	
1	/				/					/160.7////////		
2	/				/					/161.0////////		
3	/				/					/161.0////////		

NOTES:

W1-THEORETICAL WEIGHT

W2-ACTUAL WEIGHT

NR-NORMALIZING ROLLED

AK1-ABSORB ENERGY FOR THE FIRST SET

SAMPLE ORIENTATION: L-LONGITUDINAL T-TRANSVERSE

SAMPLE TYPE: S-STRIP C- CLUBBED F-FULL-SECTION

Q&T-QUENCHING AND TEMPERING

AK2-ABSORB ENERGY FOR THE SECOND SET

N-NORMALIZING

A-ANNEALING

Av.-AVERAGE

LE-SIDE EXPANSION

HE-HOT EXPANDED

HR-HOT ROLLED

N&T-NORMALIZING AND TEMPERING

MTR Approved

Kenton Dechant
Kenton
2014 Oct 10

HENGYANG VALIN
STEEL TUBE CO.,LTD

MILL TEST CERTIFICATE

Add: 10 Dalixincun, Hengyang City, Hunan, P.R. China P.C.:421001

Tel and Fax: +86 734 8873739

E-mail: hysicc@hysteeltube.com

(ACCORDING TO EN10204 3.1B)

CUSTOMER			CERTIFICATE NO.	C201425625-1		
CONTRACT-ITEM NO.	2111001258-05	P.O.NO.	BSC100090	DATE:	2014-8-19	PAGE: 2/3
PRODUCT	SEAMLESS STEEL LINE PIPE			DELIVERY CONDITION	HR	
SPECIFICATION	SEE SPECIFICATION NOTE		HEAT TREATMENT			
GRADE	B.B/X42, Grade 290			DIMENSIONS	NPS 2 XH 40FT	
TOTAL BUNDLES:	50	TOTAL PIECES:	946	TOTAL LENGTH:	37864.844	ft
				TOTAL WEIGHT:	86.335	mt

NO	HEAT No. BATCH No.	Type	CHEMICAL COMPOSITION (%)																																	
			C	Si	Mn	Cr	Mo	W	Cu	Ni	P	Al	Sn	As	Pb	Sb	Nb	Ti	Zr	N	Bi	S	V	B	Ca	CE	SUM1	SUM2	SUM3	R1	R2	R3				
			*100			*1000										*10000			*100		*1000															
		P																																		
1	1424371	H	14	29	126	69	22		79	19	14						1	10					32	37	2		38	192.7	4.7	14.7			9.0			
	947300813	P	13	28	124	55	16		56	17	11						1	9					33	38	1		36	147.8	4.8	13.8			9.5			
	947300813	P	14	29	127	55	16		57	20	12						1	10					41	39	1		37	151.9	4.9	14.9			9.1			
	1424374	H	13	27	124	56	17		63	18	13						1	11					36	36	1		36	157.6	4.6	15.6			9.5			
2	947300814	P	14	28	127	56	15		57	18	11						1	9					31	39	1		37	149.9	4.9	13.9			9.1			
	947300814	P	13	29	127	56	16		57	19	12						1	10					35	39	1		36	151.9	4.9	14.9			9.8			
	1424372	H	15	28	126	52	19		75	20	13						1	12					25	35	2		38	169.5	4.5	16.5			8.4			
3	947300815	P	14	31	130	54	17		50	17	14						1	9					47	42	1		38	142.2	5.2	14.2			9.3			
	947300815	P	14	30	130	55	16		51	17	14						1	9					41	42	1		38	143.2	5.2	14.2			9.3			
		H																																		
		P																																		
		P																																		
		H																																		
		P																																		
		P																																		

NON-DESTRUCTIVE TEST				BEVELLING	
POSITION	PIPE BODY	PIPE END	END SURFACE(GROOVE)		
NDT Type(Level)	ET/L2	MPI		ACCEPTABLE	
	UT/L3	UT/L3		VISUAL & DIMENSION	
LAMINAR				ACCEPTABLE	
TEST RESULT	ACCEPTABLE	ACCEPTABLE	N/A	COATING	
RESIDUAL MAGNETISM			ACCEPTABLE		
UT THICKNESS MEASUREMENT			N/A		
HYDROSTATIC TEST	Min(psi/s)	3000/6	ACCEPTABLE	ACCEPTABLE	

NOTES: H-HEAT ANALYSIS P-PRODUCT ANALYSIS CE-EQUIVALENT CARBON R-RATIO R1=C_a/S R2=Al/N R3=Mn/C
CEI/W=C+Mn/6+(Cr+Mo+V)/5+(Cu+Ni)/15 CEPGM=C+Si/30+(Mn+Cr+Cu)/20+Ni/60+Mo/15+V/10+S*8 SUM1=Cr+Cu+Mo+Ni+V SUM2=Nb+V SUM3=Nb+V+Ti
ET-ISO10893-2-2011, UT-ISO10893-10-2011, MPI-ISO10893-5-2011, EMT-ISO10893-3-2011, WT-ISO10893-12-2011, Lamination T-ISO-10893-8-2011
L4/L3/L2-ACCEPT LEVEL L4/L3/L2,NOTCH DEPTH IS 12.5%/10%/5% THE SPECIFIED WALL THICKNESS.

HENGYANG VALIN
STEEL TUBE CO.,LTD

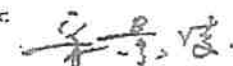
MILL TEST CERTIFICATE

Add: 10 Dalixincun, Hengyang
City, Hunan, P.R. China P.C.: 421001
Tel and Fax: +86 734 8873739
E-mail: hysicc@hysteeltube.com

(^ ACCORDING TO EN10204 3.1B)

CUSTOMER				CERTIFICATE NO.	C201425625-1	
CONTRACT-ITEM NO.	2111001258- 05	P.O.NO.	BSC100090	DATE:	2014-8-19	PAGE: 3/3
PRODUCT	SEAMLESS STEEL LINE PIPE			DELIVERY CONDITION	HR	
SPECIFICATION	SEE SPECIFICATION NOTE		HEAT TREATMENT			
GRADE	B,B/X42,Grade 290			DIMENSIONS	NPS 2 XH 40FT	
TOTAL BUNDLES:	50	TOTAL PIECES:	946	TOTAL LENGTH:	37864.844 ft	TOTAL WEIGHT: 86.335 mt
		REMARK : 1. ORIGIN:MADE IN CHINA 2. ALL ELEMENTS TO BELISTED				

SPECIFICATION NOTE	API 5L(45th)PSL1, ASTM/ASME A/SA106B-2013,CSA Z245.1 GRADE 290 CAT 1-2014
--------------------	---

<p>We hereby certify that material herein described has been manufactured in accordance with the standards and specifications required in your order and satisfies the corresponding requirements.</p> <p>This certificate is issued by a computerized system and it is valid with electronic signature. In case the owner of the certificate would release a copy of it ,he must attest its conformity to the original one taking upon himself the responsibility for any unlawful or not allowed use.</p> <p>Any alteration and/or falsification will be subject to the law.</p> <p>If you need to assure the authenticity of this certificate ,please do not hesitate to contact Hengyang Valin Steel Tube CO.,LTD, E-mail hysicc@hysteeltube.com</p> <p>CUSTOMER THIRD PARTY</p>	<p>Quality Manager: </p> <p>Certificate-maker: 唐娅娜</p>
--	---

HEAT# 4703606 3 150 RF WN STD 'LF2'

National Procurement PO# PUR632976 Item# 7
 Heat Number 4777159
 Trans Amp Piping Prod. Products Ltd. - Rev'd By: SB
 P.O./Seq #: CL-14-149886 2

3" CL 150 W/N FLANGE RF STD
 BORE A350-LF2 CL 1



SAN ENG STEEL FORGING CO LTD
 311, Jen Hsin Road, Jen Wu District
 Kaohsiung, Taiwan, R.O.C.
 TEL: 07-3724249; FAX: 07-3712823
 URL: www.saneng.com.tw
 e-mail: saneng@ktsb.secd.net.tw

MILL TEST CERTIFICATE

EN10204-3.1.BQINS00493.1.B

Customer:

Order No.:

Certificate No.: SE103944

Date: 12/18/2013

Page: 2 OF 4

FORGED CARBON STEEL FLANGES

ASTM A-350 LF2-13 CL. 1/ASME SA-350 LF2-13 CL. 1

ASME B16.5-13
 CSA Z245.12

PRODUCT

MATERIAL SPECIFICATIONS

DIMENSIONAL SPECIFICATIONS

Item No.	CODE NO	DESCRIPTION	QUANTITY	CHEMICAL COMPOSITION (%)											CE(%)		
				C	SI	Mn	P	S	Cu	Cr	Ni	Mo	V	Nb		N	
11		1500 WNRRTJ XS 2" LF2	0.230	0.160	0.800	1.350	0.035	0.040	0.400	0.300	0.400	0.120	0.090	0.020	-	-	0.429
12		150 WNRRTJ STD 3" LF2	0.220	0.230	1.190	0.018	0.004	0.008	0.020	0.010	0.003	0.008	0.001	0.007	-	-	0.425
13		150 WNRRTJ STD 3" LF2	0.220	0.230	1.170	0.019	0.006	0.007	0.010	0.010	0.002	0.008	0.001	0.007	-	-	0.420
14		1500 BLRF 3" LF2	0.200	0.220	1.040	0.018	0.005	0.160	0.090	0.080	0.020	0.005	0.001	0.006	-	-	0.412
15		1500 BLRF 3" LF2	0.180	0.220	1.050	0.018	0.005	0.080	0.110	0.090	0.020	0.001	0.001	0.007	-	-	0.399
16		1500 WNRRTJ XS 2" LF2	0.200	0.210	1.140	0.022	0.004	0.010	0.090	0.010	0.001	0.004	0.001	0.008	-	-	0.398
17		2500 WNRRTJ XS 3" LF2	0.190	0.200	1.020	0.012	0.006	0.120	0.100	0.080	0.010	0.002	0.001	0.007	-	-	0.396
18		300 BLRF 3" LF2	0.220	0.230	1.170	0.018	0.006	0.007	0.010	0.010	0.002	0.006	0.001	0.007	-	-	0.420
19		600 WNRRTJ STD 3" LF2	0.220	0.220	1.180	0.016	0.005	0.007	0.020	0.020	0.005	0.005	0.001	0.007	-	-	0.424
20		150 BLRF 3/4" LF2	0.200	0.210	1.250	0.022	0.006	0.150	0.090	0.090	0.011	0.012	0.002	0.006	-	-	0.438

Item No.	Heat No.	T.S.(¹) (MPa)	Y.S.(¹) (MPa)	E.L.(¹) (%)	Hardness (HB)	R.A.(¹) (%)	Impact Test			Material Supplier	REMARKS:
							Temp: -46°C	Temp: 20.0 Joule	Temp: 20.0 Joule		
11	4703633	535.0	358.0	36.4	154/152	68.6	86.0	49.0	78.0	ACOMINAS	890°C XHRMS CONFORMS WITH NACE MR0103-12 AND NACE MR0175/ISO 15156-2:08 CLAUSE 7.2.1.4 REGION 3 AND ANNEX A. CONFORMS WITH Z245.12 CAT II GR248 SOUR SERVICE-09 (FOR USE AS WELDING NECK AND BLIND FLANGES ONLY) TEST SPECIMEN SIZE: 10X10 TEST SPECIMEN ORIENTATION: TRANSVERSE IMPACT TEST TEMP: -46°C MN TO C RATIO IS GREATER THAN 3.0*
12	4703906	529.0	372.0	36.2	154/151	69.5	89.0	109.0	80.0	ACOMINAS	
13	4677159	527.0	364.0	33.8	153/151	70.4	116.0	98.0	73.0	ACOMINAS	
14	751675	510.0	356.0	35.0	152/150	71.3	96.0	118.0	123.0	GODO STEEL	
15	Y300289	518.0	376.0	36.8	152/150	72.1	108.0	123.0	111.0	KOTOBUKI	
16	4723483	516.0	388.0	37.0	152/150	69.5	124.0	94.0	115.0	ACOMINAS	
17	C18746	512.0	388.0	38.0	152/150	70.4	90.0	105.0	91.0	SEAH BESTEEL	
18	4677159	527.0	364.0	33.8	153/151	70.4	116.0	98.0	73.0	ACOMINAS	
19	4803012	529.0	366.0	35.0	153/151	71.3	90.0	51.0	84.0	ACOMINAS	
20	83762	553.1	391.3	34.8	158/155	70.4	57.0	28.0	98.0	WEI CHIH STEEL	

*1: T.S. = Tensile Strength, Y.S. = Yield Strength, E.L. = Elongation, R.A. = Reduction of Area.

*2: N=Normalized, A=Annealed, Q=Quenched, T=Tempered, S=Solution Treated, S.R.=Stress Relieved, A=C=Air Cooled, F=C=Furnace Cooled, W=C=Water Cooled, O=C=Oil Cooled.

*3: C.E. Value = C + (Mn/8) + (Cr + Mo + V) / 5 + (Ni + Cu) / 15

We hereby certify that the material has been tested in accordance with the above specification and also with the requirements called for by the above order.



Manager of Quality Assurance Dept



SAN ENG STEEL FORGING CO. LTD
 311 Jen Han Road, Jen Wu District
 Kachisung, Taiwan, R.O.C.
 TEL: 07-3724249; FAX: 07-3712923
 URL: www.saneng.com.tw
 e-mail: saneng@icbc.secd.net.tw

MILL TEST CERTIFICATE

EN:0204-Q-1-BIDIN500493-1-B)
 W.E.F. FITTINGS & FLANGES (CANADA)
 Customer: LTD
 Order No.: D0005322

Certificate No.: SE000522
 Date: 02/11/2015
 Page: 1 OF 2

FORGED CARBON STEEL FLANGES

ASTM A-350 LP2-14 CL. / ASME SA-350 LP2-14 CL. 1

ASME B16.5-13
 CSA Z245.12

Item No.	Heat No.	DESCRIPTION	QUANTITY	CHEMICAL COMPOSITION (%)											REMARKS	
				C	SI	Mn	P	S	Cu	Cr	Ni	Mo	V	Nb		N
1	4886442	150 SORF SOLID 2 1/2" LF2N	Min	0.300	0.150	0.600	0.035	0.040	0.400	0.300	0.400	0.120	0.020	0.020	0.007	0.400
2	4703632	150 SORF SOLID 3" LF2N	Max	0.210	0.200	1.120	0.015	0.003	0.010	0.010	0.010	0.002	0.005	0.004	0.007	0.400
3	1007398	300 SORF SOLID 1/2" LF2N		0.210	0.240	1.150	0.019	0.003	0.007	0.020	0.010	0.002	0.007	0.001	0.006	0.400
4	41369	300 SORF SOLID 3/4" LF2N		0.190	0.230	1.040	0.012	0.005	0.005	0.020	0.070	0.060	0.018	0.001	0.001	0.350
5	4703602	300 SORF SOLID 1" LF2N		0.210	0.200	1.170	0.008	0.010	0.060	0.070	0.040	0.005	0.003	0.001	0.007	0.400
6	4554034	600 SORF SOLID 2" LF2N		0.210	0.240	1.150	0.019	0.003	0.007	0.020	0.070	0.002	0.007	0.001	0.006	0.400
7	4553925	600 SORF SOLID 3/4" LF2N		0.210	0.200	1.150	0.017	0.005	0.005	0.010	0.070	0.002	0.005	0.001	0.006	0.400
8	4803131	600 SORF SOLID 1" LF2N		0.230	0.210	1.150	0.021	0.006	0.007	0.020	0.010	0.003	0.007	0.001	0.006	0.400
9	4803131	600 SORF SOLID 1 1/4" LF2N		0.210	0.200	1.160	0.021	0.006	0.010	0.020	0.010	0.004	0.007	0.001	0.006	0.400
10	4803135	600 SORF SOLID 2 1/2" LF2N		0.210	0.210	1.160	0.023	0.006	0.010	0.020	0.010	0.002	0.004	0.001	0.006	0.400

2-1/2" BLIND FLANGE
 600 SW XH BORE HOLE
 150 SORF SOLID 2 1/2" LF2N
 300 SORF SOLID 1/2" LF2N
 300 SORF SOLID 3/4" LF2N
 300 SORF SOLID 1" LF2N
 600 SORF SOLID 2" LF2N
 600 SORF SOLID 3/4" LF2N
 600 SORF SOLID 1" LF2N
 600 SORF SOLID 1 1/4" LF2N
 600 SORF SOLID 2 1/2" LF2N

Item No. Heat No. T.S. (MPa) Y.S. (MPa) El. (%) Hardness (HBN) R.A. (%) C SI Mn P S Cu Cr Ni Mo V Nb N
 1 4886442 524.0 375.0 36.0 153/151 70.0 104.0 80.0 53.0 ACCOMINAS
 2 4703632 527.0 372.0 35.0 152/151 68.5 109.0 97.0 75.0 ACCOMINAS
 3 1007398 512.0 362.0 36.2 152/150 71.3 152.0 98.0 137.0 WEI CHIN STEEL
 4 41369 539.4 379.5 34.0 153/156 65.9 22.0 23.0 RED OCTOBER
 5 4703602 527.0 372.0 36.0 153/151 69.6 109.0 97.0 ACCOMINAS
 6 4554034 520.0 362.0 35.0 153/151 68.6 109.0 97.0 ACCOMINAS
 7 4553925 535.0 354.0 33.8 154/152 68.6 72.0 ACCOMINAS
 8 4803131 524.0 370.0 33.6 153/150 68.6 76.0 ACCOMINAS
 9 4803131 533.0 368.0 34.2 153/151 68.6 94.0 ACCOMINAS
 10 4803135 533.0 368.0 34.2 153/151 68.6 114.0 ACCOMINAS

HEAT TREATMENT: 2) 2) N

REMARKS: CONFORMS WITH NBCE MRG-102-12 AND NBCE MRG-75103-15:66 2-08 CLAUSE 7.2.1.4 REGION 3 AND ANNEX A. CONFORMS WITH Z245.12 CAT II GR242 SOUR SERVICE-08 (FOR USE AS WELDING NECK AND BLIND FLANGES ONLY) TEST SPECIMEN SIZE: 10X15 TEST SPECIMEN ORIENTATION: TRANSVERSE IMPACT TEST TEMP: -46°C MIN TO C RATIO IS GREATER THAN 3.0*

*1: T.S = Tensile Strength; Y.S = Yield Strength; El. = Elongation; R.A = Reduction of Area
 *2: N=Non-Heat Treated; A=Annealed; Q=Quenched; T=Tempered; S.T=Solution Treated; S.R=Stress Relieved; A=C=Air Cooled; F=C=Fluence Cooled; W=C=Water Cooled; O=C=Oil Cooled.
 *3: CE Value = C + (Mn/6) + (Cr + Mo + V)/5 + (Ni + Cu)/15

We hereby certify that the material has been tested in accordance with the above specification and also with the requirements called for by the above order.

Manager of Quality Assurance Dept:



4731 - 68 Avenue, Edmonton, AB T6B 2N2; PHONE: (780) 466-0517 FAX: (780) 450-9694 Visit us at www.rio-tekcanada.ca

MILL TEST REPORT

HEAT CODE: A1253	DATE: September 18, 2015
PRODUCT DESCRIPTION: <u>Spacer Ring RF Series B: 30"-150</u> <u>Paddle Blind RF Series B: 30"-150</u> <u>Bleed Ring RF: 1-1/2"-150, 2"-300, 2"-600, 3" 150, 3"-300, 3"-600, 2"-900, 3"-900, 4"-150, 4"-300, 4"-600</u> <u>Spacer Ring RF: 3"-600, 2"-600, 2"-1500</u> <u>Pancake Blind RTJ: 4"-900</u> <u>Vent Blind RF: 2-1/2" 150, 4"-150, 3"-300, 4"-300</u> <u>RTJ Paddle Blind: 3"-900, 3"-1500, 2-1/16"-10000(BX152)</u> <u>Spec Blind RTJ: 3"-2500</u>	
ORIGINAL SUPPLIER: Arcellormittal Plate LLC VIA: VC033 MATERIAL GRADE: SA516 70N ORIGINAL HEAT NUMBER: C9942-10A	

CHEMICAL COMPOSITION (%)																		
	Starting Thickness	C	Mn	P	S	Si	Cr	Ni	Cu	Mo	Al	V	Ti	B	CB			
Code Req.		0.30	0.65-1.20	0.035	0.035	0.15-0.40	-	-	-	-	-	-	-	-	-	-	-	-
Actual	2.000"	.23	.93	.006	.001	.21	.04	.04	.07	.01	.031	.001	.003	.0002	.001			

MECHANICAL PROPERTIES										
Code Req.	HEAT TREATMENT	YIELD STRENGTH KSI (PSI x 100)	TENSILE STRENGTH KSI (PSI x 100)	ELONG. (%) 2" (50mm)	R. A. (%)	CVN TEMP. °F	IMPACT RESULTS (Ft.Lb)	AVG	HARDNESS	
									BHN	HRB
	Normalized	38 KSI min	70-90 KSI	Min 21	-	-	-	-	(201 max)	(92 max)
Actual	Normalized	(451)	(743)	31.0		-40f	12, 15, 25	17.3		78.5, 80.1, 78.2

OTHER RESULTS
Heat Treatment: <u>Normalized @ 1650°f for 56 minutes</u>
Melting Process:
Grain Size:
NDE Method & Results:
Macro Etch Test:
Additional: <u>Testing performed according to NACE MR0175/ISO 15156-2:2009 / Clr.1:2001(E), ISO 6508-1:2005(E), ASME Boiler and Pressure Vessel Code Section II, Part A, SA-370 (2013 Edition) and ASTM E18-14 and approximate hardness conversions performed according to ASTM E140-12b^{E1}, Table 2.</u>

We hereby certify that the information described herein is a true copy of the data provided to RIO-TEK Canada Inc. by the producing Mill and/or Supplier and/or data resulting from additional tests performed by RIO-TEK Canada Inc.

QA Data Clerk

Spec Order No. 33765
 Purchase Order No. 82828
 Original Thickness 2.00"
 NDE P.O. No. —
 NDE P.O. No. —

Exhibit 750A

Where INTEGRITY, RELIABILITY & QUALITY are Synonymous with RIO-TEK

CLIENTE / Customer / Client
TRANS AM PIPING PRODUCTS LTD.
 9335 ENDEAVOR DRIVE S.E.
 CALGARY, ALBERTA T3S 0A1
 CANADA

CERTIFICADO DE INSPECCION
 Inspection Certificate - Certificat de Réception
 DIN EN 10224 / 3.1
 ISO 10474 / 3.1

FECHA: 04/03/2015 N.º 170824
 HOLA: Page: 2
 of - de 27/11/2014

PRODUCTO / Article - Produit: **FLANGES**
 SU PEDIDO N.º / Your Order No.: **PO# CI-14 - 751**
 NORMAS APLICABLES / Normes Applicables: **ASME B16.5-13**
 MATERIAL CORRESPONDIENTE / Material Correspondente: **ASME SA350LF2CL-13, ASTM A350LF2CL-14**
 MODO DE FUSION (*) / Fusion Mode: **MACE MR0175/ISO15156-02-09 & MR0103-12**
 Material Correspondent: **Clause 7.2.1.4, Annex A.2 and SSC Region 3.**
 Steel Making - Elaboracion de Acier: **CSA-Z245.12-13 GR248 CAT II -SS (WN & BLIND FLANGES ONLY)**
 E = Elec. Y = Origeno basico

REQUIREMENTS - Normes Applicables: **ASME B16.5-13**
 MACE MR0175/ISO15156-02-09 & MR0103-12
 Clause 7.2.1.4, Annex A.2 and SSC Region 3.
 CSA-Z245.12-13 GR248 CAT II -SS (WN & BLIND FLANGES ONLY)

DEPARTAMENTO / Département: **QUALITY ASSURANCE**
 Section: **QUALITY ASSURANCE**
 MARCA DEL FABRICANTE / Marque du fabricant: **ULMA**
 Certified acc. PED 97/23/EC-AD200-WO
 by TUV Rheinland
 N.º 01 202 EQ 02 7443
 Management Systems certified by LBCOE
 SGI 1922164 SGI 600026 SGI 6003987
 ULMA FORJA S.COOP.
 pr Zubillaga 3 - Ardo 14
 20560 OÑATI (Gipuzkoa) SPAIN
 Tel.: 34 - 943 780552
 Fax: 34 - 943 781808
 E-mail: ulma@ulmapiping.com
 Packing List: 115440

PARTIDA Item Poste	CANTIDAD Quantity	DESCRIPCION Description	LOTE	OBSERVACIONES Remarks Observations (*)	COLADA N.º Heat No N.ºCoulée	COMPOSICION QUIMICA - STEEL MAKERS LADLE ANALYSIS - ANALYSE CHIMIQUE												
						C %	Si %	Mn %	P %	S %	Cr %	Ni %	Mo %	Nb %	V %	Cu %	Al %	Ti %
65		THR 2 600LB RF A350LF2		13F15	B40A4	506	309	32,90	58,70	44	47	45	45	-50	153			
69		SW 1/2 800LB XS/80 RF A350LF2		NE	B20A4	515	321	31,10	55,00	66	65	71	67	-50	152			
76		WN 2 1500LB S160 RTJ A350LF2		NE	A29A5	525	324	25,00	46,50	69	72	50	63	-50	158			
79		WN 2 2500LB XS/80 RTJ A350LF2		NE	T4AV4	525	319	25,50	54,50	70	76	85	77	-50	167			

(*) OBSERVACIONES: **NORMALIZED AT 900 C AND ALLOWED TO COOL IN STILL AIR.**
 Remarks Observations

EL INSPECTOR
 Works Inspector - L'inspecteur
ULMA
 ULMA-TECHNICALS COOP.
 Depto. de Garantía de calidad
 Quality Assurance Dept.

WESTBROOK

MATERIAL TEST REPORT

Page 3

Sold To: *Trans AM Piping Prods*
 Order No.: 118562 Order Date: 11/18/2014

Purchase Order: CL-14-13880

Printed: 11/18/2014

Line: Description:
 5 1 X 6 S160 A333 GR6 BLK SMLS NPL TBE

***** Specifications - Heat Code H00125: *****
 A333/A333M-11 GR.6, SA333 GR.6, A420-10A WPL6, SA420 WPL6,
 A540, A733, ASME B1.20.1, MSS SP-25, SP-95
 STARTING MATERIAL: PIPE & TUBE

Chemical Composition:

C:	Mn:	P:	S:	Si:	Cr:	Ni:	Mo:
0.140	1.110	0.008	0.010	0.200	0.065	0.065	0.036
Cu:	V:	Cb:	C.E.:				
0.200	<0.001	0.001	.363				

Mechanical Properties:

Tensile(PSI):	Yield(PSI):	Elong(%):	Hardness:	Flattening:	Bend:
69251	48490	42.00	HRB 77	OK	OK
Hydro(PSI):					
2500					

Impact Results:

Test Temp:	Achieved Values:
-50F	53-86-84 J

Comments:

Normalized 900C 13 min.
 Hot finished. Charpy specimen size .394 x .197"
 Meets Nace MR-01-75/2009, MR-01-03/2010 and ISO 15156/2009.

Line: Description:
 6 1 X 9 S160 A333 GR6 BLK SMLS NPL PBE

***** Specifications - Heat Code H00974: *****
 A333/A333M-10 GR.6, SA333 GR.6, A420-10 WPL6, SA420 WPL6,
 A540, A733, ASME B1.20.1, MSS SP-25, SP-95
 STARTING MATERIAL: PIPE & TUBE

Chemical Composition:

C:	Mn:	P:	S:	Si:	Cr:	Ni:	Mo:
0.120	1.230	0.018	0.003	0.380	0.180	0.180	0.080
Cu:	V:	Cb:	Ti:	B:	C.E.:		
0.170	0.065	0.034	0.003	.0003	.413		

Mechanical Properties:

Tensile(PSI):	Yield(PSI):	Elong(%):	Hardness:	Flattening:	Hydro(PSI):
78175	57000	48.00	HB 154-156	PASSED	3000

Impact Results:

Test Temp:	Achieved Values:	Lateral Expansion:	% of Shear:
-45C	137-132-147 J	28-28-27%	100-100-100%

Comments:

Normalized @ 900C, holding time 5 min.
 Meets Nace MR-01-75/2009, MR-01-03/2010 and ISO 15156/2009.

We hereby certify that the contents of this Material Test Report are correct and accurate to the best of our knowledge and belief, that all test results are in compliance with the material specifications and that all material meets the dimensional requirements of the order. The products described have not come into contact with mercury or any of its components. Westbrook's USA Quality System is registered to ISO 9001, Certificate No. 32813. This document is in accordance with EN10204:2004 3.1 / DIN50049 3.1B and was electronically transmitted. This inspection certificate is issued under the authority of Westbrook Mfg's Quality Control Manager.

WESTBROOK MATERIAL TEST REPORT

Page 1

PO Box 53591
 Edmonton, AB T6X0P0

Voice 780 490 4976
 Fax 780 490 0471

Sold To: Trans AM Piping Prods
 Order No.: 119955 Order Date: 12/30/2014

Purchase Order: CL-14-15066

Printed: 12/30/2014

Line: Description:
 1 2 X 1 S80 A420 WPL6 CONC SWG BXT

***** Specifications - Heat Code H00863: *****
 A350/A350M-11 LF2, SA350 LF2, A105, SA105, A420-10A WPL6,
 SA420 WPL6, A234-11 WPB, SA234 WPB, A788, ASME B16.5,
 B16.9, B16.11, B16.47, B1.20.1, MSS SP-25, SP-44, SP-79,
 SP-83, SP-95, API 605, A.W.W.A.
 STARTING MATERIAL: BAR

Chemical Composition:

C:	Mn:	P:	S:	Si:	Cr:	Ni:	Mo:
0.180	0.930	0.008	0.017	0.210	0.120	0.040	0.010
Cu:	V:	Al:	Cb:	C.E.:			
0.080	0.003	0.029	0.000	.369			

Mechanical Properties:

Tensile(PSI):	Yield(PSI):	Elong(%):	RA(%):	Hardness:
73000	45900	33.00	67.00	BHN 146-149

Impact Results:

Test Temp:	Achieved Values:
-50F	54-62-37 FT/LBS

Comments:

Normalized.
 Cold Drawn.
 Meets Nace MR-01-75/2009, MR-01-03/2010 and ISO 15156/2009.

Line: Description:
 2 2 X 1 1/2 S80 A420 WPL6 CONC SWG BXP

***** Specifications - Heat Code H00204: *****
 A350/A350M-11 LF2, SA350 LF2, A105, SA105, A420-10A WPL6,
 SA420 WPL6, A234-11 WPB, SA234 WPB, A788, ASME B16.5,
 B16.9, B16.11, B16.47, B1.20.1, MSS SP-25, SP-44, SP-79,
 SP-83, SP-95, API 605, A.W.W.A.
 STARTING MATERIAL: BAR

Chemical Composition:

C:	Mn:	P:	S:	Si:	Cr:	Ni:	Mo:
0.170	0.690	0.015	0.024	0.230	0.100	0.090	0.020
Cu:	V:	Al:	Cb:	Ti:	C.E.:		
0.220	0.005	0.028	0.008	0.002	.330		

Mechanical Properties:

Tensile(PSI):	Yield(PSI):	Elong(%):	RA(%):	Hardness:
70000	41000	31.50	63.00	BHN 131

Impact Results:

Test Temp:	Achieved Values:
-50F	23-20-12 FT/LBS

Comments:

Normalized.
 Meets Nace MR-01-75/2009, MR-01-03/2010 & ISO 15156/2009.

We hereby certify that the contents of this Material Test Report are correct and accurate to the best of our knowledge and belief, that all test results are in compliance with the material specifications and that all material meets the dimensional requirements of the order. The products described have not come into contact with mercury or any of its components. Westbrook's USA Quality System is registered to ISO 9001, Certificate No. 32813. This document is in accordance with EN10204:2004 3.1 / DIN50049 3.1B and was electronically transmitted. This inspection certificate is issued under the authority of Westbrook Mfg's Quality Control Manager.

WESTBROOK

MATERIAL TEST REPORT

Page 1

PO Box 53591
 Edmonton, AB T6X0P0

Voice 780 490 4976
 Fax 780 490 0471

Sold To: *Trans AM Piping Prods*
 Order No.: 120773 Order Date: 1/27/2015

Purchase Order: PI-15-35002

Printed: 1/27/2015

Line: Description:
 1 2 X 1 S80 A420 WPL6 CONC SWG BXP

***** Specifications - Heat Code H00934: *****
 A350/A350M-11 LF2, SA350 LF2, A105, SA105, A420-10A WPL6,
 SA420 WPL6, A234-11 WPB, SA234 WPB, A788, ASME B16.5,
 B16.9, B16.11, B16.47, B1.20.1, MSS SP-25, SP-44, SP-79,
 SP-83, SP-95, API 605, A.W.W.A.
 STARTING MATERIAL: BAR

Chemical Composition:

C: 0.200	Mn: 0.900	P: 0.009	S: 0.016	Si: 0.230	Cr: 0.130	Ni: 0.040	Mo: 0.010
Cu: 0.070	V: 0.010	Al: 0.030	Cb: 0.000	C.E.: .387			

Mechanical Properties:

Tensile(PSI): 72000	Yield(PSI): 43700	Elong(%): 34.00	RA(%): 70.00	Hardness: BHN 148-153
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Impact Results:

Test Temp: -50F	Achieved Values: 62-59-52 FT/LBS
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Comments:

Normalized.
 Cold drawn.
 Meets Nace MR-01-75/2009, MR-01-03/2010 and ISO 15156/2009.

Line: Description:
 2 1 X 3/4 S80 A420 WPL6 CONC SWG PXT

***** Specifications - Heat Code H2230 WU: *****
 A333/A333M-10 GR.6, SA333 GR.6, A420-10 WPL6, SA420 WPL6,
 A540, A733, ASME B1.20.1, MSS SP-25, SP-95
 STARTING MATERIAL: PIPE & TUBE

Chemical Composition:

C: 0.200	Mn: 1.130	P: 0.013	S: 0.005	Si: 0.310	Cr: 0.008	Ni: 0.009	Mo: 0.003
Cu: 0.005	V: 0.002	C.E.: .391					

Mechanical Properties:

Tensile(PSI): 73348	Yield(PSI): 49384	Elong(%): 31.80	Hardness: BHN 153-156	Flattening: SATISFACTORY	Hydro(PSI): 3000
-------------------------------	-----------------------------	---------------------------	---------------------------------	------------------------------------	----------------------------

Impact Results:

Test Temp: -45C	Achieved Values: 70-68-54 (J)
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Comments:

Hardness only to NACE MR-01-75/2009.
 Normalized @ 880C.
 Cold finished.
 Also meets MR-01-03/2010.

WESTBROOK MATERIAL TEST REPORT

Page 1

PO Box 53591
 Edmonton, AB T6X0P0

Voice 780 490 4976
 Fax 780 490 0471

Sold To: Trans AM Piping Prods
 Order No.: 119253 Order Date: 12/04/2014

Purchase Order: CL-14-14490

Printed: 12/04/2014

Line: Description:
 1 2 X 1/2 S80 A420 WPL6 CONC SWG BXP

***** Specifications - Heat Code H2327: *****
 A350/A350M-11 LF2, SA350 LF2, A105, SA105, A420-10A WPL6,
 SA420 WPL6, A234-11 WPB, SA234 WPB, A788, ASME B16.5,
 B16.9, B16.11, B16.47, B1.20.1, MSS SP-25, SP-44, SP-79,
 SP-83, SP-95, API 605, A.W.W.A.
 STARTING MATERIAL: BAR

Chemical Composition:

C:	Mn:	P:	S:	Si:	Cr:	Ni:	Mo:
0.170	0.830	0.027	0.027	0.210	0.020	0.010	0.000
Cu:	V:	Al:	Cb:	Sn:	Ti:	C.E.:	
0.000	0.004	0.031	0.001	0.009	0.002	.313	

Mechanical Properties:

Tensile(PSI):	Yield(PSI):	Elong(%):	RA(%):	Hardness:
70400	43700	38.50	69.50	BHN 124

Impact Results:

Test Temp:	Achieved Values:
-50F	20-20-35 FT/LB

Comments:

NORMALIZED.
 Meets Nace MR-01-75/2009, MR-01-03/2010 and ISO 15156/2009.

Line: Description:
 2 2 X 1/2 S80 A420 WPL6 CONC SWG BXT

***** Specifications - Heat Code H00806: *****
 A350/A350M-11 LF2, SA350 LF2, A105, SA105, A420-10A WPL6,
 SA420 WPL6, A234-11 WPB, SA234 WPB, A788, ASME B16.5,
 B16.9, B16.11, B16.47, B1.20.1, MSS SP-25, SP-44, SP-79,
 SP-83, SP-95, API 605, A.W.W.A.
 STARTING MATERIAL: BAR

Chemical Composition:

C:	Mn:	P:	S:	Si:	Cr:	Ni:	Mo:
0.180	0.930	0.008	0.017	0.210	0.120	0.040	0.010
Cu:	V:	Al:	Cb:	Ti:	B:	C.E.:	
0.080	0.003	0.029	0.000	<0.010	<.001	.369	

Mechanical Properties:

Tensile(PSI):	Yield(PSI):	Elong(%):	RA(%):	Hardness:
73000	45900	33.00	67.00	BHN 146-149

Impact Results:

Test Temp:	Achieved Values:
-50F	54-62-37 FT/LBS

Comments:

Normalized.
 Cold Drawn.
 Meets Nace MR-01-75/2009, MR-01-03/2010 and ISO 15156/2009.

We hereby certify that the contents of this Material Test Report are correct and accurate to the best of our knowledge and belief, that all test results are in compliance with the material specifications and that all material meets the dimensional requirements of the order. The products described have not come into contact with mercury or any of its components. Westbrook's USA Quality System is registered to ISO 9001, Certificate No. 32813. This document is in accordance with EN10204:2004 3.1 / DIN50049 3.1B and was electronically transmitted. This inspection certificate is issued under the authority of Westbrook Mfg's Quality Control Manager.

Kedco . Mtr Sheets

Page 1 of 1

Material Test Report

Current Date: Thu, 20 Mar 2014 15:31:05 +0000

Report Number: 26797

Date: Mon, Nov 11th 2013

Description: 1" SWAGES & BULL PLUGS

Heat Treatment: NORM

Specification: A420-WPL6/SA420-WPL6

Material: C1022

Year of Revision: _____

CRN: OA7470.5CR1

Comment: NACE MR0103-07
MR0175/ISO 15156-2-03

Additional DUAL CERTIFIED TO A234-
Comment: WPB/SA-234 WPB

Chemical Analysis

Heat Code: K2848	C	0.200	Cu	0.000	Al	0.033
Heat Number: 030960	Mn	0.850	Ni	0.150	Ti	0.000
	P	0.012	Cr	0.080		0.000
	S	0.022	Mo	0.050		0.000
	Si	0.230	V	0.000		0.000
	N	0.000	Cb/Nb	0.000		0.000

Carbon Equivalency Formula Used:
 $C + (Mn/6) + (Cr + Mo + V)/5 + (Ni + Cu)/15$
CE= 0.38

Mechanical Tests

Yield PSI: 49900

Tensile PSI: 77000

Elongation: 35 % @ 2"

Reduction of 64
Area %

Size: 1.315" RND

Brinell Hardness: 146

Charpy Impact Test

Individual Values: -50 F

(V1) 30 ft/lbs (V2) 13 ft/lbs (V3) 26 ft/lbs

This Material Test Report meets DIN 50049/EN 10201 3.1.B Standard

We hereby Certify that the material described has been tested in accordance with the specifications, and the results are correct as contained in the records of the Company.

Lisa Bidnos, Q.A. Manager



Sarnia
Toll Free: 1-866-511-1381
By regular telephone at: 519-336-2960
By fax at 519-344-3181

Mailing Address:
645 Kedco St.
Sarnia, ON
N7T 7H5

Edmonton
Toll Free: 1-877-465-0303
By regular telephone at: 780-465-0303
By fax at 780-465-0304

Mailing Address:
3911-76 Av.
Edmonton, AB
T6B 2S8



STATUTORY DECLARATION
Registration of Fittings

In this space, show facsimile of manufacturer's logo or trademark as it will appear on the fitting.



I, TORU SASAKI

QUALITY ASSURANCE DIVISION MANAGER

(company title, e.g. vice president, plant manager, chief engineer) (must be in a position of authority)

of THAI BENKAN COMPANY LIMITED

(name of manufacturer)

located at 58 SOI WATKRUNAI(SUKSAWAT70), BANGKRU, PHRAPRADAENG, SAMUTPRAKARN 10130

(plant address)

do solemnly declare that the fittings listed hereunder, which are subject to the Safety Codes Act (check one)

comply with the requirements of ASME B16.9 which specifies the dimensions, (title of recognized North American Standard)

materials of construction, pressure/temperature ratings and identification marking of the fittings, or

are not covered by the provisions of a recognized North American standard and are therefore manufactured to comply with _____ as supported by the attached data which identifies the dimensions, materials of construction, pressure/temperature ratings and the basis for such ratings, and the marking of the fittings for identification.

I further declare that the manufacture of these fittings is controlled by a quality control program which has been verified by the following authority, LRQA as being suitable for the manufacture of these fittings to the stated standard. The fittings covered by this declaration, for which I seek registration, are category A

In support of this application, the following information, calculations and/or test data are attached:

Company catalogue with Production range (TBC-E09-031 rev A), Pressure/Proof Test record and ISO 9001 : 2008 certificate

DECLARED before me at the Canadian Embassy in the city of Bangkok

this 24th day of March 2014
Melanie L. Eyre
First Secretary (Management)
(print) Première secrétaire (gestion)
(sign) [Signature]
(A Commissioner for 1997)

T. Sasaki
(Signature of Applicant)

For Office Use Only Scope per ACI Central's Summary sheet!
To the best of my knowledge and belief, the application meets the requirements of the Safety Codes Act and CSA Standard B51, Clause 4.2, and is accepted for registration in Category A

Registration Number: 0A01224.92

[Signature]
(For the Administrative Inspector of Alberta)
Expiry Date: March 28, 2014

Date Registered: JUL 17 2014

The information you provide is necessary only for the administration of the programs as required by the Alberta Safety Codes Act and Regulations (in the Boiler Discipline).

ACI Central Inc.

20 McAulay Court
Charlottetown, PE C1A 9M7
Canada

Data Information → Piping System Design

CRN 0A1224.9870YTN

Manufacturer: THAI BENKAN COMPANY LIMITED

FID/PV: FID-1887

Trademark: "BKE" in bold, block, stylized, large font, all enclosed in an oval type shape.

Description: Buttwelding pipe fittings. Includes Elbows (Long & Short; 90deg., 45deg., 180deg.), Reducers (concentric & eccentric), tees & caps.

Design code: ASME B16.9

Registration date: 2014/03/31

Expiry date: 2024/03/28

Pressure Rating	Type	Size	Material
As per standard	Elbows	1/2" to 16"	A234; A420; A403;
	Bends	1/2" to 8"	A815
	Reducers, Tees	3/4" to 16"	
	Caps	1-1/2" to 14"	

0A01224.92



STATUTORY DECLARATION
Registration of Fittings

In this space, show facsimile of manufacturer's logo or trademark as it will appear on the fitting.

IML or 

I, Roberto Appiani (C.E.O.)

(company title, e.g. vice-president, plant manager, chief engineer) (must be in a position of authority)

of E.M.L. Industrie Meccanica Ligure S.p.A.

(name of manufacturer)

located at Via Giancarlo Farini 25 - 16039 - Casarza Ligure - Genova - Italy

(plant address)

do solemnly declare that the fittings listed hereunder, which are subject to the Safety Codes Act (check one)

- comply with the requirements of ASME B16.11+ASME B31.1+B31.3
ASME B36.10M+B36.19M which specifies the dimensions,
ASTM A733+MSS SP79/B3/95/97 (one of recognized North American Standard)
materials of construction, pressure/temperature ratings and identification marking of the fittings, or
- are not covered by the provisions of a recognized North American standard and are therefore manufactured to comply with _____ as supported by the attached data which identifies the dimensions, materials of construction, pressure/temperature ratings and the basis for such ratings, and the marking of the fittings for identification.

I further declare that the manufacture of these fittings is controlled by a quality control program which has been verified by the following authority, RINA Services S.p.A.-ISO 9001:2008 as being suitable for the manufacture of these fittings to the stated standard. The fittings covered by this declaration, for which I seek registration, are "A" Type Fitting.

In support of this application, the following information, calculations and/or test data are attached:

IML Catalogue, B.Veritas Test G5145 A/DEF BY ITA 40 01 2235/A, IML dwgs

DECLARED before me at _____ in the _____ of _____
this _____ day of _____ (Month) _____ (Year)
(print) _____
(sign) _____
(A Commissioner for Oaths)


(Signature of Applicant)

For Office Use Only *Accepted fittings listed on doc. LOP 01-02 Rev. RE-02-00*

To the best of my knowledge and belief, the application meets the requirements of the Safety Codes Act and CSA Standard B51, Clause 4.2, and is accepted for registration in Category A

Registration Number 0109221.52

Date Registered DEC 0 5 2013

(For the Administrator/Chief Inspector of Alberta)
Expiry Date: October 3, 2013

The information requested is necessary only for the administration of the program as required by the Alberta Safety Codes Act and Regulations, in the Boiler Discipline.

See Appendix Letter for the comment and conditions of registration.



I.M.L. INDUSTRIA MECCANICA LIGURE SPA

Via Giancarlo Farina 25 - 16030 - CASARZA LIGURE - GENOVA - ITALY
 Tel. 0039 0185 467.661 - Fax 0039 0185 466.510
 E-mail: quality.ml@farinagroup.com

Messrs. : TSSA - Technical Standards & Safety Authority
 Address : 14th Floor - Center Tower - 3300 Bloor Street West
 Code : N M8X2X4 City : Toronto State : Canada

Subject : LIST OF FITTINGS - LOF01-02.

STANDARD	STEEL GRADE	PRODUCT	OUTSIDE DIAMETER				
ASME B16.11	LISTED BELOW	90° ELBOW - CROSS-TEE - 45° ELBOW - COUPLING	from 1/8" to 4"				
		HALF COUPLING - CAP - SQUARE PLUG - HEX PLUG					
		ROUND PLUG - HEX BUSHING - FLUSH BUSHING					
		STREET ELBOW	from	1/8"	to	2"	
MSS SP-79	LISTED BELOW	SOCKET WELDING REDUCER INSERTS	from	3/8"	to	4"	
MSS SP-83	LISTED BELOW	STEEL PIPE UNIONS SW + THREADED CL 3000	from	1/8"	to	3"	
MSS SP-95	LISTED BELOW	SWAGED (D) NIPPLES AND BULL PLUGS	Swaged	from	1/4"	to	8"
			Bull Plug	from	1/8"	to	12"
MSS SP-97 ASME B31.1 ASME B31.3	LISTED BELOW	INTEGRALLY REINFORCED FORGED BRANCH OUTLET FITTINGS AND BOSSES	from	1/8"	to	24"	
ASTM A 733	LISTED BELOW	CARBON STEEL AND AUSTENITIC STAINLESS STEEL PIPE NIPPLES	from 1/8" to 8"				
ASME B36.10M							
ASME B36.19M							
MATERIAL STANDARD		STEEL GRADE					
ASTM A53/A53M		GR.A-GR.B					
ASTM A105/A105M		A105					
ASTM A106/A106M		GR.A-GR.B-GR.C					
ASTM A182/A182M		F1-F2-F5-F5a-F9-F10-F91-F11-CL 1-2-3-F12-CL 1-2-F22-CL 1-3-F22V.					
		F6a-CL 1-2-3-4-F6b-F6NM					
		F304-F304H-F304L-F304N-F304LN-F309H-F310-F310MoLN-F310H-F316-F316H-F316L-F316N-F316LN-F316Ti-F317-F317L-F317H-F317LN-F321-F321H-F904L					
		E51-F53-F55-F60					
ASTM A234/A234M		WPB-WPC-WP1-WP12-CL 1-2-WP11-CL 1-2-3-WP22-CL 1-3-WP5-CL 1-3-WP9-CL 1-3-WPR-WP91-WP911					

NPT SW
 2000# 3000
 3000# 6000
 6000# 9000
 Kk
 10/2/13



I.M.L. INDUSTRIA MECCANICA LIGURE SPA

Via Giancarlo Farina, 25 - 16030 - CASARZA LIGURE - GENOVA - ITALY

Tel. 0039 0185 467.661 - Fax 0039 0185 466.510

E-mail: quality/iml@farinagroup.com

MATERIAL STANDARD	STEEL GRADE
ASTM A312/A312M	TP304, TP304L, TP304H, TP304N, TP304LN, TP310S, TP310H, TP310Cb, TP310Hcb, TP316, TP316L, TP316H, TP316H, TP316N, TP316LN, TP317, TP317L, TP321, TP321H, TP347, TP347H, TP347LN, 900, 800H
ASTM A335/A335M	P1, P2, P5, P5B, P5C, P9, P11, P12, P15, P21, P22, P23, P24, P36, CL 1-2, P91, P92, P122, P911
ASTM A350/A350M	LF1, CL 1, LF2, CL 1-2, LF3, CL 1-2, LF5, CL 1-2, LF6, CL 1-2, 3, LF9, LF787, CL 2-3
ASTM A403/A403M	WP200B, WPNIC, WPNIC10, WPNIC11, WP904L, WP304, WP304L, WP304H, WP304N, WP304LN, WP310S, WP31254, WP316, WP316L, WP316H, WP316N, WP316LN, WP317, WP317L, WP321, WP321H, WP347, WP347H, WP347LN
ASTM A420/A420M	WPL8, WPL8B, WPL8, WPL9
ASTM A790/A790M	UNS S31803, S32750, S32760
ASTM A815/A815M	WPS31803, WP410
ASTM B366	UNS N04400, N06600, N06625, GR. 1, N06625, GR. 2, N08020, N08800, N10276
ASTM B423	UNS N08825, N08221, N06845
ASTM B425	UNS N08825, N08221, N06845
ASTM B462	UNS N08020, N10276
ASTM B564	UNS N04400, N06625, N06600, N08800, N08825, N10276

Date: 27-09-2013

Issued: IML QAM - R. Cavagliari

ASFA

SAFETY CODES ACT - PROVINCE OF ALBERTA
REGISTRATION OF FITTINGS

REGISTRATION NO. **0A09221.52**

List of fittings **LOF01-02 Rev. RE-02-00**

DATE OF CAL. NO. **0**

TYPE OF FITTINGS **Pipe fittings**

DEC 05 2013

INITIALS **Melloni**

Date

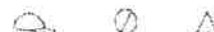
(Signature)



STATUTORY DECLARATION
Registration of Fittings

In this space, show facsimile of manufacturer's logo or trademark as it will appear on the fitting.

CAMCO, CAPPRODUCTS, CAPP



I, Guy A. Cuccio
Technical Services Manager

(company title, e.g. vice president, plant manager, chief engineer) (must be in a position of authority)

of Capitol Manufacturing, CAMCO, and CapProducts Ltd.
Members of The Phoenix Forge Group
(name of manufacturer)

located at 1125 Capitol Road, Crowley, LA 70526, USA and 25 Winnipeg Street, Vanastra, Ontario N0M 1L0, Canada
(plant address)

do solemnly declare that the fittings listed hereunder, which are subject to the Safety Codes Act (check one)

comply with the requirements of ASME B16.11, MSS SP-79, MSS SP-83, MSS SP-95, MSS SP-114
(title of recognized North American Standard) which specifies the dimensions, materials of construction, pressure/temperature ratings and identification marking of the fittings, or

are not covered by the provisions of a recognized North American standard and are therefore manufactured to comply with _____ as supported by the attached data which identifies the dimensions, materials of construction, pressure/temperature ratings and the basis for such ratings, and the marking of the fittings for identification.

I further declare that the manufacture of these fittings is controlled by a quality control program which has been verified by the following authority, Det Norske Veritas as being suitable for the manufacture of these fittings to the stated standard. The fittings covered by this declaration, for which I seek registration, are Category A Pipe Fittings

In support of this application, the following information, calculations and/or test data are attached:
Capitol and CAMCO Online Catalogs www.capitolcamco.com; CapProducts Online Catalog www.capproducts.com;
ISO 9001-2000

DECLARED before me at Crowley in the State of Louisiana, 70526 USA
this 13th day of May, 2009
(Month) (Year)

(print) Guy A. Cuccio
(sign) Renee DeBiller
(A Commissioner for Oaths) 42911

Guy Cuccio
(Signature of Applicant)

For Office Use Only

To the best of my knowledge and belief, the application meets the requirements of the Safety Codes Act and CSA Standard B51, Clause 4.2, and is accepted for registration in Category A

Registration Number: 0A09967.8 + MILA GPYNCIUK
Date Registered: JUN 19 2009 (For the Administrator/Chief Inspector of Alberta)
Expiry Date: 2019-06-19

The information you provide is necessary only for the administration of the programs as required by the Alberta Safety Codes Act and Regulations in the Boiler Discipline.
THIS IS replacement of CAN DA00 768.92. See the acceptance letter
2-0



ABSA
the pressure equipment safety authority
STATUTORY DECLARATION
Registration of Fittings

In this space, show facsimile of manufacturer's logo or trademark as it will appear on the fitting.



I, Rag. Bruno Farina

President

(company title, e.g. vice president, plant manager, chief engineer) (must be in a position of authority)

of Metaifar Prodotti Industriali spa

(name of manufacturer)

located at Via Parini 28- 23861 Cesana Brianza, Lecco, Italy

(plant address)

I do solemnly declare that the fittings listed hereunder, which are subject to the Safety Codes Act (check one)

comply with the requirements of ASME B16.5 including Long Weld Neck,
(title of recognized North American Standard)

materials of construction, pressure/temperature ratings and identification marking of the fittings, or

are not covered by the provisions of a recognized North American standard and are therefore manufactured to comply with _____ as supported by the attached data which identifies the dimensions,

materials of construction, pressure/temperature ratings and the basis for such ratings, and the marking of the fittings for identification.

I further declare that the manufacture of these fittings is controlled by a quality control program which has been verified by the following authority. Det Norske Veritas, ISO 9001:2008 as being suitable for the manufacture of these fittings to the

stated standard. The fittings covered by this declaration, for which I seek registration, are Category B: Flanges

In support of this application, the following information, calculations and/or test data are attached:

Catalogue referencing carbon, stainless and alloy steel flanges to ASTM and AMSE specifications.

DECLARED before me at _____ in the _____ of _____

this 30 day of 01, 2012
(Month) (Year)

(print)

(sign) [Signature]
(A Commissioner for Oaths)

(Signature of Applicant)

For Office Use Only

To the best of my knowledge and belief, the application meets the requirements of the Safety Codes Act and CSA Standard B51, Clause 4.2, and is accepted for registration in Category B

Registration Number: OB 11962.2

Date Registered: APR 06 2012

(For the Administrator/Chief Inspector of Alberta)

Expiry Date: 2012-02-28

The information you provide is necessary only for the administration of the programs as required by the Alberta Safety Codes Act and Regulations in the Boiler Discipline

FLANGES to BS 3293 are not part of this registration

[Handwritten mark]

November 22, 2012

Les Mansfield
TRILAD FLANGES & FITTINGS INC
PO BOX 459
PARIS, ON

Dear Les Mansfield,

The design submission, tracking number 2012-05737, originally received on August 17, 2012 was surveyed and accepted for registration as follows:

CRN : 0B12848.2

Accepted on: November 22, 2012

Reg Type : New Design

Expiry Date: November 22, 2022

Drawing No. : CAT. FL-00 & APPENDIX B

Fitting Desc: ASME B16.5, B16.36 AND B16.47 FLANGES

The registration is conditional on your compliance with the following notes:

This registration has been issued based on the understanding that:

- The flange types, sizes, pressure & temperature ratings, and material specifications are as per Appendix B attached to the Statutory Declaration;

- The accepted TRILAD fabrication facilities are as per the QC Certificate of Registration.

This registration is valid only for fittings fabricated at the location(s) covered by the QC certificate attached to the accepted AB-41 Statutory Declaration form. This registration is valid only until the indicated expiry date only if the Manufacturer maintains a valid quality management system approved by an acceptable third-party agency until that date. Should the approval of the quality management system lapse before the expiry date indicated above, this registration shall become void.

An invoice covering survey and registration fees will be forwarded from our Revenue Accounts.
Enclosed are stamped prints for your reference.

Sincerely,



PREDA, DRAGOS, P. Eng.
Design Survey Engineer



the pressure equipment safety authority

STATUTORY DECLARATION
Registration of Fittings

In this space, show facsimile of manufacturer's logo or trademark as it will appear on the fitting.



I, LESLIE E. J. MANSFIELD, CET,
QUALITY ASSURANCE & TECHNICAL SERVICES MANAGER
(company title, e.g. vice president, plant manager, chief engineer) (must be in a position of authority)
of TRILAD FLANGES & FITTINGS, INC.
(name of manufacturer)

located at 30 WOODSLEE AVENUE, PARIS, ONTARIO, N3L 3V1
(plant address)

do solemnly declare that the fittings listed hereunder, which are subject to the Safety Codes Act (check one)

- comply with the requirements of ASME B16.5, B16.36 & B16.47 which specifies the dimensions, materials of construction, pressure/temperature ratings and identification marking of the fittings, or
- are not covered by the provisions of a recognized North American standard and are therefore manufactured to comply with _____ as supported by the attached data which identifies the dimensions, materials of construction, pressure/temperature ratings and the basis for such ratings, and the marking of the fittings for identification.

I further declare that the manufacture of these fittings is controlled by a quality control program which has been verified by the following authority, SAI GLOBAL as being suitable for the manufacture of these fittings to the stated standard. The fittings covered by this declaration, for which I seek registration, are CATEGORY B

In support of this application, the following information, calculations and/or test data are attached:
TRILAD CATALOGUE FL-00 including Appendix A & B

DECLARED before me at WANTORD in the PROVINCE of ONTARIO

this 13 day of SEPT 2012
(Month) (Year)

(print) PETER B. FORBES, Q.C.

(sign) [Signature]
(A Commissioner for Oaths)

[Signature]
(Signature of Applicant)

For Office Use Only

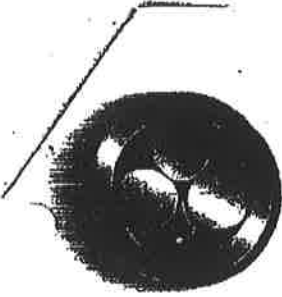
Per Acceptance Letter & Notes

To the best of my knowledge and belief, the application meets the requirements of the Safety Codes Act and CSA Standard B51, Clause 4.2, and is accepted for registration in Category B

Registration Number: QB12848.2

Date Registered: NOV 22 2012

(For the Administrator/Chief Inspector of Alberta)
Expiry Date: 2022/11/22



TRI-LAD INC.
FLANGE AND FITTINGS

March 12, 2002

Subject: Tri-Lad Inc, Flange and Fittings
Catalogue, Cat FL-00

Appendix B

In support of the application, the following catalogue pages of Cat FL-00 apply.

Catalogue Section:

- a) Large Diameter Flanges ASME/ANSI B16.47: Pages Five through fifteen inclusive.
- b) ASME/ANSI B16.5: Pages Twenty four through thirty one inclusive.
- c) Orifice Flange ASME/ANSI B16.36: Pages 34, 35, 36, 35a, 35b, 35c, 35d, 35e.
- d) Standard Flange Facings: as per ASME/ANSI B16.5, B16.47, B16.36.
- e) Pressure Temperature ratings: as per ASME/ANSI B16.5, B16.47, B16.36.
- f) Materials: as per ASME/ANSI B16.5, B16.47, B16.36.

Boris Pancoe
Mgr., Quality Assurance

ASMA	
SAFETY CODES ACT - PROVINCE OF ALBERTA	
ACCEPTED	
<i>Preda</i>	
0812848.2	
NOV 22 2012	<i>Preda</i>
Date	Signed
BRAGGS-PREDA, P.Eng. DESIGN SURVEY ENGINEER	

P.O. Box 430
220 Wayne Gretzky Parkway
Brantford, Ontario, N3T 5P3
Phone: 519-753-4154
Fax: 519-759-8709

8912 - 18th Street
Edmonton, Alberta
T6P 1K6
Phone: 780-467-5959
Fax: 780-449-1533





STATUTORY DECLARATION
Registration of Fittings

In this space, show facsimile of manufacturer's logo or trademark as it will appear on the fitting.

I, KANG-TAI, WU

(company title, e.g. vice president, plant manager, chief engineer) (must be in a position of authority)

of SAN ENG steel Forging CO., LTD
(name of manufacturer)

located at 211, REN SHIN ROAD, REN WU Dist., KAOHSIUNG City, Taiwan, R.O.C.
(plant address)

do solemnly declare that the fittings listed hereunder, which are subject to the Safety Codes Act (check one)

comply with the requirements of ASTM A105, A250, A182, A516, AWWA C200
ASME B16.5, B16.47, B16.36 which specifies the dimensions,
(title of recognized North American Standard)

materials of construction, pressure/temperature ratings and identification marking of the fittings, or
 are not covered by the provisions of a recognized North American standard and are therefore manufactured to comply with _____ as supported by the attached data which identifies the dimensions, materials of construction, pressure/temperature ratings and the basis for such ratings, and the marking of the fittings for identification.

I further declare that the manufacture of these fittings is controlled by a quality control program which has been verified by the following authority, Lloyd's Register as being suitable for the manufacture of these fittings to the stated standard. The fittings covered by this declaration, for which I seek registration, are Category B type fittings

In support of this application, the following information, calculations and/or test data are attached: Catalogue + ISO (No Flange)

DECLARED before me at _____ in the COURT of KAOHSIUNG

this _____ day of _____ (Month) _____ (Year)

(print) _____ (Signature of Applicant) K.T. Wu

(sign) _____
(A Commissioner for Oaths)

For Office Use Only See Acceptance Letter for the comments and/or conditions of registration.

To the best of my knowledge and belief, the application meets the requirements of the Safety Codes Act and CSA Standard B51, Clause 4.2, and is accepted for registration in Category B, accepted as noted.

Registration Number: OB12945.2

Date Registered: JAN 03 2013

[Signature]
(For the Administrator/Chief Inspector of Alberta)
Expiry Date: JAN 03 2023



the pressure equipment safety authority

STATUTORY DECLARATION
Registration of Fittings

In this space, show facsimile of manufacturer's logo or trademark as it will appear on the fitting.



I, ENERITZ URIZAR

QUALITY SYSTEM MANAGER

(Company title, e.g. vice president, plant manager, chief engineer) (must be in a position of authority)

of ULMA FORJA S.COOP

(name of manufacturer)

located at Bº ZUBILLAGA, 3 - 20560 ONATI - GIPUZKOA - SPAIN

(plant address)

I do solemnly declare that the fittings listed hereunder, which are subject to the Safety Codes Act (check one)

comply with the requirements of ASME B16.5, B16.47, B16.36 which specifies the dimensions, (title of recognized North American Standard)

materials of construction, pressure/temperature ratings and identification marking of the fittings, or

are not covered by the provisions of a recognized North American standard and are therefore manufactured to comply with _____ as supported by the attached data which identifies the dimensions,

materials of construction, pressure/temperature ratings and the basis for such ratings, and the marking of the fittings for identification.

I further declare that the manufacture of these fittings is controlled by a quality control program which has been verified by the following authority, ISO 9001:2008 - LRQA as being suitable for the manufacture of these fittings to the

stated standard. The fittings covered by this declaration, for which I seek registration, are FORGED FLANGES

In support of this application, the following information, calculations and/or test data are attached:

CATALOGUE

DECLARED before me at ONATI in the NAME of ULMA FORJA

this 12th day of JANUARY 2013

(Month) (Year)

(print)

(sign)

(A Commissioner for Oaths)

(Signature of Applicant)

For Office Use Only

To the best of my knowledge and belief, the application meets the requirements of the Safety Codes Act and CSA Standard B51, Clause 4.2, and is accepted for registration in Category B

Registration Number: 0 B 15975.52

JUL 25 2013

Date Registered: _____

See Acceptance Letter for the comments and/or conditions of registration.

(For the Administrator/Chief Inspector of Alberta)

Expiry Date: April 22, 2013

SCOPE OF REGISTRATION 1/3

Product: FLANGES
 Catalogue: CATALOGUE 2
 Manufacturer: ULMA FORJA S.COOP.

STANDARD	DESCRIPTION	FLANGE TYPE	NPS (INCHES)	PRESSURE CLASS (LB)	SCHEDULES	FACE	ASME/ASTM MATERIAL
ASME B16.5	BLIND	BL	1/2"-24"	150-1500	--	RF,FF,RJ	LISTED BELOW.
ASME B16.5	BLIND	BL	1/2"-12"	2.500	--	RF,FF,RJ	LISTED BELOW.
ASME B16.5	WELDING NECK	WN	1/2"-24"	150-1500	5-160	RF,FF,RJ	LISTED BELOW.
ASME B16.5	WELDING NECK	WN	1/2"-12"	2.500	5-160	RF,FF,RJ	LISTED BELOW.
ASME B16.5	LONG WELDING NECK	LWN	1/2"-24"	150-1500	--	RF,FF,RJ	LISTED BELOW.
ASME B16.5	LONG WELDING NECK	LWN	1"-12"	2.500	--	RF,FF,RJ	LISTED BELOW.
ASME B16.5	SLIP-ON	SO	1/2"-24"	150-900	--	RF,FF	LISTED BELOW.
ASME B16.5	SLIP-ON	SO	1/2"-2.1/2"	1500	--	RF,FF	LISTED BELOW.
ASME B16.5	LAP JOINT	LJ	1/2"-24"	150-1500	--	FF	LISTED BELOW.
ASME B16.5	LAP JOINT	LJ	1/2"-12"	2.500	--	FF	LISTED BELOW.
ASME B16.5	SOCKET WELD	SW	1/2"-3"	150-600	5-160	RF,FF,RJ	LISTED BELOW.
ASME B16.5	SOCKET WELD	SW	1/2"-2.1/2"	1500	5-160	RF,FF,RJ	LISTED BELOW.
ASME B16.5	THREADED	TH	1/2"-24"	150-900	--	RF,FF,RJ	LISTED BELOW.
ASME B16.5	THREADED	TH	1/2"-12"	1500-2500	--	RF,FF,RJ	LISTED BELOW.
ASME B16.47	BLIND	BL	26"-60"	75-600	--	RF,FF,RJ	LISTED BELOW.
ASME B16.47	BLIND	BL	26"-48"	75-900	--	RF,FF,RJ	LISTED BELOW.
ASME B16.47	WELDING NECK	WN	26"-60"	75-600	5-160	RF,FF,RJ	LISTED BELOW.
ASME B16.47	WELDING NECK	WN	26"-48"	75-900	5-160	RF,FF,RJ	LISTED BELOW.
ASME B16.36	ORIFICE WN	WNORIF	1"-24"	150-1500	5-160	RF,FF,RJ	LISTED BELOW.
ASME B16.36	ORIFICE WN	WNORIF	1"-12"	2500	5-160	RF,FF,RJ	LISTED BELOW.

STEEL AND ALLOY GRADES PRODUCED

Carbon Steel	Alloy and Stainless Steel	Nickel Base Alloys.
ASTM A105	ASTM A182F304/F304L/304H	ASTM B564 UNS N06625
ASTM A350LF2	ASTM A182F316/F316L/F316H	ASTM B564 UNS N08800
ASTM A350LF3	ASTM A182F321/F321H	ASTM B564 UNS N08825
ASTM A350LF6	ASTM A182F347H	ASTM B564 UNS N08811
ASTM A707L3	ASTM A182F44	ASTM B462 UNS N08020
ASTM A707L5	ASTM A182F904L	
ASTM A694F42/F46/F48/F50/F52/F56/F60/F65/70	ASTM A182F51	
	ASTM A182F53	
	ASTM A182F55	
	ASTM A182F60	
	ASTM A182F5	
	ASTM A182F9	
	ASTM A182F91	
	ASTM A182F11	
	ASTM A182F22	

ASCA

SAFETY CODES ACT - PROVINCE OF ALBERTA

REGISTRATION OF FITTINGS

0015975.52

REGISTRATION NO. 0015975.52

DWG. NO. or CAT. NO. ULMA FORJA CATALOG 2

TYPE OF FITTINGS Flanges & Line Blanks

Date JUL 26 2013

INITIALS Belley

1ST YANA ONSHCHENKO, P.Eng
DESIGN SURVEY ENGINEER

See Acceptance Letter for the comments and/or conditions of registration.



the pressure equipment safety authority

STATUTORY DECLARATION
Registration of Fittings

In this space, show facsimile of manufacturer's logo or trademark as it will appear on the fitting.



I, ENERITZ URIZAR

QUALITY SYSTEM MANAGER

(company title, e.g. vice president, plant manager, chief engineer) (must be in a position of authority)

of ULMA FORJA S.COOP

(name of manufacturer)

located at Bº ZUBILLAGA, 3 - 20560 OÑATI - GIPUZKOA - SPAIN

(plant address)

do solemnly declare that the fittings listed hereunder, which are subject to the Safety Codes Act (check one)

comply with the requirements of ASME B16.48 which specifies the dimensions, (title of recognized North American Standard)

materials of construction, pressure/temperature ratings and identification marking of the fittings, or

are not covered by the provisions of a recognized North American standard and are therefore manufactured to comply with _____ as supported by the attached data which identifies the dimensions, materials of construction, pressure/temperature ratings and the basis for such ratings, and the marking of the fittings for identification.

I further declare that the manufacture of these fittings is controlled by a quality control program which has been verified by the following authority, ISO 9001:2008 - LRQA as being suitable for the manufacture of these fittings to the

stated standard. The fittings covered by this declaration, for which I seek registration, are LINE BLANKS (SPECTACLES)

In support of this application, the following information, calculations and/or test data are attached:

CATALOGUE

DECLARED before me at OÑATI in the NAME of ULMA FORJA

this 18th day of JANUARY, 2013

(Month) (Year)

(print) _____

(sign) [Signature]

(A Commissioner for Oaths)

(Signature of Applicant)

For Office Use Only

See Acceptance Letter for the conditions and/or conditions of registration.

To the best of my knowledge and belief, the application meets the requirements of the Safety Codes Act and CSA Standard B51, Clause 4.2, and is accepted for registration in Category B

Registration Number: 0515975.52

Date Registered: JUL 26 2013

(For the Administrator/Chief Inspector of Alberta)

Expiry Date: April 22, 2013

SCOPE OF REGISTRATION 3/3

Product: LINE BLANKS.
Catalogue: CATALOGUE 2.
Manufacturer: ULMA FORJA S.COOP.

STANDARD	DESCRIPTION	FLANGE TYPE	NPS (INCHES)	PRESSURE CLASS (LB)	SCHEDULES	FACE	ASME/ASTM MATERIAL
ASME B16.48	SPECTACLE BLIND (Figure-8 Blind)	SB			--	RF,FF,RJ	LISTED BELOW.
ASME B16.48	SPADE (Paddle Blank)	SPADE			--	RF,FF,RJ	LISTED BELOW.
ASME B16.48	SPACER (Paddle Spacer)	SPACER			--	RF,FF,RJ	LISTED BELOW.

STEEL AND ALLOY GRADES PRODUCED

Carbon Steel ASTM A105 ASTM A350LF2 ASTM A694F42/F46/F48/F50/F52/F56/F60/F65/70 ASTM A516 GR60/GR65/GR70	Alloy and Stainless Steel ASTM A182F304/F304L/304H ASTM A182F316/F316L/F316H ASTM A387GR5/GR9/GR11/GR22 ASTM A240TP304L/TP316/... UNS S31803/S32750/S332750/S32205	Nickel Base Alloys.
---	--	----------------------------

0 B 15975.52

JUL 26 2013

See Acceptance Letter for the comments
and/or conditions of registration.

INSPECTION CERTIFICATE
 TYPE 3.1 (WITH PRESSURE)
 IN ACCORDANCE WITH EN10204 & DIN 50049

Parker
 ENGINEERING YOUR SUCCESS.
 PARKER HANNIFIN
 MANUFACTURING LTD
 INSTRUMENTATION PRODUCTS
 DIVISION
 RIVERSIDE ROAD
 POTTINGTON BUSINESS PARK
 BARNSTAPLE
 DEVON
 EX31 1NP
 TELEPHONE +44 (0)1271 313131
 FAX +44 (0)1271 373 636

CUSTOMER :
Par H Canada - Montreal

Sales Order	07455481
-------------	-----------------

WORKS ORDER REFERENCES

9080035					

Customer Order Ref	26850
Part Number	HPM6LS3DBBB-MD4-14299EHXJ
Qty	6

CERTIFICATE OF MATERIAL AND TEST

COMPONENT	HCT	CAST NUMBER	MATERIAL GRADE
BODY	P455	236290	316L COLD DRAWN BAR
BODY	P722	244980	316L COLD DRAWN BAR
END CONNECTOR	P551	224065	316L COLD DRAWN BAR
END CONNECTOR	H283	411048	316L COLD DRAWN BAR
END CONNECTOR	H352	421059	316L COLD DRAWN BAR
STEM	C260	371278	316L COLD DRAWN BAR
BALL	W07	263484	MO73-1

SHELL TEST PRESSURE (psi)	9000
SEAT TEST PRESSURE (psi)	6600
MAX CWP (psi)	6000
PACKING	
TEST MEDIA	WATER

--

--

We Certify that the whole of the supplies detailed hereon have been inspected and tested in accordance with the conditions and requirements of the contract and or the purchase order and, unless stated below, confirm in all respects to the specifications, and drawings relevant thereto.

QUALITY DEPARTMENT
 AUTHORISED SIGNATORY




DATE: 19/01/2015 13:46



INSPECTION CERTIFICATE

TYPE 3.1 (WITH PRESSURE)

IN ACCORDANCE WITH EN10204 & DIN 50049

CUSTOMER :

Par H Canada - Montreal



**PARKER HANNIFIN
MANUFACTURING LTD**
INSTRUMENTATION PRODUCTS
DIVISION
RIVERSIDE ROAD
POTTINGTON BUSINESS PARK
BARNSTAPLE
DEVON
EX31 1NP
TELEPHONE +44 (0)1271 313131
FAX +44 (0)1271 373 636

Sales Order	07455481
--------------------	-----------------

WORKS ORDER REFERENCES

9085412

9085412					

Customer Order Ref	26850
Part Number	HPM6LS3DBBB-MD4-14299EHXJ
Qty	5

CERTIFICATE OF MATERIAL AND TEST

COMPONENT	HCT	CAST NUMBER	MATERIAL GRADE
BODY	P455	236290	316L COLD DRAWN BAR
BODY	P722	244980	316L COLD DRAWN BAR
END CONNECTOR	P551	224065	316L COLD DRAWN BAR
END CONNECTOR	H283	411048	316L COLD DRAWN BAR
END CONNECTOR	H352	421059	316L COLD DRAWN BAR
END CONNECTOR	M767	840106	316L COLD DRAWN BAR
STEM	C260	371278	316L COLD DRAWN BAR
BALL	W07	263484	MO73-1

SHELL TEST PRESSURE (psl)	9000
SEAT TEST PRESSURE (psl)	6600
MAX CWP (psl)	6000
PACKING	
TEST MEDIA	WATER

We Certify that the whole of the supplies detailed hereon have been inspected and tested in accordance with the conditions and requirements of the contract and or the purchase order and, unless stated below, confirm in all respects to the specifications, and drawings relevant thereto.

QUALITY DEPARTMENT
AUTHORISED SIGNATORY



DATE: 19/01/2015 13:44





HI-TECH

Special Steels Limited

Rotherham Road, Laughton Common,
Dinnington, Sheffield S25 3RF
Tel: Dinnington (01909) 564545
Fax No (01909) 550682

Registered in England No. 1921116

Customer

David Paull CNC
T/A DP Eng Ltd
Jon Davey Drive
Treleigh Ind Est
Redruth TR16 4AX

TEST CERTIFICATE IN ACCORDANCE WITH BS EN 10204 3.1/ISO 10474 3.1

Certificate No.	T58639	Product	Stainless steel bar		
Order No.	Consignment	Cast No.	236290	Specification	1.4404
Our Reference	Z100306/P40572	Quantity	412 Kgs	Size	3.1/2" x 1.5/8"
Advice Note No.	DP219	Finish	Linished		
Heat Treatment	Fully solution treated and water quenched prior to cold sizing				

Chemical Analysis

C	0.018	Si	0.65	Mn	1.63	S	0.018	P	0.027
Ni	10.5	Cr	16.67	Mo	2.02	Ti	0.014	Nb	0.006
Co	0.093	Cu	0.47	N	0.037	W		Ca	
Sn		Ta		V		Al		Fe	

Mechanical Properties

Tensile Strength	626 Mpa	0.2% Proof Stress	493 Mpa
Reduction of Area	75,0%	Elongation	44,0%
Hardness	15 HRC	Impact Tests	

Special Conditions / Processing Details

In accordance with BS EN 10088-3 2005 1.4404	HCT No : P455
In accordance with MO19/1	Part No :
Conforming to NACE MR0175/MR0103	
Free from mercury and radioactive contamination	
ICC test to ASTM A262 'E' - Satisfactory	
Also conforming to ASTM A276/A479 Gr 316/316L & ASTM A182 F316/316L	
Manufacturers Test Cert No.	Concessions Agreed

"Certified that the whole of the supplied detailed hereon, unless otherwise stated, are covered by the Sources Certificate of Conformity/Test Certificate referenced hereon, and has been subject to the Quality System requirements in accordance with the conditions of our BS EN ISO 9001, 2008 registration for lot traceable products".

"Certified that the supplies/services detailed hereon have been inspected and tested in accordance with the conditions, requirements of the contract or purchase order and, unless otherwise noted below, conform in all respects to the specification(s)/drawing(s) relevant thereto".

H.C.T. P455

Checked & Approved by

Parker Hannifin IP

Quality Controller

14-06-2013 14:23:44 Page 1 of 3

13 JAN 2015

ORIGINAL CERTIFICATION

Walzwerke Einsal GmbH



VAT Reg. No DE123841325

Walzwerke Einsal GmbH - Post Box 20 - 58769 Nachrodt-Wiblingwerde

Hi-Tech Special Steels Limited
Rotherham Rd. Laughton Common
S 25 3 RF Dinnington / Sheffield
Groß-Britannien

Inspection Certificate:
DIN EN 10204/3.1

Page 1

No. WZ1012-00392 of 11.10.12

Your Order No.. 004042
Shipment No.: VL12-06658

Symbol of Manufacturers



Surveyor of inspection



our works No. AB12-10934 Item 40 Size 14404 Flat 90,42 x 42,80 mm 3,560 X 1,685 " Weight 2.363 KG

Material Number 14404 Standard Grade of Material X2CrNiMo17-12-2
Heat Number 236290 Method of melting: E

Chemical analysis															
C %	0,018	SI %	0,65	Mn %	1,63	P %	0,027	S %	0,018	Cr %	16,67	Ni %	10,5	Mo %	2,02
Ti %	0,014	Co %	0,093	N %	0,037	Cu %	0,47	Nb %	0,006						

Product Information

Steel bars, 14404 X2CrNiMo17-12-2 hot rolled, DIN EN 10058 tol. see below, quenched, pickled, straight as rolled/suitable to drawing, with short lengths see below, without stamping, in bundles

Addition Information

bar length mm: 5000 - 6000 , short lengths: from 3800 mm to max. 10 % , packaging size: max. 1500 kg quality: AISI 316 / 316 L.
additional information: no weld repair undertaken . in Wasser abgeschreckt / quenched in water , WAZ per e-mail , S % 0,015 - 0,030

Requirements

test certificate: DIN EN 10204/3.1 rev. 01/2005, tolerance of dimension/shape: DIN EN 10058 rev. 02/2004, standard: DIN EN 10088 part 3 rev. 09/2005
ASTM A 479 / A 479 M rev. 2011 , ASTM A 276 rev. 2008A , ASTM A 262 Practice E rev. 1993A , DIN EN 10272 rev 01/2008

Sample	PR1012-00169			
Mechanical properties				
Rp 0,2% Mpa	258			
Rp 1,0% Mpa	305			
Rm Mpa	566			
A5%	59,4			
Hardness				
HB	168			
Corrosion resistance				
IC-test (Delivery condition)	ok			
IC-test (sensitized)	ok			

The delivery corresponds to the requirements mentioned.
The certificate has been established by machine and acc. to EN 10204 C3s legal
without Signature.

Telephone 0 23 52 3 32-0 Telefax: 0 23 52 33 2192

H.C.T. P455
Checked & Approved by
Parker Hannifin IPDE

Walzwerke Einsal GmbH
QA-department
Feldmann
Surveyor of inspection



14/06/12



Special Testing Ltd

Bacon Lane, Sheffield S9 3NH
Tel: 0114 244 1061
Fax: 0114 244 0444 Works
Fax: 0114 244 5566 Acc/Admin
www.specialtesting.co.uk

Test Certificate 222252

AUTHENTICATION CODE 60678E7577AE
ROLLS ROYCE APPROVED LABORATORY
Approval No. 11191

CUSTOMER
HI-TECH SPECIAL STEELS LTD
ALLOY & METAL WORKS, ROTHERHAM RD
LAUGHTON COMMON, DINNERTON
SHEFFIELD S25 3RF
DATE RECEIVED 23 October 2012
TEST DATE 25 October 2012



CUSTOMER ORDER NO	PRD2830	TEST NUMBER	222252	IDENTITY	P40572	CAST*	236290	ALL REQUIREMENTS MIN UNLESS STATED		
SPECIFICATION	BS EN10088-3:2005 (X2CrNiMo17-12-2) 1.4404					TEST PIECE FROM*	3.1/2" X 1.5/8"			
TENSILE: BS EN ISO 6892-1:2009 A224		0.2% PROOF	1.0% PROOF	UTS	ELONG ON	%	R OF A %	COMMENTS		
OR	TEMP	SECTION	AREA SQ	UNIT	REQUIREMENTS					
L	RT	10.01mm	78.70mm ²	Mpa	RESULTS:	493	527	626	50mm 44.0 75.0	N/A
HARDNESS: BS EN ISO6508-1 2005			DESIGNATION	REQUIREMENTS	RESULTS					
ROCKWELL C (MID RADIAL)			HRC		15					
ROCKWELL B			HRBW		93					

END OF CERTIFICATE

H.C.T. P455
Checked & Approved by
Parker Hannifin IPDE
14-06-2013 14:23:44 Page 3 of 3

REPRESENTING*	No copy is authentic without the embossed seal and signature. This certificate can be authenticated at www.specialtesting.co.uk with the code 60678E7577AE This certificate shall not be reproduced, except in full, without the written approval of the laboratory. For and on behalf of SPECIAL TESTING LTD A Member of the Special Steel Group of Companies	 Steve Pearce Certification Manager
---------------	---	---

Test results do not in any way confer approval of the quality of manufacture of the material. All results are subject to uncertainty of measurement budgets, details available upon request.
Information marked * is supplied by the customer.





HI-TECH

Special Steels Limited

Rotherham Road, Laughton Common,
Dinnington, Sheffield S25 3RF
Tel: Dinnington (01909) 564545
Fax No (01909) 550682

Registered in England No. 1921116

Customer

David Paull CNC
T/A DP Eng Ltd
Jon Davey Drive
Treleigh Ind Est
Redruth TR16 4AX

TEST CERTIFICATE IN ACCORDANCE WITH BS EN 10204 3.1/ISO 10474 3.1

Certificate No.	T58969	Product	Stainless steel bar		
Order No.	Consignment	Cast No.	244980	Specification	1.4404
Our Reference	Z102278/P40988	Quantity	409 Kgs	Size	3.1/2" x 1.5/8"
Advice Note No.	DP257	Finish	Linished		
Heat Treatment	Fully solution treated and water quenched prior to cold sizing				

Chemical Analysis

C	0.016	Si	0.6	Mn	1.56	S	0.019	P	0.025
Ni	10.5	Cr	16.7	Mo	2.03	Ti	0.012	Nb	0.003
Co	0.071	Cu	0.46	N	0.033	W		Ca	
Sn		Ta		V		Al		Fe	

Mechanical Properties

Tensile Strength	632 Mpa	0.2% Proof Stress	503 Mpa
Reduction of Area	76,0%	Elongation	45,0%
Hardness	20 HRC	Impact Tests	

Special Conditions / Processing Details

In accordance with BS EN 10088-3 2005 1.4404	HCT No : P722
In accordance with MO19/1	Part No :
Conforming to NACE MR0175/MR0103	
Free from mercury and radioactive contamination	
ICC test to ASTM A262 'E' - Satisfactory	
Also conforming to ASTM A276/A479 Gr 316/316L & ASTM A182 F316/316L	
Manufacturers Test Cert No.	Concessions Agreed

"Certified that the whole of the supplied detailed hereon, unless otherwise stated", are covered by the Sources Certificate of Conformity/Test Certificate referenced hereon, and has been subject to the Quality System requirements in accordance with the conditions of our BS EN ISO 9001 2008 registration, for lot traceable products".

"Certified that the supplies/services detailed hereon have been inspected and tested in accordance with the conditions, requirements of the contract or purchase order and, unless otherwise noted below, conform in all respects to the specification(s)/drawing(s) relevant thereto".

H.C.T. P722
Checked & Approved by
Parker Hannifin Ltd
Quality Controller
23-04-2014 07:35:42 Page 1 of 4

2015
CERTIFIED INSPECTOR

Walzwerke Einsal GmbH



VAT Reg. No DE123841325

Walzwerke Einsal GmbH - Post Box 20 - 58769 Nachrodt-Wiblingwerde

Hi-Tech Special Steels Limited
Rotherham Rd, Laughton Common
S 25 3 RF Gunnington / Sheffield
Groß-Britannien

Inspection Certificate: Page 1
DIN EN 10204/3.1

No. WZ0913-01105 of 26.09.13

Your Order No.: 004390
Shipment No.: VL13-05634

Symbol of Manufacturers 	Surveyor of Inspection 	CE-sign 0045
-----------------------------	----------------------------	------------------

our works No. AB13-11074	Item 50	Size 14404 Flat 90,42 x 42,80 mm 3,500 X 1,685 "	Weight 5,316 KG
-----------------------------	------------	---	--------------------

Material Number 1.4404	Standard Grade of Material X2CrNiMo17-12-2 AISI 316 / 316 L
----------------------------------	---

Heat Number 244980	Method of melting: E
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Chemical analysis															
C %	0,016	SI %	0,60	Mn %	1,56	P %	0,025	S %	0,019	Cr %	16,70	Ni %	10,5	Mo %	2,03
Ti %	0,012	Co %	0,071	N %	0,033	Cu %	0,46	Nb %	0,003						

Product Information
Steel bars, 14404 X2CrNiMo17-12-2 hot rolled. DIN EN 10058 tol. see below. quenched, pickled, straight as rolled/su table to drawing. with short lengths see below, without stamping, in bundles

Addition Information
bar length mm: 5000 - 6000 , short lengths: from 3800 mm to max. 10 % , packaging size: max. 1500 kg qually: AISI 316 / 316 L,
additional information: no weld repair undertaken , in Wasser abgeschreckt / quenched in water
WAZ per e-mail , country of melt und country of manufacture: . Germany im WAZ , S % 0,015 - 0,030

Requirements
test certificate: DIN EN 10204/3.1 rev. 01/2005, with: CE-sign; 93/68/EWG, acc. to: DIN EN 10088 part 5 rev. 07/2009
tolerance of dimension/shape: DIN EN 10058 rev. 02/2004, standard: DIN EN 10088 part 3 rev. 09/2005 , ASTM A 479 / A 479 M rev. 2012 , ASTM A 276 rev. 2008A , ASTM A 262 Practice E rev. 1993A , DIN EN 10272 rev. 01/2008

Sample	PR0913-00680			
Mechanical properties				
Rp 0,2% Mpa	268			
Rp 1,0% Mpa	311			
Rm Mpa	568			
A5%	57,8			
Hardness				
HB	160			
Corrosion resistance				
IC-test (Delivery condllion)	ok			
IC-test (sensitized)	ok			
Remark				
Country of melt:	Germany			

The delivery corresponds to the requirements mentioned. The certificate has been established by machine and acc. to EN 10204. It is legal without signature.

H.C.T. P722
Checked & Approved by
Parker Hannifin IPDE

Walzwerke Einsal GmbH
QA-department
Feldmann / Seeger
Surveyor of Inspection

Telephone 0 23 52 3 32-0 Telefax: 0 23 52 3 32-02



2/10/13

Walzwerke Einsal GmbH



VAT Reg. No DE123841325

Walzwerke Einsal GmbH - Post Box 207 - 58769 Nachrodt-Wiblingowarde

Hi-Tech Special Steels Limited
 Rotherham Rd, Loughton Common
 S 25 3 RF Dinnington / Sheffield
 Groß-Britannien

Inspection Certificate:
 DIN EN 10204/3.1

Page 2

No. WZ0913-01105 of 26.09.13

Your Order No.: 004390
 Shipment No.: VL13-05634

Symbol of
 Manufacturers



Surveyor of
 Inspection



CE-sign 0045



our works No. AB13-11074	Item 50	Size 14404 Flat 90,42 x 42,80 mm 3,560 X 1,685 "	Weight 5.316 KG
-----------------------------	------------	---	--------------------

Material Number 1.4404	Standard Grade of Material X2CrNiMo17-12-2 AISI 316 / 316 L
----------------------------------	---

Heat Number 244980	Method of melting: E
-----------------------	-------------------------

Remark

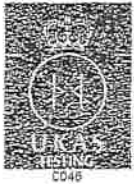
Country of manufacture: Germany

The delivery corresponds to the requirements mentioned.
 The certificate has been established by machine and acc. to EN 10204. It is legal
 without Signature.

Telephone 0 23 52 3 32-0 Telefax: 0 23 52 3 32-1 92

H.C.T. P722
Checked & Approved by
Parker Hannifin IPDE

Walzwerke Einsal GmbH
 QA-department
 Feldmann / Seeger
 Surveyor of Inspection



Special Testing Ltd

Bacon Lane, Sheffield S9 3NH
Tel: 0114 244 1061
Fax: 0114 244 0444 Works
Fax: 0114 244 5566 Acc/Admin
www.specialtesting.co.uk

Test Certificate 260232

AUTHENTICATION CODE 93AAE678C3A7
ROLLS ROYCE APPROVED LABORATORY
Approval No. 11191

CUSTOMER
HI-TECH SPECIAL STEELS LTD
ALLOY & METAL WORKS, ROTHERHAM RD
LAUGHTON COMMON, DINNINGTON
SHEFFIELD S25 3RF
DATE RECEIVED 12 December 2013
TEST DATE 17 December 2013



CUSTOMER ORDER NO	PRD 3806	TEST NUMBER	260232	IDENTITY	P40988	CAST*	244980	ALL REQUIREMENTS MIN UNLESS STATED				
SPECIFICATION	BS EN10088-3:2005 1.4404				TEST PIECE FROM*	3.1/2" X 1.5/8"						
TENSILE: BS EN ISO 6892-1:2009 A224		0.2% PROOF	1.0% PROOF	UTS	ELONG ON	%	R OF A %	COMMENTS				
OR	TEMP	SECTION	AREA SQ	UNIT	REQUIREMENTS							
L	RT	10.01mm	78.70mm ²	Mpa	RESULTS:	503	536	632	50mm	45.0	76.0	N/A
HARDNESS: BS EN ISO 6508-1 2005				DESIGNATION	REQUIREMENTS	RESULTS						
ROCKWELL C (MID RADIAL)				HRC		20						

END OF CERTIFICATE

H.C.T. P722
Checked & Approved by
Parker Hannifin IPDE
23-04-2014 07:35:42 Page 4 of 4

REPRESENTING*	<p>No copy is authentic without the embossed seal and signature. This certificate can be authenticated at www.specialtesting.co.uk with the code 93AAE678C3A7</p> <p>This certificate shall not be reproduced, except in full, without the written approval of the laboratory.</p> <p>For and on behalf of SPECIAL TESTING LTD A Member of the Special Steel Group of Companies</p> <p><i>K.Y. Elliott</i> Kath Elliott Certification Officer</p>
---------------	--

Test results do not in any way confer approval of the quality of manufacture of the material. All results are subject to uncertainty of measurement budgets, details available upon request.
Information marked * is supplied by the customer.



20/12/13

Customer
 HELE BAY PRECISION ENG CO LTD
 RIVERSIDE ROAD
 POTTINGTON IND EST
 BARNSTAPLE
 DEVON EX31 1NP

Delivery Address
 HELE BAY PRECISION ENG CO LTD
 RIVERSIDE ROAD
 POTTINGTON IND EST
 BARNSTAPLE
 DEVON EX31 1NP



HI-TECH
 Special Steels Limited
 Rotherham Road, Loughborough Common,
 Dinnington, Sheffield S25 3RF
 Tel: Dinnington (01909) 564545
 Fax No (01909) 550582

Report No. 027723 Our Ref. 094870 Date 29/10/12
 Test No. 222457 Customer O/No. 3084 Specification BS EN 10088-3 1.4404
 Despatch Note No. 045888

TEST CERTIFICATE

Item	Quantity	Weight Kg	Part No.	Heat No.	Batch No.	Description
001	2	62		224065	P208557	1.500" A/F HEX LINISHED BAR CONFORMING TO NACE MR0175 IN ACCORDANCE WITH PARKER MO19/1 HCT: P551 FREE FROM MERCURY CONTAMINATION CONFORMING TO NACE MR0175-2003/MR0175-2000 ICC TEST TO ASTM A262 'E' - SATISFACTORY ALSO CONFORMING TO ASTM A276/A479 GR 316L
		Total				

A. HEAT TREATMENT SUPPLY CONDITION
 B. TEST PIECE TREATMENT CONDITION

MELTING PRACTICE AOD TEST COUPON SIZE

Tensile Tests										Impact Tests																	
Temp		0.20% Proof		Maximum Stress		%Elong 50MM		% Reduction of Area		Temp		ENERGY				SHEAR %				LATERAL EXPANSION							
°C	*	Result	Spec-Min	Result	Spec-Min	Result	Spec-Min	Result	Spec-Min	°C	*	1	2	3	MIN	AV	1	2	3	MIN	AV	1	2	3	MIN	AV	
20	L	478	200	635	500	42	30	74	50																		

Component Hardness

Heat No.	C	Si	Mn	S	P	Cr	Ni	Mo	Co	N
224065	0.018	0.503	1.328	0.0267	0.0314	16.701	11.055	2.029	0.141	0.028

* Test Direction: L = Longitudinal; T = Transverse
 TEST CERTIFICATE in accordance with BS EN 10204 3.1 / ISO 10474 3.1
 Certified that the whole of the supplied detailed hereon, unless otherwise stated, are covered by the Sources Certificate of Conformity/Test Certificate referenced hereon, and has been supplied to the Quality System requirements in accordance with the conditions of our BSI/BS EN ISO 9001 2008 registration for lot traceable products.

Signature 

Position: Quality Controller
 HELE BAY PRECISION LTD
 VERIFIED TRUE COPY OF ORIGINAL CERTIFICATION
 29 OCT 2015
 CERTIFICATION INSPECTOR IPDE

H.C.T. P.551
 Checked & Approved by
 Certification Inspector IPDE
 30-10-2012 08:58:50 Page 1 of 4

Usine productrice Hersteller Manufacturer Ugine Avenue Paul Grod 73403 Ugine France		INSPECTION CERTIFICATE 3.1 CERTIFICAT DE RECEPTION 3.1 ABNAHMEPRUEFZEUGNIS 3.1 EN 10204 / 3.1			UGITECH Providing special steel solutions				
Numéro / Nummer / Number 81129560 000010		Ordre de fab. / Auftrag / Prod. Order A1227EX94000		N° coulé / Schmelzen Nr / Heat N° 224065		N° lot MM / Chargen / Batch 1227EX9400			
Certification - Werkzeugnis - Certificate AD 2000-MERKBLATT W0/TRD100 Pressure Equipment Directive 97/23/EC ISO 9001 ISO/TS 16949 ISO 14001		ISO 9100 ISO 9120		Marque d'usine Herstellerzeichen Supplier's Mark 		97			
				Poinçon de l'expert Prüfstempel Inspector's stamp 		98			
Produit Erzeugnisform Product		UGIMA 316LFG BAR ROLLED BLACK SOLUTION ANNEALEDHEXAGONAL 40,000MM LONG. 5,500M + 200,00MM -0,000MM UGIMA 316LFG BARRE LAMINÉ(E) NOIR(E) HYPERTREMPÉ(E)HEXAGONAL(E) 40,000MM LONG. 5,500M + 200,000MM UGIMA 316LFG STAB GEWALZT SCHWARZ LÖSUNGSGEGLÖHTSECHSKANT 40,000MM LONG. 5,500M + 200,000MM -0,0 UGIMA 316LFG BAR ROLLED BLACK SOLUTION ANNEALEDHEXAGONAL 40,000MM LONG. 5,500M + 200,000MM -0,00							
Client et/ou destinataire - Besteller und/oder Empfänger - Purchaser and/or Consignor 19516 HI-TECH SPECIAL STEELS LTD		N° de commande client - Kundenbestellnummer - Purchase order number 2950008323							
Norme de référence / Bezugsnorm / Standard for reference AISI 316L		EN 10088-3 ED 2005 1.4404							
Spécification client / Kundenspezifikation / Customer's specification									
Nombre Stückzahl Pieces Nbr 80		Profil Profil Shape HX		Dimension Ausmessung Dimension 40,000 MM		Longueur Länge Length 5,500		Poids Gewicht Weight 4970 KG	
Mode d'élaboration Erchmelzungsart Melting process EAF + AOD + CC		N° prélèvement Probenummer Test number 3 PA3		Demandé / Vorschrift / Required Min Max 0,0300 0,7500 2,0000 13,0000 18,0000 2,5000 0,0300 0,0450		42 43 44 45 46 47 48 49 % C % SI % MN % NI % CR % MO % S % P 10,0000 16,5000 2,0000 18,0000 2,5000 0,0300 0,0450		coulée/ Schmelzen / Heat Produit / Erzeugnisform/ Product	
Demandé / Vorschrift / Required Min Max		50 51 % N % CO 0,0280 0,1410		52 53 54 55 70 71 72 73 74 75		76 77 78 79 80 81 82 83 84 85 86 87		coulée/ Schmelzen / Heat Produit / Erzeugnisform/ Product	
Demandé / Vorschrift / Required Min Max		76 77 78 79 80 81 82 83 84 85 86 87		80 81 82 83 84 85 86 87		80 81 82 83 84 85 86 87		coulée/ Schmelzen / Heat Produit / Erzeugnisform/ Product	
The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable requirements of ASTM A304				Ugine le 20.06.2012 L'agent Réceptionnaire de l'usine Der Werkstoffverständige The work inspector					
We declare that the mentioned product is in compliance with the requirements of the contract and that, after checking and tests, it meets all respects the specified requirements and applicable standards and regulations, except reservations or exceptions as listed in this declaration of conformity. Document validated by electronic signature material manufactured in the REACH regulation respect.				040000591095 Page 1/2					

Checked & Approved by
Parker Hannifin IPDE
30-10-2012 08:58:50 Page 2 of 4



21/7/12

Usine productrice Hersteller Manufacturere Ugine Avenue Paul Girod 73403 Ugine France	INSPECTION CERTIFICATE 3.1 CERTIFICAT DE RECEPTION 3.1 ABNAHMEPRUEFZEUGNIS 3.1 <hr/> EN 10204 / 3.1	UGITECH Providing special steel solutions
---	--	---

Numéro / Nummer / Number 81129560 000010	Ordre de fab. / Auftrag / Prod. Order A1227EX94000	N° coulée / Schmelzen Nr / Heat N° 224065	N° lot MM / Chargen / Batch 1227EX9400
--	--	---	--

	24	90	T° C	Limite d'élasticité Elasticity		RM Zugfestigkeit Tensile	Allongement Bruchdehnung Elongation		Striction Bruchverzug Red area	Dureté-Haerte-Hardness			
				Yield Strength 0.2%	1%		ASD	AAD		HB	HV	HRB	HRC
	13	Min Max	°C 20 20	Mpa 200 235	Mpa 500 700	% 40	% 73	% 159					
N° prélèvement Probenummer Test number	3PA3	120 L 1.0	20	295	335	553	51	73	159				

A l'état de référence / treatment on test sample / Probestreifenbehandlung	25	26A	26B	27	28	29	30	31	32	33	34
---	----	-----	-----	----	----	----	----	----	----	----	----

	101	31	Type Form Type	T° C	Sens Richtung Direction	Min	Valeurs individuelles Einzelwerte Individual values		Moyenne Mittelwerte Average	Expansion latérale Seitliche Breitung Lateral Expansion
							J	K		
Taux de corroyage Forging ratio Verschmiedungsgrad	30,3									
A l'état de livraison / Lieferzustand / As delivered	13		KISOV	20	L	J 100	J 223-238-217	J 226		

INTERCRYSTALLINE CORROSION RESISTANT ACCORDING TO ASTM A262 PRACTICE E
 INTERCRYSTALLINE CORROSION RESISTANT ACC. TO ISO 3651-2

Quantité livrée / delivered quantity / gelieferte Quantität

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable material requirements of ASME/ENCA-3800

Ugine le 29.06.2012
 L'agent Réceptionnaire de l'usine
 Der Werkschwerfändige
 The work Inspector

[Signature]

Checked & Approved by
Parker Hannifin IPDE
 30-10-2012 08:58:50 Page 3 of 4



Special Testing Ltd

Bacon Lane, Sheffield S9 3NH
Tel: 0114 244 1061
Fax: 0114 244 0444 Works
Fax: 0114 244 5566 Acc/Admin
www.specialtesting.co.uk

Test Certificate 222457

AUTHENTICATION CODE 7F3317B05181
ROLLS ROYCE APPROVED LABORATORY
Approval No. 11191

CUSTOMER
HI-TECH SPECIAL STEELS LTD
ALLOY & METAL WORKS, ROTHERHAM RD
LAUGHTON COMMON, DINNERTON
SHEFFIELD S25 3RF
DATE RECEIVED 25 October 2012
TEST DATE 26 October 2012



CUSTOMER ORDER NO	PRD2847	TEST NUMBER	222457	IDENTITY	P40573	CAST	224065	ALL REQUIREMENTS MIN UNLESS STATED			
SPECIFICATION	BS EN10088-3:2005 (X2CrNiMo17-12-2) 1.4404					TEST PIECE FROM*	1 1/2" A/F HEX				
TENSILE: BS EN ISO 6892-1:2009 A224	0.2% PROOF		1.0% PROOF		UTS	ELONG ON	%	R OF A %	COMMENTS		
OR TEMP	SECTION	AREA SQ	UNIT	REQUIREMENTS							
L RT	10.00mm	78.54mm ²	Mpa	RESULTS	478	507	635	50mm	42.0	74.0	N/A
HARDNESS: BS EN ISO6506-1 2005				DESIGNATION	REQUIREMENTS	RESULTS					
BRINELL (MID RADIAL)				HBW 10/3000		180					
HARDNESS: BS EN ISO6508-1 2005				DESIGNATION	REQUIREMENTS	RESULTS					
ROCKWELL C (MID RADIAL)				HRC		10					
ROCKWELL B				HRBW		91					

END OF CERTIFICATE

H.C.T. P551
 Checked & Approved by
 Parker Hannifin IPDE
 30-10-2012 08:58:50 Page 4 of 4

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----------------------	---

Test results do not in any way confer approval of the quality of manufacture of the material. All results are subject to uncertainty of measurement budgets details available upon request.
Information marked * is supplied by the customer





HI-TECH

Special Steels Limited

Rotherham Road, Laughton Common,
Dinnington, Sheffield S25 3RF
Tel: Dinnington (01909) 564545
Fax No (01909) 550682

Registered in England No. 1921116

Customer

David Paull CNC
T/A DP Eng Ltd
Jon Davey Drive
Treleigh Ind Est
Redruth TR16 4AX

TEST CERTIFICATE IN ACCORDANCE WITH BS EN 10204 3.1/ISO 10474 3.1

Certificate No.	T58981	Product	Stainless steel bar		
Order No.	Consignment	Cast No.	411048	Specification	1.4404
Our Reference	Z102272/P41081	Quantity	495 Kgs	Size	1.25" A/F Hex
Advice Note No.	DP259	Finish	Finished		
Heat Treatment	Fully solution treated and water quenched prior to cold sizing				

Chemical Analysis

C	0.017	Si	0.457	Mn	1.292	S	0.0291	P	0.0295
Ni	10.125	Cr	16.559	Mo	2.038	Ti		Nb	
Co	0.22	Cu	0.492	N	0.036	W		Ca	
Sn		Ta		V		Al	0.005	Fe	

Mechanical Properties

Tensile Strength	673 Mpa	0.2% Proof Stress	495 Mpa
Reduction of Area	72,0%	Elongation	41,0%
Hardness	16 HRC	Impact Tests	

Special Conditions / Processing Details

In accordance with BS EN 10088-3 2005 1.4404	HCT No : H283
In accordance with MO19/1	
Conforming to NACE MR0175/MR0103	Part No : 7711238202
Free from mercury and radioactive contamination	
ICC test to ASTM A262 'E' - Satisfactory	
Also conforming to ASTM A276/A479 Gr 316/316L & ASTM A182 F316/316L	
Manufacturers Test Cert No.	Concessions Agreed

"Certified that the whole of the supplied detailed hereon, unless otherwise stated*, are covered by the Sources Certificate of Conformity/Test Certificate referenced hereon, and has been subject to the Quality System requirements in accordance with the conditions of our BS EN ISO 9001 2008 registration, for lot traceable products"

"Certified that the supplies/services detailed hereon have been inspected and tested in accordance with the conditions, requirements of the contract or purchase order and, unless otherwise noted below, conform in all respects to the specification(s)/drawing(s) relevant thereto"

H.C.T. H283

Checked & Approved by
Parker Hannifin
Quality Controller

13-05-2014 09:40:01 Page 1 of 4

09/05/2014

10 JAN 2014


SERIES

CERTIFICATE NUMBER

Usine productrice/Hersteller/Manufacturer
 Ugine
 Avenue Paul Girod - CS
 90100
 73403 Ugine Cedex
 France

CERTIFICAT DE RECEPTION 3.1
INSPECTION CERTIFICATE 3.1
ABNAHMEPRUEFZEUGNIS 3.1

UGITECH
 Providing special steel solutions



EN 10204 / 3.1
 NF L 00-015 Certified material test report

N° lot MM / Chargen / Batch
 1419SS2500

Numéro / Nummer / Number
 81372670 000010



Ordre de fab. / Auftrag / Prod. Order
 A1419SS25000

N° coulée / Schmelzen Nr / Heat N°
 411048

Certification - Werkzeugnis - Certificate
 AD 2000-MERKBLATT W0/TRD100
 Pressure Equipment Directive
 97/23/EC
 ISO 9001
 ISO/TS 16949

Marque d'usine
 Herstellerzeichen
 Supplier's Mark

Poinçon de l'expert
 Prüfstempel
 Inspector's stamp

UGIMA 4404HM BAR ROLLED BLACK SOLUTION ANNEALED HEXAGONAL 34,000MM LONG. 5,460M + 2
 00,000MM -0,000MM

Produit
 Erzeugnisform
 Product

UGIMA 4404HM BARRE LAMINÉ(E) NOIR(E) HYPERTREMPÉ(E) HEXAGONAL(E) 34,000MM LONG. 5,460M + 200,000
 UGIMA 4404HM STAB GEWALZT SCHWARZ LÖSUNGSGEGLÜHT SECHSKANT 34,000MM LONG. 5,460M + 200,000MM -0,
 UGIMA 4404HM BAR ROLLED BLACK SOLUTION ANNEALED HEXAGONAL 34,000MM LONG. 5,460M + 200,000MM -0,0

Client - Besteller - Purchaser
 19516 HI-TECH SPECIAL STEELS LTD

N° de commande client - Kundenbestellnummer - Purchase order number
 2959003240

Norme de référence / Besugsnorm / Standard for reference
 ASTM A276-10 TYPE 316L/316
 EN 10088-3 ED 2005 1.4404/4401

ASTM A479/A479M-13 TYPE 316L/316

Spécification client / Kundenspezifikation / Customer's specification
 ESS M011/1 FOR ANALYSIS ONLY Y4 18/12/2012

Nombre Stueckzahl Pieces Nbr 144	18	Profil Profile Shape HX	19	Dimension Ausmessung Dimension 34,000 MM	21-1	Longueur Laenge Length 5,460	21-2	Poids Gewicht Weigh 6248 KG	22
---	----	----------------------------------	----	---	------	---------------------------------------	------	--------------------------------------	----

Mode d'élaboration Erchmel zungsart Melting process EAF + AOD + CC	N° prélèvement Probnummer Test number 6R9K	Demandé / Vorschrift / Required 39A	42	43	44	45	46	47	48	49
			% C	% SI	% MN	% NI	% CR	% MO	% CU	% S
			Min	Max	0,0300	1,0000	2,0000	13,0000	18,0000	2,5000

Demandé / Vorschrift / Required	50	51	52	53	54	55	70	71	72	73	74	75
	% P	% N	% CO	% AL								
	Min	Max	0,0400	0,1000	0,7500							

Demandé / Vorschrift / Required	76	77	78	79	80	81	82	83	84	85	86	87
	Min	Max										
	coulée/ Schmelzen / Heat	Produit / Erzeugnisform/ Product	0,0295	0,0360	0,2200	0,0050						

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable material requirements of ASME NCA 3800

Ugine le 27.03.2014
 L'agent Réceptionnaire de l'usine
 Der Werksachvorstündige

The work inspector
 C. B10TEAU

H.C.T. H283
Checked & Approved by
Parker Hannifin IPDE
 13.05.2014 09:40:02 Page 2 of 4




[Signature]
 C. B10TEAU

Usine productrice/Hersteller/Manufacturer
 Ugine
 Avenue Paul Girod - CS
 90100
 73403 Ugine Cedex
 France

CERTIFICAT DE RECEPTION 3.1
 INSPECTION CERTIFICATE 3.1
 ABNAHMEPRUEFZEUGNIS 3.1

EN 10204 / 3.1
 NF L 00-015 Certified material test report

UGITECH
 Providing special steel solutions



Numéro / Nummer / Number
 81372670 000010

Ordre de fab. / Auftrag / Prod. Order
 A1419SS25000

N° coulée / Schmelzen Nr / Heat N°
 411048

N° lot MM / Chargen / Batch
 1419SS2500

24	90	T°C	Limite d'élasticité Streckgrenze Yield Strength		RM Zugfestigkeit Tensile	Allongement Bruchdehnung Elongation		Striction Einschnürung Red area	Dureté-Haerte-Hardness				
			0,2%	1%		A5D	A4D		HB	HV	HRB	HRC	
13	Min Max Min Max	°C 20 20	Mpa 205	Mpa 235	Mpa 515 700	% 40	% 30	% 40	215				
N° prélèvement Probenummer Test number 39B	1 L	20	240	291	581	56	58	74	162				

A l'état de Référence / treatment on test sample / Probestreifenbehandlung

14	25	26A	26B	27	28	89	29	30	88	100	37
Taux de corroyage Forging ratio Verschmiedungsgrad 42,0%	Type Form Type	T°C	Sens Richtung Direction	Min	Valeurs individuelles Einzelwerte Individual values		Moyenne Mittelwerte Average	Expansion latérale Seitliche Breitung Lateral Expansion			
101	31	33	32	95			35	36			91
A l'état de livraison / Lieferzustand / As delivered TEMPERATURE OVER 1040°C AIR	13 KISOV	°C 20	L	J 100		J 235-231-235	J 233				
A l'état de Référence / treatment on test sample / Probestreifenbehandlung	14										

MATERIAL IS FREE FROM MERCURY AND RADIOACTIVE CONTAMINATION , WELDS OR WELD REPAIRS AT TIME OF SHIPMENT

FREE OF RADIOACTIVITY STATEMENT & TOXIC PRODUCT

INTERGRANULAR CORROSION PER ASTM A262 PRACTICES A & E ACCEPTABLE

COUNTRY OF MELT SOURCE : FRANCE

Quantité livrée / delivered quantity / gelieferte Quantität

H.C.T. H283

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable material requirements of ASME NCA-3600

Checked & Approved by
Parker Hannifin IPDE
 13-05-2014 09:40:02 Page 3 of 4

Ugine le 27.03.2014
 L'agent Réceptionnaire de l'usine

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable material requirements of ASME NCA-3600

Dir Weksachverständige
 The work Inspector
 C. BIOTEAU



Special Testing Ltd

Bacon Lane, Sheffield S9 3NH
Tel: 0114 244 1061
Fax: 0114 244 0444 Works
Fax: 0114 244 5566 Acc/Admin
www.specialtesting.co.uk

Test Certificate 271499

AUTHENTICATION CODE E9D47721E429
ROLLS ROYCE APPROVED LABORATORY
Approval No. 11191

CUSTOMER
HI-TECH SPECIAL STEELS LTD
ALLOY & METAL WORKS, ROTHERHAM RD
LAUGHTON COMMON, DINNINGTON
SHEFFIELD S25 3RF
DATE RECEIVED 01 May 2014
TEST DATE 07 May 2014



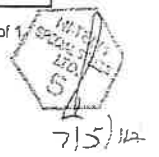
CUSTOMER ORDER NO	PRD4191	TEST NUMBER	271499	IDENTITY	P41081	CAST*	411046	ALL REQUIREMENTS MIN UNLESS STATED		
SPECIFICATION	BS EN10088-3:2005 1.4404			TEST PIECE FROM*			1.25" A/F HEX			
TENSILE: BS EN ISO 6892-1:2009 A224	0.2% PROOF		1.0% PROOF		UTS		ELONG ON	%	R OF A %	COMMENTS
OR TEMP	SECTION	AREA SQ	UNIT	REQUIREMENTS						
L RT	9.99mm	78.38mm ²	MPa	RESULTS	495	553	673	50mm	41.0	72.0 N/A
HARDNESS: BS EN ISO6506-1 2005				DESIGNATION	REQUIREMENTS	RESULTS				
BRINELL (MID RADIAL)				HBW 10/3000		215				
HARDNESS: BS EN ISO6508-1 2005				DESIGNATION	REQUIREMENTS	RESULTS				
ROCKWELL C (MID RADIAL)				HRC		16				
ROCKWELL B				HRBW		95				

END OF CERTIFICATE

H.C.T. H283
 Checked & Approved by
 Parker Hannifin IPDE
 13-05-2014 09:40:02 Page 4 of 4

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---------------	--

Test results do not in any way confer approval of the quality of manufacture of the material. All results are subject to uncertainty of measurement budgets, details available upon request. Information marked * is supplied by the customer.





HI-TECH

Special Steels Limited

Rotherham Road, Laughton Common,
Dinnington, Sheffield S25 3RF
Tel: Dinnington (01909) 564545
Fax No (01909) 550682

Registered in England No. 1921116

Customer

David Paull CNC
T/A DP Eng Ltd
Jon Davey Drive
Treleigh Ind Est
Redruth TR16 4AX

TEST CERTIFICATE IN ACCORDANCE WITH BS EN 10204 3.1/ISO 10474 3.1

Certificate No.	T59068	Product	Stainless steel bar		
Order No.	Consignment	Cast No.	421059	Specification	1.4404
Our Reference	Z103006/P41149	Quantity	456 Kgs	Size	1.25" A/F Hex
Advice Note No.	DP273	Finish	Linished		
Heat Treatment	Fully solution treated and water quenched prior to cold sizing				

Chemical Analysis

C	0.016	Si	0.398	Mn	1.297	S	0.03	P	0.0244
Ni	10.089	Cr	16.548	Mo	2.029	Ti		Nb	
Co	0.123	Cu	0.486	N	0.034	W		Ca	
Sn		Ta		V		Al	0.006	Fe	

Mechanical Properties

Tensile Strength	677 Mpa	0.2% Proof Stress	530 Mpa
Reduction of Area	70,0%	Elongation	39,0%
Hardness	15 HRC	Impact Tests	

Special Conditions / Processing Details

In accordance with BS EN 10088-3 2005 1.4404
In accordance with MO19/1
Conforming to NACE MR0175/MR0103
Free from mercury and radioactive contamination
ICC test to ASTM A262 'E' - Satisfactory
Also conforming to ASTM A276/A479 Gr 316/316L & ASTM A182 F316/316L

HCT No : H352

Part No : 7711238202

Manufacturers Test Cert No.


Concessions Agreed

"Certified that the whole of the supplied detailed hereon, unless otherwise stated, are covered by the Sources Certificate of Conformity/Test Certificate referenced hereon, and has been subject to the Quality System requirements in accordance with the conditions of our BS EN ISO 9001 2008 registration, for lot traceable products".


"Certified that the supplies/services detailed hereon have been inspected and tested in accordance with the conditions, requirements of the contract or purchase order and, unless otherwise noted below, conform in all respects to the specification(s)/drawing(s) relevant thereto".

H.C.T. H352
Checked & Approved by
Parker Hannifin IPDE
Quality Controller

30-07-2014 16:20:39 Page 1 of 4

Usine productrice/Hersteller/Manufacturer Ugine Avenue Paul Girod - CS 90100 73403 Ugine Cedex France	CERTIFICAT DE RECEPTION 3.1 INSPECTION CERTIFICATE 3.1 ABNAHMEPRUEFZEUGNIS 3.1 <hr/> EN 10204 / 3.1 NF L 00-015 Certified material test report	UGITECH Providing special steel solutions 
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Numéro / Nummer / Number 81411102 000010	Ordre de lab. / Auftrag / Prod. Order A1429ZS85000	N° coulée / Schmelzen Nr / Heat N° 421059	N° lot MM / Chargen / Batch 1429ZS8500
---	---	--	---

Certification - Werkzeugsnis - Certificate AD 2000-MERKBLATT WO/TRD100 Pressure Equipment Directive 97/23/EC ISO 9001 ISO/TS 16949	ISO 9100 ISO 9120	Marque d'usine Herstellerzeichen Supplier's Mark	 Polnçon de l'expert Prufstempel Inspector's stamp
---	----------------------	--	--

UGIMA 4404HM BAR ROLLED BLACK SOLUTION ANNEALED HEXAGONAL 34,000MM LONG. 5,460M + 200,000MM -0,000MM Produit UGIMA 4404HM BARRE LAMINÉ(E) NOIR(E) HYPERTREMPÉ(E) HEXAGONAL(E) 34,000MM LONG. 5,460M + 200,000 Erzeugnisform UGIMA 4404HM STAB GEWALZT SCHWARZ LÖSUNGSGEGLÜHT SECHSKANT 34,000MM LONG. 5,460M + 200,000MM -0, Product UGIMA 4404HM BAR ROLLED BLACK SOLUTION ANNEALED HEXAGONAL 34,000MM LONG. 5,460M + 200,000MM -0,0
--

Client - Besteller - Purchaser 19516 HI-TECH SPECIAL STEELS LTD	N° de commande client - Kundenbestellnummer - Purchase order number 2959004325
--	---

Norme de référence / Besugsnorm / Standard for reference ASTM A276-10 TYPE 316L/316 EN 10088-3 ED 2005 1.4404/4401 ASTM A479/A479M-13 TYPE 316L/316
--

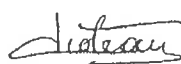
Spécification client / Kundenspezifikation / Customer's specification ESS M011/1 FOR ANALYSIS ONLY Y4 18/12/2012

Nombre Stueckzahl Pieces Nbr 192	Profil Profile Shape HX	Dimension Ausmessung Dimension 34,000 MM 21-1	Longueur Laenge Length 5,460	Poids Gewicht Weigh 2616 KG
---	----------------------------------	--	---------------------------------------	--------------------------------------

Mode d'élaboration Erchmelzungsart Melting process EAF + AOD + CC	N° prélèvement Probenummer Test number 76M2	Demandé / Vorschrift / Required								
		42 % C	43 % SI	44 % MN	45 % NI	46 % CR	47 % MO	48 % CU	49 % S	
	Min				10,0000	16,5000	2,0000		0,0150	
	Max	0,0300	1,0000	2,0000	13,0000	18,0000	2,5000	1,0000	0,0300	
		coulée/ Schmelzen / Heat 0,0160 0,3980 1,2970 10,0890 16,5480 2,0290 0,4860 0,0300								

Demandé / Vorschrift / Required	50	51	52	53	54	55	70	71	72	73	74	75
	% P	% N	% CO	% AL								
Min												
Max	0,0400	0,1000	0,7500									
coulée/ Schmelzen / Heat	0,0244	0,0340	0,1230	0,0060								

Demandé / Vorschrift / Required	76	77	78	79	80	81	82	93	84	85	86	87
	Min											
Max												
coulée/ Schmelzen / Heat												

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable material requirements of ASME NCA-3800. H.C.T. 11352 Checked & Approved by Parker Hannifin P'DE	Ugine le 24.06.2014 L'agent Réceptionnaire de l'usine Der Werksachverständige The work inspector  C. BLOTEAU 040000776610 Page 1/2
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Usine productrice/Hersteller/Manufacturer Ugine Avenue Paul Girod - CS 90100 73403 Ugine Cedex France	CERTIFICAT DE RECEPTION 3.1 INSPECTION CERTIFICATE 3.1 ABNAHMEPRUEFZEUGNIS 3.1 <hr/> EN 10204 / 3.1 NF L 00-015 Certified material test report	UGITECH Providing special steel solutions
---	---	---

Numéro / Nummer / Number 81411102 000010	Ordre de fab. / Auftrag / Prod. Order A1429ZS85000	N° coulée / Schmelzen Nr / Heat N° 421059	N° lot MM / Chargen / Batch 1429ZS8500
--	--	---	--

		T °C	Limite d'élasticité Streckgrenze Yield Strength		RM Zugfestigkeit Tensile	Allongement Bruchdehnung Elongation		Striction Einschnürung Red area	Dureté-Haerte-Hardness								
			0,2%	1%	Mpa	Mpa	Mpa		A5D %	A4D %	%	HB	HV	HRB	HRC		
24	90	°C															
13	Min	20	205	235	515	40	30	40	215								
	Max	20			700												
	Min																
	Max																
N° prélèvement Probenummer Test number	76M2 1	L	20	279	336	590	51	53	73	171							
39B																	
A l'état de Référence / treatment on test sample / Probstreifenbehandlung																	

Résilience-Kerbschlagzaehigkeit-Notch Toughness									
Taux de corroyage Forging ratio Verschmiedungsgrad	Type Form Type	T °C	Sens Richtung Direction	Min	Valeurs Individuelles Einzelwerte Individual values		Moyenne Mittelwerte Average	Expansion latérale Seitliche Breitung Lateral Expansion	
42,0	31	33	32	95			35	36	91
A l'état de livraison / Lieferzustand / As delivered	KISOV	°C		J		J		J	
TEMPERATURE OVER 1040°C AIR		20	L	100		228-234-236		232	
						--			
						--			
A l'état de Référence / treatment on test sample / Probstreifenbehandlung									

MATERIAL IS FREE FROM MERCURY AND RADIOACTIVE CONTAMINATION , WELDS OR WELD REPAIRS AT TIME OF SHIPMENT

FREE OF RADIOACTIVITY STATEMENT & TOXIC PRODUCT

INTERGRANULAR CORROSION PER ASTM A262 PRACTICES A & E ACCEPTABLE

COUNTRY OF MELT SOURCE : FRANCE

Quantité livrée / delivered quantity / gelieferte Quantität	H.C.T. H352
The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable material requirements of ASME NCA-3800	Ugine le 24.06.2014 L'agent Réceptionnaire de l'usine
The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable material requirements of ASME NCA-3800	Der Werksachverständige The work inspector C. BLOTEAU
Checked & Approved by Parker Hannifin	040000776610 Page 2/2
30-07-2014 16:20:39 Page 3 of 6	63



Special Testing Ltd

Bacon Lane, Sheffield S9 3NH
Tel: 0114 244 1061
Fax: 0114 244 0444 Works
Fax: 0114 244 5566 Acc/Admin
www.specialtesting.co.uk

Test Certificate 279315

AUTHENTICATION CODE 6C42B74D6566
ROLLS ROYCE APPROVED LABORATORY
Approval No. 11191


CUSTOMER
HI-TECH SPECIAL STEELS LTD
ALLOY & METAL WORKS, ROTHERHAM RD
LAUGHTON COMMON, DINNINGTON
SHEFFIELD S25 3RF
DATE RECEIVED 29 July 2014
TEST DATE 30 July 2014



CUSTOMER ORDER NO	PRD 4326	TEST NUMBER	279315	IDENTITY	P41149	CAST*	421059	ALL REQUIREMENTS MIN UNLESS STATED				
SPECIFICATION	BS EN10088-3:2005 1.4404					TEST PIECE FROM*		1.25" A/F Hexagon				
TENSILE: BS EN ISO 6892-1:2009 A224		0.2% PROOF		1.0% PROOF		UTS		ELONG ON %		R OF A %		COMMENTS
OR	TEMP	SECTION	AREA SQ	UNIT	REQUIREMENTS							
L	RT	10.00mm	78.54mm ²	MPa	RESULTS	530		581		677		50mm 39.0 70.0 N/A
HARDNESS: BS EN ISO6508-1 2005					DESIGNATION	REQUIREMENTS	RESULTS					
ROCKWELL C (MID RADIAL)					HRC		15					
ROCKWELL B					HRBW		96					

END OF CERTIFICATE

H.C.T. H352
Checked & Approved by
Parker Hannifin IPDE
30-07-2014 16:20:39 Page 4 of 4

REPRESENTING*	No copy is authentic without the embossed seal and signature. This certificate can be authenticated at www.specialtesting.co.uk with the code 6C42B74D6566
	This certificate shall not be reproduced, except in full, without the written approval of the laboratory.
	 For and on behalf of SPECIAL TESTING LTD A Member of the Special Steel Group of Companies
	Steve Pearce Certification Manager

Test results do not in any way confer approval of the quality of manufacture of the material. All results are subject to uncertainty of measurement budgets, details available upon request.
Information marked * is supplied by the customer.



30/7/14



HI-TECH

Special Steels Limited

Rotherham Road, Laughton Common,
Dinnington, Sheffield S25 3RF
Tel: Dinnington (01909) 564545
Fax No (01909) 550682

Registered in England No. 1921116

Customer

Hele Bay Precision Eng Co Ltd
Riverside Road
Pottington Ind Est
Barnstaple
Devon
EX31 1NP

TEST CERTIFICATE IN ACCORDANCE WITH BS EN 10204 3.1.B/ISO 10474 3.1.B

Certificate No.	T55289	Product	Stainless Steel Bar
Order No.	2587	Cast No.	840106
Our Reference	Z86287/P38418	Quantity	129 Kgs
Advice Note No.	36847	Finish	Linished
		Specification	BS EN 10088-3 2005 1.4404
		Size	1.500" A/F Hex
Heat Treatment Fully solution treated and water quenched prior to cold finishing			

Chemical Analysis

C	0.018	Si	0.52	Mn	1.30	S	0.024
P	0.026	Ni	11.07	Cr	16.62	Mo	2.04
Ti		Nb		Co		Cu	

Mechanical Properties

Tensile Strength	620 MPa	0.2% Proof Stress	434 MPa
Reduction of Area	72.0%	Elongation	42.0%
Brinell/Rockwell Hardness	11 HRC	Impact Tests	

N 0.024

Special Conditions/ Processing Details

In accordance with BS EN 10088-3 2005 1.4404	
In accordance with Parker M019	
Conforming to NACE MRO175-2003	
Free from Mercury contamination	
This material is capable of passing an ICC Test in accordance with ASTM A262 Practice 'E'	
Also conforming to ASTM A276/A479 GR 316	
Manufacturers Test Cert No.	H.C.T. M767

"Certified that the whole of the supplies detailed hereon, unless otherwise stated", are covered by the Source's Certificate of Conformity/Test Certificate referenced hereon, and has been subject to the Quality Systems requirements in accordance with the conditions of our B.S.I./BS.EN. ISO. 9001 Registration, for lot traceable products".

"Certified that the supplies/services detailed hereon have been inspected and tested in accordance with the conditions, requirements of the contract or purchase order and, unless otherwise noted below, conform in all respects to the specification(s)/drawing(s) relevant thereto".

Quality Controller



N. Nr N° 80634922000010		N° de commande usine - Werkbestellnummer - Works order number 7XM75000		0837XM7500	
INSPECTION CERTIFICATE 3.1 CERTIFICAT DE RECEPTION 3.1 ABNAHMEPRUEFZEUGNIS 3.1 EN 10204 / 3.1 Page 1/ 2					
Site d'UGINE	Certification Werkzeugs - Certificate AD 2000-MERKBLATT W0/TRD100 Pressure Equipment Directive 97/23/EC ISO 9001 : 2000 ISO/TS 16949 : 2002 ISO 14001 : 2004		par - von by Industrie Service		Marque d'usine - Herstellerzeichen - Supplier's Mark
			 ISO/TS 14949 VERSION 2002		Poinçon de l'expert - Prüfstempel - Inspector's stamp
Produit - Erzeugnisform - Product UGIMA 316LFG BAR ROLLED BLACK SOLUTION ANNEALED HEXAGONAL 40,000MM LONG. 6,100M +200,000MM -0,000MM (EN) UGIMA 316LFG BARRE LAMINÉ(E) NOIR(E) HYPERTREMPÉ(E) HEXAGONAL(E) 40,000MM LONG. 6,100M +200,000MM -0,000MM (FR) UGIMA 316LFG BAR ROLLED BLACK SOLUTION ANNEALED HEXAGONAL 40,000MM LONG. 6,100M +200,000MM -0,000MM (EN) UGIMA 316LFG STAB GEWALZT SCHWARZ ABGESCHRECKT SECHSKANT 40,000MM LONG. 6,100M +200,000MM -0,000MM (DE)					
Client et/ou destinataire - Besteller und/oder Empfänger - Purchaser and/or Consignor 0000019516 HI-TECH SPECIAL STEELS LTD			N° de commande client - Kundebestellnummer - Purchaser order number 9223		
Marque commerciale - Handelsmarke - Trade name UGIMA 316LFG					
Norme de référence - Bezugsnorm - Standard for reference EN 10088-3 ED 2005 1.4404 ; AISI 316L ;					
Spécifications client - Kundenspezifikation - Customer's specification MM019/1 POUR ANALYSE rév. - du -					
(1) Etat de livraison - Lieferzustand - As delivered SOLUTION ANNEALED			(1) Traitement de référence - Probestreifenbehandlung - Treatment on test sample		
Identification du produit Erzeugnis Bezeichnung Product Identification		N° de cde usine Werkbestellnummer Works order number 15	N° poste Posti Nr Item Nr 17	N° de coulée - Schmelzen Nr - Heat No 840106	
7XM75		000			
Nombre Stückzahl Pieces Nbr 18 144		Profil Profile Shape 19 HX		Dimension Ausmessung Dimension 21 40.000 mm	
				Longueur Laenge Length 21 6.100 m	
				Poids Gewicht Weight 22 9624 kg	
(3) L = Long Laengs - Long T = Travers Quer - Transverse 58		(1) TE = Trempé à l'eau-Wasserhaerten-Waterquencht TH = Trempé à l'huile-Ölhaerten-Oil Quench A = Hypertrempé-Lösungsgelueht-Solution annealed RO = Rond-Rund-Round QR = Carré-Viereckig-Square		R = Revenu-Anlassen-Tempered RT = Recuit-Geglueht-Annealed TRM = Recuit maxi-Welchgeglueht-Maxi annealed HX = Hexagonal-Sechskant-Hexagonal	
(4) A l'état de référence Zum Bezugs Zustand At reference condition 59A		(5) A l'état de livraison In Lieferzustand In state of delivery 59B		7 62 66	
		Contrôles de marquage, d'aspect et de dimensions : satisfaisants Bezeichnung, Beschligung und Ausmessung : ohne Beanstandung Marking, inspection and measurement : without objection		7 62 66	
		Nous certifions que les produits énumérés ci-dessus sont conformes aux prescriptions de la commande Wir bestätigen hiermit dass die obengenannten Erzeugnisse den Bestellwrschriften entsprechen We certify hereby that the above mentioned products are consistent with the order prescriptions		7 62 66	
				UGINE, le 29/10/2008 L'agent Réceptionnaire de l'usine Der Werkschwerstündige The work inspector C. BIOTEAU	

H.C.T. M767
 Checked & Approved by
 Parker Hannifin IPDE
 10-02-2009 16:49:23 Page 2 of 4



N° de commande usine - Werksbestellnummer - Works order number
80634922000010 4 7XM75000 0837XM7500 11

INSPECTION CERTIFICATE 3.1
CERTIFICAT DE RECEPTION 3.1
ABNAHMEPRUEFZEUGNIS 3.1

EN 10204 / 3.1

Page 2/ 2

Numéro de prélèvement Test Number	Demandé Verschrift Direction (3)	Traction-Zugversuch-Tensile test							Résilience-Kerbschlagversuch-Notch Toughness						
		Température d'essai Test Temperature	Limite d'élasticité Streckgrenze Yield Strength		Résistance à la traction Zugfestigkeit Tensile	Allongement Elongation Elongation	Section Einschnürung Red of Area	Dureté Haerte Hardness	Dureté Haerte Hardness	Type Form Type	Sens Richtung Direction (3)	Température d'essai Test Temperature	Valeurs Individuelles Einzelwerte Individual Values		Moyenne Mittelwert Average
39B	24 L Min Max	25 °C 20	0,2% 26A MPa 200	1% 26B MPa 235	27 MPa 500 700	28 % 40	29 % 75	30 HB 215	37 HRC	31 ISOV	32 L	33 °C 20	35 J	36 J	30B HBL1V
(5)			314	353	559	54	75	159					206-202-198		
39A	40 Min Max N° de coulée Schmelz N° Heat N. B40106		42 % C	43 % Si	44 % Mn	45 % Ni	46 % Cr	47 % Mo	48 % N	49 % S	50 % P				
38 Mode d'élaboration Erzeugnisart Melting process EAF + AOD		51 Min Max	52	53	54	55	70	71	72	73	74				

5
UNCONTROLLED COPY OF
THE ORIGINAL MILL CERTIFICATE
SIGNED *[Signature]*
DATE 6/2/09

(3) L = Long Längs - Long T = Travers Quer - Transverse 58	(1) TE = Trempe à l'eau-Wasserhaerten-Waterquench TH = Tempé à l'huile-Ölhaften-Oil Quench A = Hypertrémpé-Loesungsgeglueht-Solution annealed RO = Rond-Rond-Round QR = Carré-Viereckig-Square	R = Revenu-Anlassen-Tempered RT = Recuit-Geglueht Annealed TRM = Recuit maxi-Weichgeglueht-Maxi annealed HX = Hexagonal-Sechskant-Hexagonal	Ugine. In: 29/10/2008 L'agent Réceptionnaire de l'usine Der Werkssachverständige The work inspector <i>[Signature]</i> C. BIOTEAU
(4) A l'état de référence Zum Bezug Zustand At reference condition 69A	(5) A l'état de livraison In Lieferzustand In state of delivery 69C	Contrôles de marquage, d'aspect et de dimensions : satisfaisants Bezeichnung, Beschligung und Ausmessung : ohne Beanstandung Marking, inspection and measurement : without objection 62 Nous certifions que les produits énumérés ci-dessus sont conformes aux prescriptions de la commande Wir bestätigen hiermit dass die obengenannten Erzeugnisse den Bestellvorschriften entsprechen We certify hereby that the above mentioned products are consistent with the order prescriptions 60	68 63

H.C.T. M767
Checked & Approved by
Parker Hannifin IPDE
10-02-2009 16:49:23 Page 3 of 4



0046

Special Testing Works Ltd

Bacon Lane, Sheffield S9 3NH
Tel: 0114 244 1061
Fax: 0114 244 0444 Works
Fax: 0114 244 5565 Acc/Admin
www.specialtesting.co.uk

Test Certificate 118858

ROLLS ROYCE APPROVED LABORATORY
Approval No. 11191

CUSTOMER
HI-TECH SPECIAL STEELS LTD
ALLOY & METAL WORKS, ROTHERHAM RD
LAUGHTON COMMON, DINNINGTON
SHEFFIELD S25 3RF
DATE RECEIVED 13 January 2009
TEST DATE 14 January 2009




CUSTOMER ORDER NO	Z84546	TEST NUMBER	118858	IDENTITY	P38418	CAST	B40106	ALL REQUIREMENTS MIN UNLESS STATED				
SPECIFICATION	BS EN 10088-3 2005 1.4404				SIZE OF TEST PIECE			1.1/2" A/F HEX				
TENSILE: BS EN 10.002-1 2001		0.2% PROOF		1.0% PROOF		UTS		ELONG ON %		R OF A %	COMMENTS	
O	TEMP	SECTION	AREA SQ	UNIT	REQUIREMENTS							
L	RT	11.25mm	99.40mm ²	Mpa	RESULTS	434	468	620	56mm	42.0	72.0	N/A
HARDNESS: BSEN ISO 6506-1 1999 (superceded by BSEN ISO 6506-1 2005)				DESIGNATION	REQUIREMENTS	RESULTS						
BRINELL				HBW 10/3000	N/A	189						
HARDNESS: BSEN ISO 6508-1 1999 (superceded by BSEN ISO 6508-1 2005)				DESIGNATION	REQUIREMENTS	RESULTS						
ROCKWELL C				HRc	N/A	11						
ROCKWELL B				HRb	N/A	90						

END OF CERTIFICATE

THIS IS A TRUE AND VERIFIED COPY OF THE ORIGINAL TEST HOUSE CERTIFICATE
4/2/09

H.C.T. M767
Checked & Approved by
Parker Hannifin IPDB
10-02-2009 16:49:23 Page 4 of 4

REPRESENTING Hardness taken mid radially	No copy is authentic without the embossed seal and signature  For and on behalf of SPECIAL TESTING WORKS LTD A Member of the Special Steel Group of Companies Liam Burdett Asst Testhouse Manager
---	---

Test results do not in any way confer approval of the quality of manufacture of the material



C260

ACEROS INOXIDABLES

Larralde LOIU (VIZCAYA) España
 P.O. Box 1.323/48060 Begoa
 Tel.34-(4) 4 71 13 00
 Fax.34-(4) 4 53 16 36

Management Systems
 Certified by
 LRQA
 ISO 9001 / SUI 6000340
 ISO 14001 / SUI 1570478

330248-12

OLARRA

OLARRA U.K. LTD.
 FOREST PARK - CLEOBURY MORTIMER
 NR KIDDERMINSTER - DY14 9BD - ENGLAND

Trade Mark - Zeichen des Lieferanten
 Anagrama del suministrador

Works Inspector Stamp - Werk sachverständiger
 Sello del Inspector

Certificate type - APZ Nach
 Certificado Epc EN 10204/3.1

Certificate n° - Prüf-Nr
 Certificado n° 194069

Date - Datum - Fecha
 27-05-2014

Our order N°
 Werks - Nr 542515

Heat
 Schmelze 371278
 Cotada

Your order N°
 Bestell - Nr OL6252
 Pedido N°

Steel Grade
 Werkstoff 316-S-11 AV
 Calidad

According to
 Entsprechend
 Corresponde BS 970:PART 3:1991.

Shape and Size - Gegenstand
 Perfil y dimensión
 ROUND 13 mm

Tolerance - Toleranz
 Tolerancia h 9 / DIN 671 / EN 10278

Bundles
 Bunde 2
 Bultos

Bars
 Stäbe
 Barras

Weight
 Gewicht
 F peso 1264 Kg

Requirements - Anforderungen - Especificaciones

EN 10.088-3.2005.
 EN 10.272-2007.
 ASTM A 182 / A 182M-13a.
 ASTM A 479 / A 479M-13b.
 ASTM A 276-13a.
 ASME SA 479 / SA 479M-13
 NACE MR-0175-2003/ISO 15156-3 2009.
 SAE AMS 5853H-12.
 316S31AV-1.4404-1.4401-Type 316-Type 316L.
 PED 97/23/EC, Annex I, Paraq.4.3/DGR 97/23/EG

Anhang | Absatz 4.3 Certificate/Zertifikat Nr. 348/2008/MUC

Melting process / Erhmelzungsart / Proceso de Fusión
 E.A.F. / A.O.D.

Heat treatment / Wärmebehandlung / Tratamiento térmico
 1060C 4H/Std WATERWASSER/AGUA

Solution annealed/Abgeschreckt/Wilperisemple-Cold drawn/Gezogen/Estirado-Polished/Poliert/Pulido-

Test results - Ergebnis der Prüfungen - Resultados de los ensayos

Dimension of Specimen Abmessungen des Probeabmaßes Medida de las probetas	Rp0.2% N/mm2 MPA	Rp 1% N/mm2 MPA	Rm N/mm2 MPA	A %L 5D	A %L 4D	Z %	Hardness Härte HBw	Impact test / Kernschlag / Resiliencia 180 V Jules	
RD. 10,00 mm.	Min.	316	426	600	15				
	Max.								
Temperature °C 20	Spec. N° Probe Nr. Pto N°	1	522	610	661	32	35	72	217

	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	N	Co
Min.						16,50	2,00	11,00			
Max.	0,030	1,00	2,00	0,045	0,030	16,50	2,50	14,00	0,70		
	0,018	0,31	1,70	0,034	0,028	16,95	2,01	11,00	0,41	0,0270	0,14

Visual and dimensional inspection
 Beschichtigung und Ausmessung O.K.
 Control visual y dimensional

Radioactivity inspection
 Radioaktivitätskontrolle O.K.
 Control de Radioactividad

Anilizing test
 Spätrost Verwechungspr O.K.
 Anilmezola

Grain Size
 Korngröße
 Tamaño de grano

Remarks - Bemerkungen - Observaciones

IC test acc./IK prüfung nach ASTM A 262 E.02. OK

EDV / EDP
 Acc. EN 10.204
 Alfredo Molina
 Certification
 Mng.

PARKER HANNIFIN LTD
 VERIFIED TRUE COPY OF
 ORIGINAL CERTIFICATION

H.C.T. C260

Checked & Approved by
 Parker Hannifin IPDE

011548

0391015

Acciaierie Valbruna S.p.A.



CERTIFICATO DI COLLAUDO
ABN AHMEPRUEFZEUGNIS
INSPECTION CERTIFICATE
CERTIFICAT DE RECEPTION
EN 10204 (2004) , 3.1

36100 VICENZA (Italia) - Viale della scienza, 25 z.f.
Stab.: 39100 BOLZANO (Italia) - Via A. Volta, 4
Telephon number : 0039 (0) 44496821

Cliente / Besteler / Purchaser/Client
VALBRUNA U.K. LTD.
OLDBURY ROAD
B70 9BH-WEST BROMWICH B70 9BH GB-BB

Produttore: ACCIAIERIE VALBRUNA S.P.A.
Hersteller/Hersteller/producer

Stato di fornitura: - Annealed Cold Drawn
Lieferzustand/Delivery state/État de livraison

Specifiche:
Anforderungen / Requirements / Exigences
VAL STOCK 2010 1.4404/316L A.CF
AMS 5648 L S31600 A
ASME SA182 2010 S31603 A (1)
ASME SA479 2010 S31600 A (4)
ASTM A182 2012B S31603 (7)
ASTM A276 2013 S31603 A.CF
ASTM A370 2012A
EN 10088-3 2005 1.4401 A.CF
EN 10272 2007 1.4404 A.CF
NACE MR0175 2009 S31600 A (8)
QQ-S-763 F 316L A.C.F

AISI 316
AMS 5653 H S31603 A.CF
ASME SA276 2010 S31600 A.CF (2)
ASME SA479 2010 S31603 A (5)
ASTM A262 2010. PRACTICE E
ASTM A314 2008 S31600
ASTM A479 2013A S31600 A
EN 10088-3 2005 1.4404 A.CF
NACE MR0103 2010 S31600 A
NACE MR0175 2009 S31603 A (9)

Certificato nr: MEST515624/2014 / 1
Collaud Test/Exam

Conforma prod nr: E114004779
WebStar Order Ref.:

Marchio di Fabbrica:
Zeichen des Lieferanten
Trade mark
Sigle du fournisseur

Punzone del Collaudatore:
Stempel des Werkprüfverfähergen
Inspector's stamp/Stampo del collaudatore

Avviso di Spedizione: D-VII 14016294
Lieferungsverpackungszettel

Ordine nr: 404044762 WEST BROMWICH
Bestellnummer/Order/Commande

Tipo di Elaborazione: E+AOD
Erzeugungszustand/Manufacturing process/Mode of fabrication

AISI 316L
ASME SA182 2010 S31600 A (6)
ASME SA276 2010 S31603 A.CF (3)
ASTM A182 2012B S31600 A (6)
ASTM A276 2013 S31600 A.CF
ASTM A314 2008 S31603
ASTM A479 2013A S31603 A
EN 10272 2007 1.4401 A.CF
NACE MR0103 2010 S31603 A
QQ-S-763 F 316 A.CF

- (0) SEC.II PT.A 2010 EDITION ADD. 2011a
- (1) SEC.II PT.A 2010 EDITION ADD. 2011a
- (2) SEC.II PT.A 2010 EDITION ADD. 2011a
- (4) SEC.II PT.A 2010 EDITION ADD. 2011a
- (5) For products machined directly from bar refer also
- (7) For products machined directly from bar refer also
- (9) ANSI/NACE MR0175/ISO 15156-3, second edition 2009-10-15
- (9) ANSI/NACE MR0175/ISO 15156-3, second edition 2009-10-15

- (0) For products machined directly from bar refer to ASME SA479.
- (1) For products machined directly from bar refer to ASME SA479.
- (3) SEC.II PT.A 2010 EDITION ADD. 2011a
- (5) SEC.II PT.A 2010 EDITION ADD. 2011a
- (6) to ASTM A479.
- (7) to ASTM A479.
- (8) Technical circular 1:2011 Published 2011-06-14
- (9) Technical circular 1:2011 Published 2011-06-14

Qualità: 1.4401/1.4404/316/316L
Webstar/Qualitätsbezeichnung

Marcia: MVAPML
Werkzeugmaschinen
Brand/Marka MAXIVAL

Tolleranza: DIN 671 - h9
Toleranz/Allowance/Tolerances

Punzonatura: 1.4401/4/316/L
Kennzeichnung/Marking/Markierung

Pos. nr. Part. nr. N° de poste	Oggetto Component Product description Description du produit	Dimensioni - mm Abmessungen Dimensions Dimension	Lunghezza - mm Länge Length Longitude	Colata Schmelze Heat Coulée	Pezzi Stückzahl Pieces Pièces	Peso - KG Gewicht Weight Poids	Lotto nr. Lot Lot nr Lote nr
0030	Round	20,000	3045 / 3100	263484		1133,0	402706580

TEST ALLO STATO DI FORNITURA													
Test on delivery condition Prüfung auf lieferbarem produkt Test à l'état de fourniture Prueba sobre el material así como entregado													
TEST	Proveita/Inspección Essential Properties Log. prop. Essent. Essent. Prop. Essent. Log. prop. Essent. Log. prop. Essent. mm	°C	Prova Essent. Essent. Essent.	Smorramento Stressrupture Tens. Strain Tens. Strain Tens. Strain N/mm2	Smorramento Stressrupture Tens. Strain Tens. Strain Tens. Strain N/mm2	Resistenza Zugspannung Tensile strength Tensile strength Tensile strength N/mm2	Allungamento Dehnung Elongation Elongation Elongation %	Stirazione Zugverschiebung Displacement of wire Displacement %	Resilienza Schlagvermögen Impact Power Impact Power Impact Power KV J	Durezza Härte Hardness Hardness Hardness HB			
Valori richiesti 1 Anforderungen/Required values Values demanded		min max		207	235	517 900	20 30	- 50	100	140 235			
A	10	20	L	523	578	721	37 39	68 68	168 174 175	232			
TEST						min	max						
B	Grain size for ASTM E112							5					

Mechanical properties according to ASTM A370.

Analisi chimica

Chemische Zusammensetzung/Chemical Analysis/Analyse chimica

Colata Heat Schmelze/Heat	min - max 0,030	1,00	1,25 2,00	16,50 18,00	2,00 2,50	1,00	10,00 13,00	0,040	0,030	0,100				
	C %	Si %	Mn %	Cr %	Mo %	Cu %	Ni %	P %	S %	N %				
263484	0,012	0,65	1,46	16,67	2,00	0,60	10,07	0,029	0,026	0,058				

Intergranular corrosion test per ASTM A262 pract. E: ok.
Absence of cracks at 20 x magnification after bend test.

Vicenza, 18/09/14
Vicomit
(Mod. ACE2)

H.C.T. WOT
M. Rizzotto

Checked & Approved by
Parker Hannifin IPDE

26-09-2014 13:26:53 Page 1 of 2

SPHERICAL COMPONENTS LTD

Pagina - 1 di 2

Acciaierie Valbruna S.p.A.



CERTIFICATO DI COLLAUDO
ABNAHMEPRUEFZEUGNIS
INSPECTION CERTIFICATE
CERTIFICAT DE RECEPTION
EN 10204 (2004) , 3.1

36100 VICENZA (Italia) - Viale della scienza, 25 z.i.
Stab.: 39100 BOLZANO (Italia) - Via A. Volta, 4
Telephon number : 0039 (0) 444968211

Clienti / Besch./Purchaser/Cient
VALBRUNA U.K. LTD.
OLDBURY ROAD
B70 9BH-WEST BROMWICH B70 9BH GB-GB

Produttore: ACCIAIERIE VALBRUNA S.P.A.
Hersteller/Hersteller/Produtora

Stato di fornitura: - Annealed Cold Drawn
Lieferzustand/Delivery state/Etat de livraison

I. Korrosion nach EN ISO 3651-2A Sensibilisierung : T1 : OK
Corrosion test per EN ISO 3651-2A sensitized T1 : OK
Solution annealed 1070°C for 1 h / water

Sono state soddisfatte tutte le condizioni richieste
Die gestellten Anforderungen sind E. Anlage erfüllt
The material has been furnished in accordance with the requirements
Le matériel a été livré conforme aux exigences

Controllo antimiscelanza: OK
Verwechslungsprüfung: spektralanalytisch durchgeführt
Anmixing testing performed: OK
Controllo antimiscelanza fatto: a. e.

Controllo visivo e dimensionale: soddisfatta le esigenze
Besichtigungs und Ausmessung: ohne Beanstandung
Visual inspection and dimensional checks: satisfactory
Controlo visual et dimensionale: satisfaisant

Melted and manufactured in Italy No welding or weld repair Material free from Mercury contamination
We declare that the finished product is checked for radioactive contamination through Portal System when it leaves the production plant.
The Quality Management System is Certified acc. Pressure Equipment Directive [97/23/EC] Annex 1, s. 4.3 by TÜEV and LLOYD'S
Any act of tampering, modification, alteration, counterfeiting and/or falsification and/or any other action which modifies the contents of this test certificate shall constitute a violation of applicable civil and criminal laws. Acciaierie Valbruna shall protect its rights and interests before any competent court, authority and jurisdiction.
Maximal and/or Valplus grades/products are manufactured with ladle techniques to control composition, distribution, size and shape of non-metallic inclusions for improved machinability.
The supplied product conforms to requirements expressly requested by the purchaser and conforms to requirements specified by certified norms and standards. Should the product be used for more severe, critical and/ or in any case different applications than those the material is generally intended for, any different and/or supplementary requirements shall be specifically demanded, at least, upon order of the Product by the Purchaser. Acciaierie Valbruna SpA shall not be responsible for any improper use of the Products.

QUALITY MANAGEMENT SYSTEM CERTIFIED BY LLOYD'S REGISTER

Avviso di Spedizione: D-V114016294
Lieferanweisung/Packungsschlüssel

Certificato nr: MEST515624/2014/ 1
Prüfung/Inspektion

Conferma ordine nr: EI14004779
Werkstatt/Order/Nr.

Marchio di Fabbrica:
Zeichen des Lieferwerkes
Trade mark
Stempel / usine / production

Funzione del Collaudatore:
Stempel des Werkstufenschwändigen
Inspector's stamp/Personnel's stamp



VERIFIED TRUE COPY
SIGNED
(Signature)
SPHERICAL COMPONENTS LTD

Vicenza, 18/09/14
VCC000
(Mod. MCE2)

Il collaudatore è stabilimento Parker Hannifin / Werk-Beschäftigter / Works Inspector / L' agent d' usine

H.C.F. W07
M. Rizzo

Pagina - 2 di 2

Checked & Approved by
Parker Hannifin IPDE
26-09-2014 13:26:53 Page 2 of 2



ernefittings middle east co.ltd.
P.O. Box 10155
Jubail Industrial City, 31961
Kingdom of Saudi Arabia
Telephone +966 3 3408191
Fax +966 3 3408197

Inspection Certificate
EN 10204 - 3.1

Certificate No.
001411/14-PD

Rev.
18/11/2014

Date
18/11/2014

Code No.
RSF53

Ident No.

Our Order No./Item No.
002123JT-0240 / 140705

Your Order No.
CI-14-356

Quantity

Manufacturer
TPCO

1 = Heat Analysis

J-Factor: (Si + Mn) * (P + Sn) * 10000

CEQ: C + (Mn / 6) + (Cr + Mo + V) / 5 + (Cu + Ni) / 15

Leakage Test

Requirements of the Order

ASME B16.9-2012, material:WPL6, TR-base material:ASME Sect. II part D table Y-1, TR-fitting:ASTM A 420/A 420M-13, NACE MR0103-2012, ASME SA-420/SA-420M-13, TR-addit fitting:NACE MR0175/ISO15156-2-2009A.2, certificate:EN 10204/3.1, rust protection:Millstandard, execution:Seamless, This material meets the mech. and chem. reqt

Designation
reducers
KO-S-WPL6-3"1/2"-STDXS

Base Material
Tube Works Cert.No.
12122518

Analysis

Heat No.
E

Melting Process
E

Index
1

C
0.15

Si
0.23

Mn
1.14

P
0.008

S
0.002

Cr
0.03

Mo
0.01

Ni
0.03

Cu
0.05

V
<0.01

Nb
<0.01

Al
0.025

B
<0.0005

Ti
<0.01

N
0.0062

Ca
0.0008

Ceq
<0.36

Mech. Technological Test

Tensile Test

Temp. (°C)
+20 °C

Yield Strength (ReH)
428

Rd 0.2
373

Tensile Strength Rm (MPa)
533

Elongation 2"
31.5

Pos. of Sample
LNZ

Temp. (°C)
-46 °C

Cross Sec. (mm²)
40

Impact Values (J)
42-41-42

Form: ISO V

Notched Bar Impact Test

Hardness Test

136-142 HB

Heat Treatment

normalized temperature 920 °C

Cooling in air

Visual Inspection and Dimensional Check

Marking

Comments

cold formed

SAUDI / WPL6 / RSF53 / 3"1/2" / STD/XS

o.K

Add. Mark

The products supplied are in compliance with the requirements of the order. They were manufactured, sampled, tested and inspected in accordance with the specifications and were found to meet the requirements.
Inspection representative
18/11/14 Pape Djiana
The certificate is issued by the computerized system and is valid without signature.
-323

Certified acc. to PED 97/23/EG, annex I, sec. 4.3 by Certification body for pressure equipment of the TÜV NORD Systems (notified body, reg.-no. 0045).

	I.M.L. - INDUSTRIA MECCANICA LIGURE S.P.A. Via Giancarlo Farina, 25 - 16030 Casarza Ligure - GE - ITALY Tel. +39 0185 467661 - Fax +39 0185 466510 - E-mail quality.imal@farinagroup.com MATERIAL TEST DEPARTMENT	COMPANY WITH QUALITY SYSTEM ISO 9001: 2008 CERTIFIED BY RINA CERT. N°23/91/8
---	--	---

INSPECTION CERTIFICATE EN 10204:2004 / 3.1	Nr 25195	Dated 23.04.2014
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TRANS AM PIPING PRODUCTS LTD. 9335 Endeavor Drive S.E. Calgary, Alberta T3S 0A1 CA	Purchase Order Nr CI-14 - 263 C/O #1 Item Nr 58 Packing List Nr 486 Invoice Nr
---	---

Heat Code	Heat Nr	Description
T3	79442	FITTING TEE SW 3M 1/2" A350/LF2

Material in accordance ASME SA ASTM A350-13 Gr. LF2 cl.1
 NACE MR 0175 - ISO 15158 Ed. 2009 / NACE MR 0103 Ed. 2012
 P.E.D. 97/23/EC ANNEX 1 PAR. 4.3

Material remarks MATERIAL FULLY KILLED & FINE GRAIN PRACTICED

Element	C	SI	Mn	S	P	Cr	NI	Mo	TI	Cu
ASTM A350 LF2 cl.1 (LADLE)	0,195	0,230	0,950	0,010	0,015	0,120	0,060	0,010	0,009	0,250

Element	V	Nb	N	AL	C.E.	PRE
ASTM A350 LF2 cl.1 (LADLE)	0,001	0,001	-	0,024	0,400	-

Test specimen Sect. mm2	Length mm	Shape 1=O - 2=□	Tensile N/mm2	Yield Strength > 0,2% N/mm2	Yield Strength >1% N/mm2	Elongation %	Reduction of area %
122,65	60,00	1	508,0	323,0	-	31,8	54,0

HARDNESS			IMPACT TEST			
HBW	TYPE	Test specimen	°C	1-Joule	2-Joule	3-Joule
153,0 - 161,0		10x10mm	-46	47	47	51

Heat treatment	Normalized at 900°C / Air Cool	ELECTRIC FURNACE
----------------	--------------------------------	------------------

Dimension in accordance	ASME B16.11 Ed.2011 - MSS SP25 Ed.2013
-------------------------	--

Visual & Dimensional	SATISFACTORY	Origin	EUROPEAN UNION	Our Ref.	2014-2E201-0000471-0058
----------------------	--------------	--------	----------------	----------	-------------------------

Notes 100% MANUFACTURED IN ITALY
 SUPPLIED MATERIAL MEET SPECIFICATIONS AND P.O. REQUIREMENTS

QUALITY CONTROL DEPT. Boris Fizzotti 	INSPECTION AUTHORITY	MANUFACTURER'S SYMBOL IML or 
--	----------------------	---



ISO 9001:2008

TRILAD Flanges and Fittings, Inc.

172 Turbo Drive
 Sherwood Park, AB, CANADA T8H 2J6
 (PHONE) 780-464-7774
 (FAX) 780-464-0044
www.tri-lad.com

CERTIFIED MATERIAL TEST REPORT

Certificate No. 14202448	EN 10204 3.1	Date of Report 12/03/2014
Customer ALLIED EDMONTON - CAD\$ 172 TURBO DRIVE SHERWOOD PARK	AB T8H 2J6	Customer Order No. 472316 Quantity
		Tri-Lad Order No. 754569 Line No. 1

Specification A350-LF2-CL 1 STOCK	Heat Treatment NORMALISED
Item Description .75 600 SW XS RF LF2 CL1 (842888)	Temperature Init 1706 F 930 C
Shop Order/Trace No.	Time N= .55HRS Lot Definition
Lot No.	
Heat Code TL10009352	
C.E. .40	Melt Practice EF

	Chemical Composition									
	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V
Heat Product	.18	1.19	.025	.017	.27	.04	.04	.09	.01	.002
Heat Product	Nb .00									
Heat Product										

Mechanical Properties										
Yield	Tensile		Elongation	Reduction of Area	Hardness	Impact Test	Impact Values			Shear Fracture
Ksi 63 Mpa 436	Ksi 84 Mpa 579		29 %	59 %	HBW 170 HBW 170	Temperature M50 F M46 C	Ft- lbs 59 40 37			
Tensile Specimen STD RD							Joules 80 54 50			
Lateral Expansion			Impact Type VNOTCH	Impact Orientation TANGENTIAL		Starting Material			Impact Specimen FULL SIZE	

Cr+Mo <= 0.32%	Notes
Cr+Cu+Mo+Ni+V <= 1.00%	0.09
Mn/C >= 3.0	0.18
CE = C + Mn/6 + (Cr+Mo+V)/5 + (Ni+Cu)/15	6.61
	0.40
ASTM A350-12 LF2 CLASS 1	CSA Z245.12-09 GR 248 CAT II M46C SS
ASME SA350 2010 Ed 2011A Addendum LF2 CLASS	ANSI/NACE MR0175/ISO15156:2009(E)
	NACE MR0103 LATEST ED.
	NACE MR0175/ISO15156-09

Material is in accordance with the applicable Standard to which it is ordered including:
 ASME Sect II, ASME B16.5, B16.9, B16.36, B16.47, CSA, MSS, AWWA C-207.

NO WELD REPAIR

Material conforms to both ASTM (A) and ASME (SA) applicable specifications.
 We hereby certify that all information presented on this CMTR conforms to the above specification.

We hereby certify the results to be a true copy of the records of the company.

Troy Gorrell
 Q.C. Inspector



ISO 9001:2008

TRILAD Flanges and Fittings, Inc.

172 Turbo Drive
 Sherwood Park, AB, CANADA T8H 2J6
 (PHONE) 780-464-7774
 (FAX) 780-464-0044
www.tri-lad.com

CERTIFIED MATERIAL TEST REPORT

Certificate No.	15208479	EN 10204 3.1	Date of Report	2/27/2015
Customer	ALLIED EDMONTON - CAD\$ 172 TURBO DRIVE SHERWOOD PARK	AB T8H 2J6	Customer Order No.	482179
			Quantity	23
			Tri-Lad Order No.	765843
			Line No.	1

Specification	A350-LF2-CL 1	STOCK	Heat Treatment	NORMALISED
Item Description	1 150 SW XS RF LF2 CL1	(883423)	Temperature	Init 1706 F 930 C
Shop Order/Trace No.			Time	N=0.45HRS
Lot No.			Lot Definition	
Heat Code	TL10010271			
C.E.	.43	Melt Practice EF		


Heat Product	Chemical Composition									
	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V
Heat Product	.19	1.18	.022	.022	.25	.03	.01	.14	.04	.005
Heat Product	Nb .00									
Heat Product										


Mechanical Properties										
Yield	Tensile		Elongation	Reduction of Area	Hardness	Impact Test Temperature	Impact Values			Shear Fracture
Ksi 60	Ksi 81		32 %		HBW 159	M50 F	Ft-lbs 22	65	53	
Mpa 414	Mpa 559			68 %	HBW 159	M46 C	Joules 30	88	72	
Tensile Specimen		STD RD								
Lateral Expansion			Impact Type	Impact Orientation	Starting Material			Impact Specimen		
			VNOTCH	TANGENTIAL				FULL SIZE		


Notes	
Cr+Mo <= 0.32%	0.18
Cr+Cu+Mo+Ni+V <= 1.00%	0.23
Mn/C >= 3.0	6.21
CE = C + Mn/6 + (Cr+Mo+V)/5 + (Ni+Cu)/15	0.43
ASTM A350-12 LF2 CLASS 1	CSA Z245.12-09 GR 248 CAT II M46C SS
ASME SA350 2010 Ed 2011A Addendum LF2 CLASS	ANSI/NACE MR0175/ISO15156:2009(E)
	NACE MR0103 LATEST ED.
	NACE MR0175/ISO15156-09

Material is in accordance with the applicable Standard to which it is ordered including:
 ASME Sect II, ASME B16.5, B16.9, B16.36, B16.47, CSA, MSS, AWWA C-207.
 NO WELD REPAIR
 Material conforms to both ASTM (A) and ASME (SA) applicable specifications.
 We hereby certify that all information presented on this CMTR conforms to the above specification.
 We hereby certify the results to be a true copy of the records of the company.

Troy Gorrell
 Q.C. Inspector

 I.M.L. - INDUSTRIA MECCANICA LIGURE S.P.A. Via Giancarlo Farina, 25 - 16030 Casarza Ligure - GE - ITALY Tel. +39 0185 467661 - Fax +39 0185 466510 - E-mail quality.iml@farinagroup.com MATERIAL TEST DEPARTMENT		COMPANY WITH QUALITY SYSTEM ISO 9001: 2008 CERTIFIED BY RINA CERT. N° 23/91/S											
INSPECTION CERTIFICATE EN 10204:2004 / 3.1		Nr ^{A03} 2014-C_IML-25961	Data / Dated 28.11.2014 ^{Z02}										
TRANS AM PIPING PRODUCTS LTD. 9335 Endeavor Drive S.E. Calgary, Alberta T3S 0A1		Ordine / PO Item DDT / Delivery note Packing List Fattura / Invoice Ns. rif. / Our ref.	CI-14-584 77 2014-2E301-0001404 2014-2E301-0001404 2014-2E401-0001329 2014-2E201-0001250-0077										
Dest. TRANS AM PIPING PRODUCTS LTD. 9335 - Endeavor Drive S.E. Calgary, Alberta T3S 0A1													
Cod. colata ^{B07} Heat Code TM7	Nr. colata ^{B07} Heat Nr 14/70645	Descrizione Description FITTING RED.TEE SW 3M 1"x3/4" A350/LF2											
Mat. in acc. a / Mat. in acc. to ^{B02} ASME SA ASTM A350-13 Gr. LF2 cl.1 NACE MR 0175 - ISO 15156 Ed. 2009 / NACE MR 0103 Ed. 2012 P.E.D. 97/23/EC ANNEX 1 PAR. 4.3													
Ann. mat. / Mat. remarks ^{B02} MATERIAL FULLY KILLED & FINE GRAIN PRACTICED													
Elementi / Elements ^(C71-C90)													
LADLE ANALYSIS	C	Si	Mn	S	P	Cr	Ni	Mo	Ti	Cu	V	Nb	N
LADLE ANALYSIS	0,190	0,170	0,930	0,007	0,010	0,090	0,050	0,010	0,021	0,170	0,002	0,002	0,000
LADLE ANALYSIS	Al								CE LF	CE SF	F1	F2	PREN
LADLE ANALYSIS	0,028								0,380	0,345	0,322	0,100	--
CE LF=C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE SF=C+Mn/6 F1=Cu+Ni+Cr+Mo+V F2=Cr+Mo													
Provetta / Test specimen Forma / Shape °C ^{C03} Snervamento>0,2% ^{C11} Snervamento>1,0% ^{C11} Rottura / Tenelle ^{C12} Allungamento / Elongation ^{C13} Contrazione / Reduction of area ^{C15}													
122,65 50,00 1=O - 2=□ 20 318,0 - 515,0 33,8 55,4													
DUREZZA / HARDNESS ^{C22} RESILIENZA / IMPACT TEST													
HBW Tipo/Type ^{C40} Provetta / Test Specimen °C ^{C03} 1-Joule ^{C42} 2-Joule ^{C42} 3-Joule ^{C42} Media/Average ^{C45}													
153,0 - 158,0 KV 10x10mm -50 55 51 53 53,0													
Tratt. Term. / Heat treatment ^{C70} Normalized at 900°C / Air Cool ELECTRIC FURNACE													
Dim in acc. a / Dim. acc. to ^{B14} ASME B16.11 Ed.2011 - MSS SP25 Ed.2013													
Marcatura in acc. ^{B06} Marking in acc. to	MSS SP25 Ed. 2013	Vis. & Dim.	SATISFACTORY										
Note / Notes		Origine / Origin of Steel											
100% MANUFACTURED IN ITALY SUPPLIED MATERIAL MEETS SPECIFICATIONS AND P.O. REQUIREMENTS		EUROPEAN UNION											

UFFICIO CONTROLLO QUALITA' QUALITY CONTROL DEPARTMENT 	ENTE UFFICIALE DI COLLAUDO INSPECTION AUTHORITY	MARCHIO PRODUZIONE MANUFACTURER'S SYMBOL IML or 
---	--	---

 I.M.L. - INDUSTRIA MECCANICA LIGURE S.P.A. Via Giancarlo Farina, 25 - 16030 Casarza Ligure - GE - ITALY Tel. +39 0185 467661 - Fax +39 0185 466510 - E-mail quality.iml@farinagroup.com MATERIAL TEST DEPARTMENT		COMPANY WITH QUALITY SYSTEM ISO 9001: 2008 CERTIFIED BY RINA CERT. N° 23/91/S																																																									
INSPECTION CERTIFICATE EN 10204:2004 / 3.1		Nr ^{A03} 2014-C_IML-25883	Data / Dated 10.11.2014 ^{Z02}																																																								
TRANS AM PIPING PRODUCTS LTD. 9335 Endeavor Drive S.E. Calgary, Alberta T3S 0A1		Ordine / PO Item DDT / Delivery note Packing List Fattura / Invoice No. rif. / Our ref.	CI-14-388 C/O No. 2 61 2014-2E301-0001298 2014-2E301-0001298 2014-2E201-0000856-0091																																																								
Dest. TRANS AM PIPING PRODUCTS LTD. 9335 - Endeavor Drive S.E. Calgary, Alberta T3S 0A1																																																											
Cod. colata ^{B07} Heat Code TP3	Nr. colata ^{B07} Heat Nr 14/70545	Descrizione ^{B01 - (B08 - B11)} Description FITTING TEE SW 3M 1" A350/LF2																																																									
Mat. in acc. a / Mat. in acc. to ^{B02} ASME SA ASTM A350-13 Gr. LF2 cl.1 NACE MR 0175 - ISO 15156 Ed. 2009 / NACE MR 0103 Ed. 2012 P.E.D. 97/23/EC ANNEX 1 PAR. 4.3																																																											
Ann. mat. / Mat. remarks ^{B02} MATERIAL FULLY KILLED & FINE GRAIN PRACTICED																																																											
Elementi / Elements ^(C17 - C20)																																																											
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Dim in acc. a / Dim. acc. to ^{B14} ASME B16.11 Ed.2011 - MSS SP25 Ed.2013																																																											
Marcatura in acc. ^{B06} Marking in acc. to	MSS SP25 Ed. 2013	Vis. & Dim.	Satisfactory																																																								
Origine ^{B01} Origin of Steel		EUROPEAN UNION																																																									

Note / Notes
 100% MANUFACTURED IN ITALY
 SUPPLIED MATERIAL MEETS SPECIFICATIONS AND P.O. REQUIREMENTS

UFFICIO CONTROLLO QUALITA' ^{A05} QUALITY CONTROL DEPARTMENT 	ENTE UFFICIALE DI COLLAUDO ^{Z03} INSPECTION AUTHORITY	MARCHIO PRODUZIONE ^{A04} MANUFACTURER'S SYMBOL IML or 
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HENGYANG VALIN
STEEL TUBE CO.,LTD

MILL TEST REPORT

(ACCORDING TO EN10204 3.1)

Add: 10 Dalixincun, Hengyang
City, Hunan, P.R. China P.C.: 421001
Tel and Fax: +86 734 8873739
E-mail: hstec@hysteeltube.com

CUSTOMER	TRANS AM		CERTIFICATE NO.	YCHYST2014084-01
CONTRACT NO.	2111001402-2	P. O. NO.	PO.CI14-534-B (LOT B)	L.C. NO.: 4FAHDS-00813
PRODUCT	SEAMLESS CARBON STEEL PIPE FOR OIL AND GAS USE		DELIVERY CONDITION	N(CD)
SPECIFICATION	ASTM A333-6-2013, ASME SA333-6-2013, API 5LBN PSL-2 45TH EDITION, NACE MR-0175-2011/ISO 15156- 2(REGION 3)-2009 /MR-0103-2012/SS (CSA Z245.1 GRADE 241 CATEGORY II-2014)		HEAT TREATMENT	860°C(7min)
GRADE	GR. 6, BN, GRADE 241		DIMENSIONS	1/2" x 0.147" x 20ft
TOTAL BUNDLES:	TOTAL PIECES:	TOTAL LENGTH:	TOTAL WEIGHT:	mt

REMARK : 1.Origin: made in china;2.All elements to be listed; 3. Pipe produced from "fully killed" steel.
4.Silicon and calcium treated for inclusion morphology control in steel melting.
5. Billet produced by: HENGYANG VALIN STEEL TUBE Co., Ltd


We hereby certify that material herein described has been manufactured in accordance with the standards and specifications required in your order and satisfies the corresponding requirements.

This certificate is issued by a computerized system and it is valid with electronic signature. In case the owner of the certificate would release a copy of it, he must attest its conformity to the original one taking upon himself the responsibility for any unlawful or not allowed use.

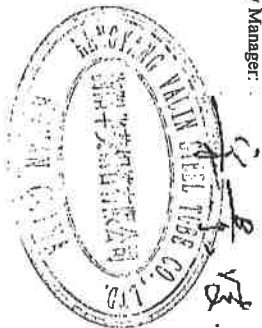
Any alteration and/or falsification will be subject to the law.

If you need to assure the authenticity of this certificate, please do not hesitate to contact Hengyang Valin Steel Tube CO., LTD, E-mail: hstec@hysteeltube.com

CUSTOMER THIRD PARTY

Quality Manager: 

Certificate-maker: 曹永泉





柏緯鐵工股份有限公司

高雄縣仁武鄉烏林村仁心路 303 號
BOTH-WELL STEEL FITTINGS CO., LTD.
 NO.303, JEN-HSIN ROAD JEN-WU HSIANG
 KAOHSIUNG HSIEN, TAIWAN R.O.C.(81460)
 TEL: 886-7-371-0497, 371-1536, 372-0260
 web site: http://www.bothwell.com.tw e-mail: bothwell@www.bothwell.com.tw or box@mail.bothwell.com.tw

An ISO 9001:2000 Registered Manufacturer



MILL TEST & INSPECTION CERTIFICATE

ACCORDING TO EN10204/DIN50049/3.1.B

ORIGIN: TAIWAN

CUSTOMER: WEIFANG STEEL CANADA LTD.

INVOICE NO: BW089706095

DATE: 12/10/08

CERT NO: 83363-4 ORDER NO: AG0031-LF2

L/C NO:

PAGE: 4

ITEM	BOTH WELL HT. CD.	RAW MATERIAL HEAT NO.	DESCRIPTION				QUANTITY	SPECIFICATION:						
								ASTM A350 -04a	ASME SA350 -E04					
051	Y045	X1659	HEX BUSHING 1/4"x1/8" NPT					DIMENSION:						
053	Y045	X1659	HEX BUSHING 1/2"x1/4" NPT					ASME B16.11-2005						
053	Y045	X1659	HEX BUSHING 1/2"x1/4" NPT					SURFACE:						
054	Y045	X1659	HEX BUSHING 1/2"x3/8" NPT					BY VISUAL...GOOD						
056	Y046	X1658	HEX BUSHING 3/4"x1/2" NPT											
056	Y046	X1658	HEX BUSHING 3/4"x1/2" NPT											
066	Y046	X1658	90D ELBOW 1/2" 3000# S/W											
ITEM	BOTH WELL HT. CD.	CHEMICAL COMPOSITION (%)												
		C	Si	Mn	P	S	Cu	Cr	Ni	Mo	V	Cb(Nb)	N	
Min		-	0.150	0.600	-	-	-	-	-	-	-	-	-	-
Max		0.300	0.300	1.350	0.035	0.040	0.400	0.300	0.400	0.120	0.080	0.020	-	
051	Y045	0.190	0.200	1.090	0.010	0.003	0.030	0.060	0.020	0.010	0.002	0.000	-	
053	Y045	0.190	0.200	1.090	0.010	0.003	0.030	0.060	0.020	0.010	0.002	0.000	-	
053	Y045	0.190	0.200	1.090	0.010	0.003	0.030	0.060	0.020	0.010	0.002	0.000	-	
054	Y045	0.190	0.200	1.090	0.010	0.003	0.030	0.060	0.020	0.010	0.002	0.000	-	
056	Y046	0.190	0.210	0.980	0.014	0.001	0.040	0.260	0.080	0.020	0.003	0.000	-	
056	Y046	0.190	0.210	0.980	0.014	0.001	0.040	0.260	0.080	0.020	0.003	0.000	-	
066	Y046	0.190	0.210	0.980	0.014	0.001	0.040	0.260	0.080	0.020	0.003	0.000	-	
ITEM	BOTH WELL HT. CD.	MECHANICAL TEST					Remark:							
		Tensile Strength (KSI)	Yield Strength (KSI)	Elongation (%)	R of A (%)	Hardness (AVG.) (HB)	CONFORM TO NACE MR0175-2003/MR0103							
Min		70.0	36.0	22.0	30.0	-	STEEL MAKING PROCESS : ELECTRIC FURNACE							
Max		95.0	-	-	-	197	HEAT TREATED(°C) NORMALIZED: 900°C TEMPERED: 620°C							
							IMPACT VALUE(CHARPY) -50°F(-46.0°C)							
							HEAT NO. HT. CD. JOULE(J) AVG.(J)							
							X1659 Y045 168 181 160 169.667							
							X1658 Y046 167 206 192 188.333							
051	Y045	79.0	59.7	33.0	80.1	146	WE CERTIFY THE ABOVE MENTIONED FITTINGS HAVE BEEN MANUFACTURED AND TESTED IN ACCORDANCE WITH THE SPECIFICATIONS SHOWN							
053	Y045	79.0	59.7	33.0	80.1	146								
053	Y045	79.0	59.7	33.0	80.1	146								
054	Y045	79.0	59.7	33.0	80.1	146								
056	Y046	78.9	60.5	35.2	80.0	146								
056	Y046	78.9	60.5	35.2	80.0	146								
066	Y046	78.9	60.5	35.2	80.0	146								
						 Q.C. MANAGER CHIN CHENG HSIEH		 INSPECTOR CHUN CHIEH HUANG						



SHANGHAI CRYSTAL PALACE PIPE CO., LTD

MATERIAL TEST CERTIFICATE



ISO9001:2008 ; PED Material Certificate (No.: QAC0021058/A) DATE OF ISSUE: 2012/5/8

CERTIFICATE NO.: 2012-3-19-5	CUSTOMER: TIAN JIN SHENGGONG INTERNATIONAL CO., LTD
ORDER NO.: 2012-03-019	P.O.NO.: SC-15404/64864
GRADE: ASTM A312-09 TP316/316L	COMMODITY: STAINLESS STEEL SEAMLESS PIPE.
HEAT NO.: YT13523	CONDITION: COLD FINISH / SOLUTION TREATED / PICKLED / PLAIN END.


CHEMICAL CONTENTS (WT%)								
ELEMENTS	C	Mn	P	S	SI	NI	Cr	Mo
SPECIFICATION	≤ 0.035	≤ 2.00	≤ 0.045	≤ 0.030	≤ 1.00	10.0~14.0	16.0~18.0	2.00~3.00
RESULTS (LADLE)	0.022	0.78	0.038	0.004	0.37	11.09	16.60	2.07

PHYSICAL PROPERTIES														
NPS	W.T (SCH)	Length (feet)	Dimensions			Bundle No.	Pieces	Weight (kg)	0.2%YS (Mpa)	TS (Mpa)	EL (%)	FLATTENING TEST	HARDNESS HRB	EDDY CURRENT TEST (100%)
			3/4"	80S	20									

REMARKS:
 AS PER A/SA312-09
 IN COMPLIANCE TO NACE MR0175-2003, MR0175/ISO 15156
 SOLUTION HEAT TREATMENT: 1050°C X 1.5m/min
 NO WELD REPAIR WAS PERFORMED
 FREE FROM MERCURY CONTAMINATION
 FREE FROM RADIATION CONTAMINATION
 IC TESTING ACCORDANCE TO ASTM A262 E - SATISFACTORY
 COUNTRY OF ORIGIN: CHINA
 PMI TESTING DONE.
 MATERIAL TEST CERTIFICATE TO EN 10204/3.1

1. WE HEREBY CERTIFY THAT THE MATERIAL DESCRIBED HEREIN HAS BEEN TESTED AND THE TEST RESULTS ARE IN COMPLIANCE WITH THE TERMS OF THE PURCHASE ORDER OR CONTRACT
 2. THE CERTIFICATE SHALL NOT BE REPRODUCED, EXCEPT IN FULL, WITHOUT THE WRITTEN APPROVAL OF THE COMPANY.

SHANGHAI CRYSTAL PALACE PIPE CO., LTD
 MANAGER OF QUALITY ASSURANCE DEPARTMENT

 I.M.L. - INDUSTRIA MECCANICA LIGURE S.P.A. Via Giancarlo Farina, 25 - 16030 Casarza Ligure - GE - ITALY Tel. +39 0185 467961 - Fax +39 0185 468510 - E-mail quality.iml@farinagroup.com MATERIAL TEST DEPARTMENT		COMPANY WITH QUALITY SYSTEM ISO 9001: 2008 CERTIFIED BY RINA CERT. N° 23/91/8								
INSPECTION CERTIFICATE EN 10204:2004 / 3.1		Nr 25118	Dated 31.03.2014							
TRANS AM PIPING PRODUCTS LTD. 9335 Endeavor Drive S.E. Calgary, Alberta T3S 0A1		Purchase Order Nr Item Nr Packing List Nr Invoice Nr	CI-14 - 107 C/O 4 40 387 328							
Heat Code Z71	Heat Nr 13/77623	Description FITTING 90 ELB. SW 3M 3/4" A350/LF2								
Element	C	Si	Mn	S	P	Cr	Ni	Mo	Ti	Cu
ASTM A350 LF2 cl.1 (LADLE)	0,200	0,240	0,930	0,010	0,014	0,090	0,070	0,010	0,016	0,150
Element	V	Nb	N	AL					C.E.	PRE
ASTM A350 LF2 cl.1 (LADLE)	0,004	0,003	-	0,025					0,390	-
Test specimen Sect. mm2 Length mm	Shape 1=O - 2=□	Tensile N/mm2	Yield Strength > 0,2% N/mm2	Yield Strength >1% N/mm2	Elongation %	Reduction of area %				
122,65 50,00	1	521,0	328,0	-	38,4	58,9				
HARDNESS		IMPACT TEST								
HBW	TYPE	Test specimen	°C	1-Joule	2-Joule	3-Joule				
163,0 - 167,0		10x10mm	-46	58	55	52				
Heat treatment	Normalized at 900°C / Air Cool					ELECTRIC FURNACE				
Dimension in accordance	ASME B16.11 Ed.2011 - NACE MR 0175 ISO 15156 Ed.2009 - MSS SP25 Ed.2008 - NACE MR 0103 Ed.2012 - SUPPLIED MATERIAL MEETS SPECIFICATIONS AND P.O. REQUIREMENTS									
Material in accordance	ASME SA ASTM A350-13 Gr. LF2 cl.1									
Visual & Dimensional	SATISFACTORY	Origin	EUROPEAN UNION	Our Ref.	2014-2E201-0000018-0040					

Notes ---

QUALITY CONTROL DEPT. Boris Fizzotti 	INSPECTION AUTHORITY	MANUFACTURER'S SYMBOL IML or 
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MILL TEST REPORTS

Bonney Forge
14496 Croghan Pike
Mt. Union, PA 17066

CERTIFIED MILL TEST REPORT

AIV Canada 3/9/2015

LOT NO.
UL7 Body

CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS

3/4" 9HL-1L3S-T NACE A350-LF2-CL1

C	0.190	MN	0.870	P	0.013	S	0.011	SI	0.190
NI	0.060	CR	0.100	MO	0.020	CU	0.150	V	0.017
AL	0.026	Nb	0.001						
CE(LONG FORMULA) = 0.376									
T/S(PSI) 74404 Y/S(PSI) 47717 EL(%) 34.200 RA(%) 64.700									
BRINELL HARDNESS 143, 144									
CHARPY -50 F 41/28/24(FT-LBS) AVG. 31.000(FT-LBS)									

UL8 Bonnet

3/4" 9HL-1L3S-T NACE A350-LF2-CL1

C	0.185	MN	0.900	P	0.014	S	0.009	SI	0.250
NI	0.050	CR	0.090	MO	0.010	CU	0.140	V	0.017
AL	0.027	Nb	0.003						
CE(LONG FORMULA) = 0.371									
T/S(PSI) 74839 Y/S(PSI) 53519 EL(%) 31.200 RA(%) 68.600									
BRINELL HARDNESS 145, 148									
CHARPY -50 F 30/49/38(FT-LBS) AVG. 39.000(FT-LBS)									

1. TESTING AND ACCEPTANCE CRITERIA FOR THESE VALVES ARE IN ACCORDANCE WITH THE REQUIREMENTS OF API 598 (NINTH EDITION, SEPTEMBER 2009).
2. TRIM COMPONENTS AND BOLTING ARE IN ACCORDANCE WITH PURCHASE ORDER REQUIREMENTS AND MATERIAL SPECIFICATIONS.

3. CERTIFYING TO ASTM A350 LF2 14 EDITION.
4. THE SUPPLIED MATERIAL WAS QUENCH AND TEMPERED IN ACCORDANCE WITH ASTM A350 HEAT TREATING REQUIREMENTS.
5. THE PRODUCT SUPPLIED WAS INSPECTED IN ACCORDANCE WITH EN 10204:2004 EDITION TYPE 3.1 INSPECTION DOCUMENT. (EUROPEAN STANDARD)

THIS DOCUMENT HAS BEEN ELECTRONICALLY SUBMITTED.

Cancel	Logout
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MILL TEST REPORTS

Bonney Forge
 14496 Croghan Pike
 Mt. Union, PA 17066

CERTIFIED MILL TEST REPORT

AIV Canada 3/9/2015

LOT NO.
 UL7 Body

CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS
 1" HL-1L3S-T NACE A350-LF2-CL1

C	0.190	MN	0.870	P	0.013	S	0.011	SI	0.190
NI	0.060	CR	0.100	MO	0.020	CU	0.150	V	0.017
AL	0.026	Nb	0.001						
CE(LONG FORMULA) = 0.376									
T/S(PSI) 74404 Y/S(PSI) 47717 EL(%) 34.200 RA(%) 64.700									
BRINELL HARDNESS 143, 144									
CHARPY -50 F 41/28/24(FT-LBS) AVG. 31.000(FT-LBS)									

UL8 Bonnet

1" HL-1L3S-T NACE A350-LF2-CL1

C	0.185	MN	0.900	P	0.014	S	0.009	SI	0.250
NI	0.050	CR	0.090	MO	0.010	CU	0.140	V	0.017
AL	0.027	Nb	0.003						
CE(LONG FORMULA) = 0.371									
T/S(PSI) 74839 Y/S(PSI) 53519 EL(%) 31.200 RA(%) 68.600									
BRINELL HARDNESS 145, 148									
CHARPY -50 F 30/49/38(FT-LBS) AVG. 39.000(FT-LBS)									

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2. TRIM COMPONENTS AND BOLTING ARE IN ACCORDANCE WITH PURCHASE ORDER REQUIREMENTS AND MATERIAL SPECIFICATIONS.

3. CERTIFYING TO ASTM A350 LF2 14 EDITION.
4. THE SUPPLIED MATERIAL WAS QUENCH AND TEMPERED IN ACCORDANCE WITH ASTM A350 HEAT TREATING REQUIREMENTS.
5. THE PRODUCT SUPPLIED WAS INSPECTED IN ACCORDANCE WITH EN 10204:2004 EDITION TYPE 3.1 INSPECTION DOCUMENT. (EUROPEAN STANDARD)

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MILL TEST REPORTS

Bonney Forge
 14496 Croghan Pike
 Mt. Union, PA 17066

CERTIFIED MILL TEST REPORT

MRC Canada 5/1/2015

LOT NO.
 ul7 Body

CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS
 1" hl-4l3s-sw A350-LF2-CL1

C	0.190	MN	0.870	P	0.013	S	0.011	SI	0.190
NI	0.060	CR	0.100	MO	0.020	CU	0.150	V	0.017
AL	0.026	Nb	0.001						
CE(LONG FORMULA) = 0.376									
T/S(PSI) 74404 Y/S(PSI) 47717 EL(%) 34.200 RA(%) 64.700									
BRINELL HARDNESS 143, 144									
CHARPY -50 F 41/28/24(FT-LBS) AVG. 31.000(FT-LBS)									

up5 Bonnet

1" hl-4l3s-sw A350-LF2-CL1

C	0.185	MN	0.850	P	0.010	S	0.009	SI	0.180
NI	0.080	CR	0.130	MO	0.010	CU	0.210	V	0.015
AL	0.025	Nb	0.002						
CE(LONG FORMULA) = 0.377									
T/S(PSI) 73679 Y/S(PSI) 46702 EL(%) 31.300 RA(%) 75.100									
BRINELL HARDNESS 158, 156									
CHARPY -50 F 106/120/146(FT-LBS) AVG. 124.000(FT-LBS)									

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2. TRIM COMPONENTS AND BOLTING ARE IN ACCORDANCE WITH PURCHASE ORDER REQUIREMENTS AND MATERIAL SPECIFICATIONS.

3. CERTIFYING TO ASTM A350 LF2 14 EDITION.
4. THE SUPPLIED MATERIAL WAS QUENCH AND TEMPERED IN ACCORDANCE WITH ASTM A350 HEAT TREATING REQUIREMENTS.
5. THE PRODUCT SUPPLIED WAS INSPECTED IN ACCORDANCE WITH EN 10204:2004 EDITION TYPE 3.1 INSPECTION DOCUMENT. (EUROPEAN STANDARD)

THIS DOCUMENT HAS BEEN ELECTRONICALLY SUBMITTED.





MILL TEST REPORTS

Bonney Forge
 14496 Croghan Pike
 Mt. Union, PA 17066

CERTIFIED MILL TEST REPORT

AIV Canada 3/9/2015

LOT NO.
 UL8 Body

CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS
 1/2" HL-1L3S-T NACE A350-LF2-CL1

C	0.185	MN	0.900	P	0.014	S	0.009	SI	0.250
NI	0.050	CR	0.090	MO	0.010	CU	0.140	V	0.017
AL	0.027	Nb	0.003						
CE(LONG FORMULA) = 0.371									
T/S(PSI) 74839 Y/S(PSI) 53519 EL(%) 31.200 RA(%) 68.600									
BRINELL HARDNESS 145, 148									
CHARPY -50 F 30/49/38(FT-LBS) AVG. 39.000(FT-LBS)									

UP5 Bonnet

1/2" HL-1L3S-T NACE A350-LF2-CL1

C	0.185	MN	0.850	P	0.010	S	0.009	SI	0.180
NI	0.080	CR	0.130	MO	0.010	CU	0.210	V	0.015
AL	0.025	Nb	0.002						
CE(LONG FORMULA) = 0.377									
T/S(PSI) 73679 Y/S(PSI) 46702 EL(%) 31.300 RA(%) 75.100									
BRINELL HARDNESS 158, 156									
CHARPY -50 F 106/120/146(FT-LBS) AVG. 124.000(FT-LBS)									

1. TESTING AND ACCEPTANCE CRITERIA FOR THESE VALVES ARE IN ACCORDANCE WITH THE REQUIREMENTS OF API 598 (NINTH EDITION, SEPTEMBER 2009).
2. TRIM COMPONENTS AND BOLTING ARE IN ACCORDANCE WITH PURCHASE ORDER REQUIREMENTS AND MATERIAL SPECIFICATIONS.

3. CERTIFYING TO ASTM A350 LF2 14 EDITION.
4. THE SUPPLIED MATERIAL WAS QUENCH AND TEMPERED IN ACCORDANCE WITH ASTM A350 HEAT TREATING REQUIREMENTS.
5. THE PRODUCT SUPPLIED WAS INSPECTED IN ACCORDANCE WITH EN 10204:2004 EDITION TYPE 3.1 INSPECTION DOCUMENT. (EUROPEAN STANDARD)

THIS DOCUMENT HAS BEEN ELECTRONICALLY SUBMITTED.

Cancel	Logout
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MILL TEST REPORTS

Bonney Forge
 14496 Croghan Pike
 Mt. Union, PA 17066

CERTIFIED MILL TEST REPORT

AIV Canada 3/9/2015

LOT NO.
 UL8 Body

CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS
 3/4" HL-1L3S-T NACE A350-LF2-CL1

C	0.185	MN	0.900	P	0.014	S	0.009	SI	0.250
NI	0.050	CR	0.090	MO	0.010	CU	0.140	V	0.017
AL	0.027	Nb	0.003						
CE(LONG FORMULA) = 0.371									
T/S(PSI) 74839 Y/S(PSI) 53519 EL(%) 31.200 RA(%) 68.600									
BRINELL HARDNESS 145, 148									
CHARPY -50 F 30/49/38(FT-LBS) AVG. 39.000(FT-LBS)									

UP5 Bonnet

3/4" HL-1L3S-T NACE A350-LF2-CL1

C	0.185	MN	0.850	P	0.010	S	0.009	SI	0.180
NI	0.080	CR	0.130	MO	0.010	CU	0.210	V	0.015
AL	0.025	Nb	0.002						
CE(LONG FORMULA) = 0.377									
T/S(PSI) 73679 Y/S(PSI) 46702 EL(%) 31.300 RA(%) 75.100									
BRINELL HARDNESS 158, 156									
CHARPY -50 F 106/120/146(FT-LBS) AVG. 124.000(FT-LBS)									

1. TESTING AND ACCEPTANCE CRITERIA FOR THESE VALVES ARE IN ACCORDANCE WITH THE REQUIREMENTS OF API 598 (NINTH EDITION, SEPTEMBER 2009).
2. TRIM COMPONENTS AND BOLTING ARE IN ACCORDANCE WITH PURCHASE ORDER REQUIREMENTS AND MATERIAL SPECIFICATIONS.

3. CERTIFYING TO ASTM A350 LF2 14 EDITION.
4. THE SUPPLIED MATERIAL WAS QUENCH AND TEMPERED IN ACCORDANCE WITH ASTM A350 HEAT TREATING REQUIREMENTS.
5. THE PRODUCT SUPPLIED WAS INSPECTED IN ACCORDANCE WITH EN 10204:2004 EDITION TYPE 3.1 INSPECTION DOCUMENT. (EUROPEAN STANDARD)

THIS DOCUMENT HAS BEEN ELECTRONICALLY SUBMITTED.

Cancel	Logout
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MILL TEST REPORTS

Bonney Forge
 14496 Croghan Pike
 Mt. Union, PA 17066

CERTIFIED MILL TEST REPORT

AIV Canada 3/9/2015

LOT NO.
 UP9 Closure 1

CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS
 1/2" HN-703-T A350-LF2-CL1

C	0.180	MN	0.850	P	0.009	S	0.010	SI	0.230
NI	0.050	CR	0.070	MO	0.010	CU	0.130	V	0.017
AL	0.025	Nb	0.002						
CE(LONG FORMULA) = 0.353									
T/S(PSI) 77450 Y/S(PSI) 58015 EL(%) 35.700 RA(%) 77.600									
BRINELL HARDNESS 161									
CHARPY -50 F 64/114/121(FT-LBS) AVG. 99.667(FT-LBS)									

[Click here for Original Steel Mill Certification](#)

UP9 Closure 2

1/2" HN-703-T A350-LF2-CL1

C	0.180	MN	0.850	P	0.009	S	0.010	SI	0.230
NI	0.050	CR	0.070	MO	0.010	CU	0.130	V	0.017
AL	0.025	Nb	0.002						
CE(LONG FORMULA) = 0.353									
T/S(PSI) 77450 Y/S(PSI) 58015 EL(%) 35.700 RA(%) 77.600									
BRINELL HARDNESS 161									
CHARPY -50 F 64/114/121(FT-LBS) AVG. 99.667(FT-LBS)									

[Click here for Original Steel Mill Certification](#)

UP9 Body

1/2" HN-703-T A350-LF2-CL1

C	0.180	MN	0.850	P	0.009	S	0.010	SI	0.230
NI	0.050	CR	0.070	MO	0.010	CU	0.130	V	0.017
AL	0.025	Nb	0.002						

CE(LONG FORMULA) = 0.353
T/S(PSI) 77450 Y/S(PSI) 58015 EL(%) 35.700 RA(%) 77.600
BRINELL HARDNESS 161
CHARPY -50 F 64/114/121(FT-LBS) AVG. 99.667(FT-LBS)

[Click here for Original Steel Mill Certification](#)

1. THE MATERIAL SUPPLIED WAS INSPECTED AND MANUFACTURED IN ACCORDANCE WITH EN DIN 10204:2004 EDITION TYPE 3.1 INSPECTION DOCUMENT.
2. THE BALL VALVES ARE DESIGNED IN ACCORDANCE TO ASME B16.34 AND API 608 REQUIREMENTS.
3. THE BALL VALVES MEET THE FIRESAFE REQUIREMENTS OF API 607 AND API SPEC 6FA.
4. THE BALL VALVES SUPPLIED IDENTIFIED AS NACE ON THE NAMEPLATE, MEETS THE REQUIREMENTS OF NACE MR0103-2007.
5. THE PRODUCT SUPPLIED WAS INSPECTED IN ACCORDANCE WITH EN 10204:2004 EDITION TYPE 3.1 INSPECTION DOCUMENT. (EUROPEAN STANDARD)
6. TESTING AND ACCEPTANCE CRITERIA FOR THESE VALVES ARE IN ACCORDANCE WITH THE REQUIREMENTS OF API-598 (NINTH EDITION, SEPTEMBER 2009).
7. TRIM COMPONENTS AND BOLTING ARE IN ACCORDANCE WITH THE PURCHASE ORDER REQUIREMENTS AND MATERIAL SPECIFICATIONS.
8. THE SUPPLIED MATERIAL WAS QUENCH AND TEMPERED IN ACCORDANCE WITH ASTM A350 HEAT TREATING REQUIREMENTS.

THIS DOCUMENT HAS BEEN ELECTRONICALLY SUBMITTED.

Cancel	Logout
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MILL TEST REPORTS

Bonney Forge
14496 Croghan Pike
Mt. Union, PA 17066

CERTIFIED MILL TEST REPORT

AIV Canada 3/9/2015

LOT NO.
UP9 Closure 1

CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS

1" HN-705-T A350-LF2-CL1

C	0.180	MN	0.850	P	0.009	S	0.010	SI	0.230
NI	0.050	CR	0.070	MO	0.010	CU	0.130	V	0.017
AL	0.025	Nb	0.002						
CE(LONG FORMULA) = 0.353									
T/S(PSI) 77450 Y/S(PSI) 58015 EL(%) 35.700 RA(%) 77.600									
BRINELL HARDNESS 161									
CHARPY -50 F 64/114/121(FT-LBS) AVG. 99.667(FT-LBS)									

[Click here for Original Steel Mill Certification](#)

UP9 Closure 2

1" HN-705-T A350-LF2-CL1

C	0.180	MN	0.850	P	0.009	S	0.010	SI	0.230
NI	0.050	CR	0.070	MO	0.010	CU	0.130	V	0.017
AL	0.025	Nb	0.002						
CE(LONG FORMULA) = 0.353									
T/S(PSI) 77450 Y/S(PSI) 58015 EL(%) 35.700 RA(%) 77.600									
BRINELL HARDNESS 161									
CHARPY -50 F 64/114/121(FT-LBS) AVG. 99.667(FT-LBS)									

[Click here for Original Steel Mill Certification](#)

UP9 Body

1" HN-705-T A350-LF2-CL1

C	0.180	MN	0.850	P	0.009	S	0.010	SI	0.230
NI	0.050	CR	0.070	MO	0.010	CU	0.130	V	0.017
AL	0.025	Nb	0.002						

CE(LONG FORMULA) = 0.353
T/S(PSI) 77450 Y/S(PSI) 58015 EL(%) 35.700 RA(%) 77.600
BRINELL HARDNESS 161
CHARPY -50 F 64/114/121(FT-LBS) AVG. 99.667(FT-LBS)

[Click here for Original Steel Mill Certification](#)

1. THE MATERIAL SUPPLIED WAS INSPECTED AND MANUFACTURED IN ACCORDANCE WITH EN DIN 10204:2004 EDITION TYPE 3.1 INSPECTION DOCUMENT.
2. THE BALL VALVES ARE DESIGNED IN ACCORDANCE TO ASME B16.34 AND API 608 REQUIREMENTS.
3. THE BALL VALVES MEET THE FIRESAFE REQUIREMENTS OF API 607 AND API SPEC 6FA.
4. THE BALL VALVES SUPPLIED IDENTIFIED AS NACE ON THE NAMEPLATE, MEETS THE REQUIREMENTS OF NACE MR0103-2007.
5. THE PRODUCT SUPPLIED WAS INSPECTED IN ACCORDANCE WITH EN 10204:2004 EDITION TYPE 3.1 INSPECTION DOCUMENT. (EUROPEAN STANDARD)
6. TESTING AND ACCEPTANCE CRITERIA FOR THESE VALVES ARE IN ACCORDANCE WITH THE REQUIREMENTS OF API-598 (NINTH EDITION, SEPTEMBER 2009).
7. TRIM COMPONENTS AND BOLTING ARE IN ACCORDANCE WITH THE PURCHASE ORDER REQUIREMENTS AND MATERIAL SPECIFICATIONS.
8. THE SUPPLIED MATERIAL WAS QUENCH AND TEMPERED IN ACCORDANCE WITH ASTM A350 HEAT TREATING REQUIREMENTS.

THIS DOCUMENT HAS BEEN ELECTRONICALLY SUBMITTED.

Cancel

Logout



Welder Qualification

This card is valid only while employed by a CWB certified company

Transferable Welder

Name: **CORY A. SIEGNER** Exp. Date: **Oct 15, 2014**
Employer: **National Process Equipment, Calgary, AB**
Thickness Range: **3mm & above** Material: **Carbon Steel**
Process: **FCAW/MCAW**
Mode: **SEMI-AUTO** Standard: **CSA W47.1**
Single Electrode Mechanized Classification: **S**
Single Electrode Automatic
Class: **FLAT/HORIZONTAL/VERTICAL UP**

See Reverse for Conditions



Welder Qualification

This card is valid only while employed by a CWB certified company.

Transferable Welder

Name: **CORY A. SIEGNER** Exp. Date: **Oct 03, 2014**
Employer: **National Process Equipment, Calgary, AB**
Thickness Range: **3mm & above** Material: **Carbon Steel**
Process: **SMAW**
Mode: **MANUAL** Standard: **CSA W47.1**
Classification: **S**
Electrode: **F4**
Class: **FLAT/HORIZONTAL/VERTICAL UP/OVERHEAD**

See Reverse for Conditions



Welder Qualification

This card is valid only while employed by a CWB certified company

Transferable Welder

Name: **JOEL S. COMEAU** Exp. Date: **Nov 09, 2013**
 Employer: **National Process Equipment, Calgary, AB**
 Thickness Range: **3mm & above** Material: **Carbon Steel**
 Mode of Transfer: **Spray/Globular/Pulsed** Process: **GMAW**
 Mode: **SEMI-AUTO** Standard: **CSA W47.1**
Single Electrode Mechanized Classification: **S**
Single Electrode Automatic
 Class: **FLAT/HORIZONTAL**

See Reverse for Conditions



Welder Qualification

This card is valid only while employed by a CWB certified company

Transferable Welder

Name: **JOEL S. COMEAU** Exp. Date: **Nov 09, 2013**
 Employer: **National Process Equipment, Calgary, AB**
 Thickness Range: **3mm & above** Material: **Carbon Steel**
 Process: **SMAW**
 Mode: **MANUAL** Standard: **CSA W47.1**
 Classification: **S**
 Electrode: **F4**
 Class: **FLAT/HORIZONTAL**

See Reverse for Conditions



Welder Qualification

This card is valid only while employed by a CWB certified company

Transferable Welder

Name: **JOEL S. COMEAU** Exp. Date: **Dec 11, 2013**
 Employer: **National Process Equipment, Calgary, AB**
 Thickness Range: **3mm & above** Material: **Carbon Steel**
 Process: **FCAW/MCAW**
 Mode: **SEMI-AUTO** Standard: **CSA W47.1**
Single Electrode Mechanized Classification: **S**
Single Electrode Automatic
 Class: **FLAT/HORIZONTAL**

See Reverse for Conditions



Welder Qualification

This card is valid only while employed by a CWB certified company

Transferable Welder

Name:	JOEL S. COMEAU	Exp. Date:	Dec 11, 2015
Employer:	National Process Equipment, Calgary, AB		
Thickness Range:	3mm & above	Material:	Carbon Steel
		Process:	FCAW/MCAW
Mode:	SEMI-AUTO	Standard:	CSA W47.1
	Single Electrode Mechanized	Classification:	S
	Single Electrode Automatic		
Class:	FLAT/HORIZONTAL		

See Reverse for Conditions



Welder Qualification

This card is valid only while employed by a CWB certified company

Transferable Welder

Name: JOEL S. COMEAU	Exp. Date: Nov 09, 2015
Employer: National Process Equipment, Calgary, AB	
Thickness Range: 3mm & above	Material: Carbon Steel
Mode of Transfer: Spray/Globular/Pulsed	Process: GMAW
Mode: SEMI-AUTO	Standard: CSA W47.1
Single Electrode Mechanized	Classification: S
Single Electrode Automatic	
Class: FLAT/HORIZONTAL	

See Reverse for Conditions

012/904883

96346A



JOURNEYMAN CERTIFICATE

THIS IS TO CERTIFY THAT
JOEL SCOTT COMEAU
HAS COMPLETED AN ALBERTA APPRENTICESHIP PROGRAM AND HAVING ACHIEVED
THE STANDARDS ESTABLISHED UNDER THE ALBERTA APPRENTICESHIP AND
INDUSTRY TRAINING ACT, IS HEREBY AUTHORIZED TO WORK IN THE TRADE AS A
JOURNEYMAN AND TO USE THE TITLE CERTIFIED JOURNEYMAN

WELDER

EFFECTIVE DATE
November 21st, 2006

ISSUE DATE
December 9th, 2008


HONOURABLE DOUG HORNER
MINISTER OF ADVANCED EDUCATION
AND TECHNOLOGY

Alberta
Government


SHIRLEY DUL, EXECUTIVE
DIRECTOR OF APPRENTICESHIP
& INDUSTRY TRAINING





Welder Qualification

This card is valid only while employed by a CWB certified company

Transferable Welder

Name: **JOEL S. COMEAU** Exp. Date: **Jun 14, 2015**
Employer: **National Process Equipment, Calgary, AB**
Thickness Range: **3mm & above** Material: **Carbon Steel**
Process: **SMAW**
Mode: **MANUAL** Standard: **CSA W47.1**
Classification: **FW**
Electrode: **F4**
Class: **FLAT/HORIZONTAL/VERTICAL UP/OVERHEAD**

See Reverse for Conditions



Welder Qualification

This card is valid only when employed by a CWB certified company

Transferable Welder

Name: **JOEL S. COMEAU**

Exp. Date: **Nov 09, 2015**

Employer: **National Process Equipment, Calgary, AB**

Thickness Range: **3mm & above**

Material: **Carbon Steel**

Mode: **MANUAL**

Process: **SMAW**

Standard: **CSA W47.1**

Classification: **S**

Electrode: **F4**

Class: **FLAT/HORIZONTAL**

See Reverse for Conditions

012-0/885898

129122A



JOURNEYMAN CERTIFICATE

THIS IS TO CERTIFY THAT
MICHAEL JAMES JOSEPH JARVIS
HAS COMPLETED AN ALBERTA APPRENTICESHIP PROGRAM AND HAVING ACHIEVED
THE STANDARDS ESTABLISHED UNDER THE ALBERTA APPRENTICESHIP AND
INDUSTRY TRAINING ACT, IS HEREBY AUTHORIZED TO WORK IN THE TRADE AS A
JOURNEYMAN AND TO USE THE TITLE CERTIFIED JOURNEYMAN

WELDER

EFFECTIVE DATE
February 25th, 2011

ISSUE DATE
April 4th, 2011

[Signature]
HONOURABLE GREG WEADICK
MINISTER OF
ADVANCED EDUCATION
AND TECHNOLOGY

Alberta

[Signature]
CAROLINE EDWARDS
EXECUTIVE DIRECTOR
OF APPRENTICESHIP
& INDUSTRY TRAINING



[Signature]



Welder Qualification

This card is valid only while employed by a CWB certified company

Test Centre Welder Test Record Transferable Welder

Name:	MICHAEL J. JARVIS	Exp. Date:	Feb 12, 2016
Test Facility:	Calgary Welder Test Centre	Material:	Carbon Steel
Thickness Range:	3mm & above	Process:	FCAW/MCAW
Mode:	SEMI-AUTO	Standard:	CSA W47.1
	Single Electrode Mechanized	Classification:	S
	Single Electrode Automatic		
Class:	FLAT		

See Reverse for Conditions



Welder Qualification

This card is valid only while employed by a CWB certified company

Test Centre Welder Test Record Transferable Welder

Name:	MICHAEL J. JARVIS	Exp. Date:	May 17, 2016
Test Facility:	Calgary Welder Test Centre		
Thickness Range:	3mm & above	Material:	Carbon Steel
Mode:	MANUAL	Process:	SMAW
		Standard:	CSA W47.1
		Classification:	S
		Electrode:	F4

Class: FLAT/HORIZONTAL/VERTICAL UP/OVERHEAD

See Reverse for Conditions



Welder Qualification

This card is valid only while employed by a CWB certified company

Test Centre Welder Test Record

Transferable Welder

Name:	MIKE JARVIS	Exp. Date:	May 17, 2014
Test Facility:	SAIT Polytechnic, Manufacturing & Automation		
Thickness Range:	3mm & above	Material:	Carbon Steel
Mode:	MANUAL	Process:	SMAW
		Standard:	CSA W47.1
		Classification:	S
		Electrode:	F4
Class:	FLAT/HORIZONTAL/VERTICAL UP/OVERHEAD		

See Reverse for Conditions



Welder Qualification

This card is valid only while employed by a CWB certified company

Transferable Welder

Name	RONALD J. STOROSCHUK	Exp. Date:	Nov 05, 2015
Employer:	National Process Equipment, Calgary, AB	Material:	Carbon Steel
Thickness Range:	3mm & above	Process:	FCAW/MCAW
Mode:	SEMI-AUTO	Standard:	CSA W47.1
	Single Electrode Mechanized	Classification:	S
	Single Electrode Automatic		
Class:	FLAT/HORIZONTAL		

See Reverse for Conditions



Welder Qualification

This card is valid only while employed by a CWB certified company

Transferable Welder

Name: **RONALD J. STOROSCHUK** Exp. Date: **Nov 16, 2014**
Employer: **National Process Equipment, Calgary, AB**
Thickness Range: **3mm & above** Material: **Carbon Steel**
Mode of Transfer: **Spray/Globular/Pulsed** Process: **GMAW**
Mode: **SEMI-AUTO** Standard: **CSA W47.1**
Single Electrode Mechanized Classification: **S**
Single Electrode Automatic
Class: **FLAT/HORIZONTAL**

See Reverse for Conditions

012/685195

81984A

JOURNEYMAN CERTIFICATE

THIS IS TO CERTIFY THAT
RONALD JOHN STOROSCHUK
HAS COMPLETED AN ALBERTA APPRENTICESHIP PROGRAM AND HAVING ACHIEVED
THE STANDARDS ESTABLISHED UNDER THE ALBERTA APPRENTICESHIP AND
INDUSTRY TRAINING ACT, IS HEREBY AUTHORIZED TO WORK IN THE TRADE AS A
JOURNEYMAN AND TO USE THE TITLE CERTIFIED JOURNEYMAN

WELDER

EFFECTIVE DATE
March 29th, 2007

ISSUE DATE
May 9th, 2007


HONOURABLE DOUG HORNER
MINISTER OF ADVANCED EDUCATION
AND TECHNOLOGY

Alberta
Government


SHIRLEY DOOL, EXECUTIVE
DIRECTOR OF APPRENTICESHIP
& INDUSTRY TRAINING





**WELDING SUPERVISOR CARD
CARTE DE SUPERVISEUR EN SOUDAGE**

PRESENTED TO / PRÉSENTÉE À

RON STOROSCHUK

Who has completed the welding supervisor examinations as required by
CSA Standard
Qui a complété les examens de superviseur en soudage, tel que requis par
la norme CSA

W47.1

Valid while employed with:
Valable tant qu'employé par:

National Process Equipment

10/17/2008

Issue Date / Date d'émission

Jan
Authorized Signature / Signature autorisée

THIS CARD REMAINS THE PROPERTY OF THE CWB AND CAN BE RECALLED AND/OR CANCELLED AT ANY TIME. FRAUDULENT USE OF THIS CARD COULD RESULT IN LOSS OF QUALIFICATIONS FOR THE WELDING SUPERVISOR. THIS CARD MUST NOT BE REPRODUCED WITHOUT THE WRITTEN CONSENT OF THE CWB.

CETTE CARTE DEMEURE LA PROPRIÉTÉ DU CWB. ELLE PEUT ÊTRE RAPPELÉE ET/OU ANNULÉE EN TOUT TEMPS. L'USAGE FRAUDULEUX DE CETTE CARTE PEUT MENER À LA PERTE DES QUALIFICATIONS DU SUPERVISEUR EN SOUDAGE. CETTE CARTE NE DOIT PAS ÊTRE REPRODUITE SANS L'AUTORISATION ÉCRITE DU CWB.

CWB

7250 West Credit Avenue, Mississauga, ON L5N 5N1
www.cwbgroup.com

Tel: 1-800-844-6790
Fax: (905) 542-1318
CWB Form 110EF/2002-1

Alberta

Municipal Affairs
2337rd Housing

the pressure equipment safety authority



Grande "A" Pressure Vessel's

Certificate of Competency


Ronald Stroschuk

This is to certify that **Ronald Stroschuk** having complied with provisions of the Safety Codes Act, is authorized to engage in pressure welding in accordance with the prescribed Regulations.

Dated at Edmonton
November 21, 2009

W-27929

File no.


Chief Inspector and Administrator





Welder Qualification

This card is valid only while employed by a CWB certified company

Transferable Welder

Name: RONALD J. STOROSCHUK	Exp. Date: Jul 09, 2015
Employer: National Process Equipment, Calgary, AB	
Thickness Range: 3mm & above	Material: Carbon Steel
Mode: MANUAL	Process: SMAW
	Standard: CSA W47.1
	Classification: FW
	Electrode: F4
Class: FLAT/HORIZONTAL/VERTICAL UP/OVERHEAD	

See Reverse for Conditions



Welder Qualification

This card is valid only while employed by a CWB certified company

Transferable Welder

Name: **RONALD J. STOROSCHUK** Exp. Date: **Jul 09, 2015**
Employer: **National Process Equipment, Calgary, AB**
Thickness Range: **3mm & above** Material: **Carbon Steel**
Process: **SMAW**
Mode: **MANUAL** Standard: **CSA W47.1**
Classification: **FW**
Electrode: **F4**

Class: **FLAT/HORIZONTAL/VERTICAL UP/OVERHEAD**

See Reverse for Conditions



Welder Qualification

This card is valid only while employed by a CWB certified company

Transferable Welder

Name: **RONALD J. STOROSCHUK**

Exp. Date: **Nov 08, 2015**

Employer: **National Process Equipment, Calgary, AB**

Thickness Range: **3mm & above**

Material: **Carbon Steel**

Mode: **MANUAL**

Process: **SMAW**

Standard: **CSA W47.1**

Classification: **S**

Electrode: **F4**

Class: **FLAT/HORIZONTAL**

See Reverse for Conditions



Natural Resources Canada / Ressources naturelles Canada

This card is proof of the certification of the individual as specified.
 Cette carte est la preuve de la certification de l'individu comme indiqué.



Name/
Nom Derek J. Clayton
 Reg. No./
No. matricule 13230
 Issue Date/
Date d'émission 2007/01/16
 Expiry Date/
Expiration 2013/12/31
 Signature

Derek Clayton

Derek James Clayton
13230

Registration Number
Numéro de matricule

is certified by the Canadian
Nuclear Safety Commission
as an Exposure Device
Operator.

est accrédité par la Commission
canadienne de sûreté nucléaire
à titre d'opérateur d'appareil
d'exposition.

2013/02/01
Issue Date
Date d'émission

2015/06/01
Expiry Date
Date d'expiration

[Signature]
Designated Officer
Fonctionnaire désigné



Commission canadienne
de sûreté nucléaire





Natural Resources
Canada

Ressources naturelles
Canada



Name/
Nom **Derek J. Clayton**
Reg. No. /
No. matricule **13230**
Issue Date/
Date d'émission **2015/01/08**

This card does not identify the stated individual to be an employee or representative of Natural Resources Canada, Government of Canada.
Cette carte n'identifie pas l'individu d'être un employé ou un représentant de Ressources naturelles Canada, Gouvernement du Canada

Corrective lenses for [] near [] far vision.
Verres correctifs pour la vision de [] près [] distance.

Signature [] 



Natural Resources
Canada

Ressources naturelles
Canada

Certified to / Certifié selon : CAN / CGSB-48.9712

13230

Method Méthode	Level Niveau	Sector Secteur	Cert. Date Date cert.	Date recert. Date recert.	Expires Expiration
PT	2	EMC	2013/07/22		2017/12/31

For verification of certification status, policies and definitions, visit website:
<http://ndt.nrcan.gc.ca/> Pour la vérification de la certification, les politiques, et les définitions,
visitez le site web: <http://ndt.nrcan.gc.ca/>

Manager, Certifying Agency
Gestionnaire, Organisme de certification

NAME: DEREK CLAYTON

NEAR VISION:

uncorrected RE J1 LE J1

corrected RE _____ LE _____

COLOUR VISION: 14/14 Pass

DATE: SEPT 30 / 14

SHADES OF GREY: 17/17 Pass

DATE: SEPT 30 / 14

EXAMINER: ADAM LONS
Print

[Signature]
Signature

REQUIREMENTS:

- 1) NEAR-VISION - The examination shall assure natural or corrected near-distance acuity in at least one eye such that the applicant is capable of reading a minimum of Jaeger Number 2 or equivalent type and size letter at a distance of not less than 30 cm (12 inches) on a standard Jaeger test chart. The ability to perceive an Ortho-Rater minimum of 10 or similar test patterns is also acceptable. This test shall be administered annually.
- 2) COLOUR-VISION - The examination, by use of Ishihara plates, or other similar method, shall demonstrate the capability of distinguishing contrast among colours used in non-destructive examination. All 14 Ishihara plates shall be used in the assessment and the individual must correctly identify 13 out of 14 plates. Successful completion of a practical test in the applicable method shall be accepted as demonstrating acceptable colour contrast differentiation. This test shall be administered annually.
- 3) SHADES OF GREY - An examination, by use of a calibrated step tablet or other similar method, shall demonstrate the capability of distinguishing contrast among shades of grey used in non-destructive examination. The individual must correctly identify all the steps presented. Successful completion of a practical test in the applicable method shall be accepted as demonstrating acceptable differentiation in shades of grey. This test shall be administered upon initial certification and at no greater interval than three-years thereafter.

This certifies that Derek Clayton has successfully completed the training and examination requirements of IRISNDT Personnel Certification Program for Materials Testing and is certified in the following methods:

METHOD /LEVEL	CERTIFICATION	CERTIFIED BY		CERTIFICATION DATES		
	ORIGINAL GRADE	NAME	SIGNATURE	ORIGINAL	CURRENT	DUE
FT	87%	Gordon Robertson		Dec. 10	Jan. 11	Dec. 15
HT II	99%	Gordon Robertson		Mar. 09	Jan. 11	Dec. 15
NACE	98%	Gordon Robertson		Mar. 09	Jan. 11	Dec. 15
XRF	99%	Gordon Robertson		Mar. 09	Jan. 11	Dec. 15

Initial Certification(s) carried out by examination.

Re-certification(s) carried out by examination in accordance with IRISNDT Personnel Certification Manual (Work Practice).

LEGEND:

Certification Dates:

Original: Date of original certification with IRISNDT

Current: Date of most recent certification

Due: Due date for re-certification

Certification Methods:

XRF: X-Ray Fluorescence Analysis

HT: Hardness Testing (HT I, HT II)

NACE: Nace MR 0175 Compliance Testing

FT: Ferrite Testing

SP: Spectroscopy

Certification is valid only with a physical eye examination in accordance with the requirements of the IRISNDT Personnel Certification Manual (Work Practice).



EMPLOYEE: **Derek Clayton**

SNT / ASNT CERTIFICATIONS		QUALIFICATION GRADES		CERTIFICATION DATES		
Method & Level	Certified By	Initial	Recert	Initial	Current	Due
PT Level II	IRISNDT	93%	NA	Aug 2013	Aug 2013	Dec 2015

OTHER CERTIFICATIONS		QUALIFICATION GRADES		CERTIFICATION DATES		
PT Level II	CGSB	Pass	NA	Jul 2013	Jan 2015	Dec 2017

EMPLOYMENT EXPERIENCE:

From	To	Employer	Methods	Months
2006	Present	IRISNDT	RT, PT, MT	108

EDUCATION: High School Successful Completion Minimum 2 years-Engineering/Science at University, College or Technical School

Date	Institution	Length	Subject/Courses
2009	SAIT	40 hours	Liquid Penetrant Inspection

EYE EXAMINATIONS:

This certifies that the employee has met the training and examination requirements of IRISNDT Qualification and Certification Manual (Work Practice) in accordance with SNT-TC-1A (2006 and 2011 Editions).

CERTIFICATION:

Initial Certification and Re-certification carried out in accordance with IRISNDT Personnel Qualification and Certification Manual (Work Practice).

This certifies that the employee has met the training and examination requirements of IRISNDT Qualification and Certification Manual (Work Practice) in accordance with SNT-TC-1A (2006 and 2011 Editions).

Name: Wesley H. Weber	Signed: 	Date: January, 2015
Title: NDE Certifying Level 3		

RESTRICTIONS, NOTES and COMMENTS:

Kevin R. Ellis
5359

Registration Number
Numéro de matricule



is certified by the Canadian
Nuclear Safety Commission
as an Exposure Device
Operator.

est accrédité par la Commission
canadienne de sûreté nucléaire
à titre d'opérateur d'appareil
d'exposition.

2013/02/01
Issue Date
Date d'émission

2019/07/01
Expiry Date
Date d'expiration

Cam D.
Designated Officer
Fonctionnaire désigné



Canadian Nuclear
Safety Commission

Commission canadienne
de sûreté nucléaire

Canada



Natural Resources
Canada

Ressources naturelles
Canada



Name/
Nom **Kevin R. Ellis**
Reg. No./
No. matricule **5359**
Issue Date/
Date d'émission **2015/01/07**

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Cette carte n'identifie pas l'individu d'être un employé ou un représentant de Ressources naturelles Canada, Gouvernement du Canada

Corrective lenses for [X] near [X] far vision.
Verres correctifs pour la vision de [X] pres [X] distance.

Signature |



Natural Resources
Canada

Ressources naturelles
Canada

Certified to / Certifié selon : CAN / CGSB-48.97.12

5359

Method Méthode	Level Niveau	Sector Secteur	Cert. Date Date cert.	Date recert. Date recert.	Expires Expiration
RT	2	EMC	1995/12/29		2017/12/31

For verification of certification status, policies and definitions, visit website:
<http://ndt.nrcan.gc.ca/> Pour la vérification de la certification, les politiques, et les définitions,
visitez le site web: <http://ndt.nrcan.gc.ca/>

Manager, Certifying Agency
Gestionnaire, Organisme de certification

NAME: KEVIN ELLIS

NEAR VISION:

uncorrected RE _____ LE _____

corrected RE J1 LE J1

COLOUR VISION: 14/14 Pass DATE: 09/1/14

SHADES OF GREY: 17/17 Pass DATE: 09/1/14

EXAMINER: ADAM LOND [Signature]
Print Signature

REQUIREMENTS:

- 1) NEAR-VISION - The examination shall assure natural or corrected near-distance acuity in at least one eye such that the applicant is capable of reading a minimum of Jaeger Number 2 or equivalent type and size letter at a distance of not less than 30 cm (12 inches) on a standard Jaeger test chart. The ability to perceive an Ortho-Rater minimum of 10 or similar test patterns is also acceptable. This test shall be administered annually.
- 2) COLOUR-VISION - The examination, by use of Ishihara plates, or other similar method, shall demonstrate the capability of distinguishing contrast among colours used in non-destructive examination. All 14 Ishihara plates shall be used in the assessment and the individual must correctly identify 13 out of 14 plates. Successful completion of a practical test in the applicable method shall be accepted as demonstrating acceptable colour contrast differentiation. This test shall be administered annually.
- 3) SHADES OF GREY - An examination, by use of a calibrated step tablet or other similar method, shall demonstrate the capability of distinguishing contrast among shades of grey used in non-destructive examination. The individual must correctly identify all the steps presented. Successful completion of a practical test in the applicable method shall be accepted as demonstrating acceptable differentiation in shades of grey. This test shall be administered upon initial certification and at no greater interval than three-years thereafter.

This certifies that Kevin Ellis has successfully completed the training and examination requirements of IRISNDT Personnel Certification Program for Materials Testing and is certified in the following methods:

METHOD /LEVEL	CERTIFICATION	CERTIFIED BY		CERTIFICATION DATES		
	ORIGINAL GRADE	NAME	SIGNATURE	ORIGINAL	CURRENT	DUE
FT	95%	Gordon Robertson		Oct. 12	Oct. 12	Dec. 15
HT II	95%	Gordon Robertson		Mar. 00	Jan. 11	Dec. 15
NACE	90%	Gordon Robertson		Mar. 06	Jan. 11	Dec. 15
XRF	85%	Gordon Robertson		Mar. 00	Jan. 11	Dec. 15

Initial Certification(s) carried out by examination.

Re-certification(s) carried out by examination in accordance with IRISNDT Personnel Certification Manual (Work Practice).

LEGEND:

Certification Dates:

Original: Date of original certification with IRISNDT

Current: Date of most recent certification

Due: Due date for re-certification

Certification Methods:

XRF: X-Ray Fluorescence Analysis

HT: Hardness Testing (HT I, HT II)

NACE: Nace MR 0175 Compliance Testing

FT: Ferrite Testing

SP: Spectroscopy

Certification is valid only with a physical eye examination in accordance with the requirements of the IRISNDT Personnel Certification Manual (Work Practice).



EMPLOYEE: Kevin Ellis

SNT / ASNT CERTIFICATIONS		QUALIFICATION GRADES		CERTIFICATION DATES		
Method & Level	Certified By	Initial	Recert	Initial	Current	Due
RT Level II	IRISNDT	90%	85%	Feb 1995	Jan 2011	Dec 2015
Computed Radiography (CR)	IRISNDT	98%	NA	Jul 2011	Jul 2011	Dec 2015
PT Level II	IRISNDT	89%	90%	Apr 1999	Jan 2011	Dec 2015
MT Level II	IRISNDT	89%	90%	Dec 1999	Jan 2011	Dec 2015

OTHER CERTIFICATIONS		QUALIFICATION GRADES		CERTIFICATION DATES		
RT Level II	CGSB	Pass	NA	Dec 1995	Jan 2015	Dec 2017

EMPLOYMENT EXPERIENCE:

From	To	Employer	Methods	Months
1991	Present	IRISNDT	RT, CR, PT, MT	288

EDUCATION: High School Successful Completion Minimum 2 years-Engineering/Science at University, College or Technical School

Date	Institution	Length	Subject/Courses
1994	SAIT	80 hours	Radiography Level II

EYE EXAMINATIONS:

This certifies that the employee has met the training and examination requirements of IRISNDT Qualification and Certification Manual (Work Practice) in accordance with SNT-TC-1A (2006 and 2011 Editions).

CERTIFICATION:

Initial Certification and Re-certification carried out in accordance with IRISNDT Personnel Qualification and Certification Manual (Work Practice).

This certifies that the employee has met the training and examination requirements of IRISNDT Qualification and Certification Manual (Work Practice) in accordance with SNT-TC-1A (2006 and 2011 Editions).

Name: Wesley H. Weber Title: NDE Certifying Level 3 Signed:  Date: January, 2015

RESTRICTIONS, NOTES and COMMENTS:



Natural Resources
Canada

Ressources naturelles
Canada



Name/
Nom **Siamak Majdnia**
Reg. No. /
No. matricule **18202**
Issue Date/
Date d'émission **2013/10/16**

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Corrective lenses for [X] near [X] far vision.
Verres correctifs pour la vision de [X] près [X] distance.

Signature ↓



Natural Resources
Canada

Ressources naturelles
Canada

Certified to / Certifié selon : CAN / CGSB-48.9712

18202

Method Méthode	Level Niveau	Sector Secteur	Cert. Date Date cert.	Date recert. Date recert.	Expires Expiration
MT	2	EMC	2013/10/15		2015/12/31

For verification of certification status, policies and definitions, visit website:
<http://ndt.nrcan.gc.ca/> Pour la vérification de la certification, les politiques, et les définitions,
visitez le site web: <http://ndt.nrcan.gc.ca/>

Manager, Certifying Agency
Gestionnaire, Organisme de certification

NAME: SIAMAIL MAJONIA

NEAR VISION:

uncorrected RE J1 LE J1

corrected RE _____ LE _____

COLOUR VISION: 14/14 Pass DATE: OCT 9/14

SHADES OF GREY: 17/17 Pass DATE: OCT 9/14

EXAMINER: KEVIN ELLIS [Signature]
Print Signature

REQUIREMENTS:

- 1) NEAR-VISION - The examination shall assure natural or corrected near-distance acuity in at least one eye such that the applicant is capable of reading a minimum of Jaeger Number 2 or equivalent type and size letter at a distance of not less than 30 cm (12 inches) on a standard Jaeger test chart. The ability to perceive an Ortho-Rater minimum of 10 or similar test patterns is also acceptable. This test shall be administered annually.
- 2) COLOUR-VISION - The examination, by use of Ishihara plates, or other similar method, shall demonstrate the capability of distinguishing contrast among colours used in non-destructive examination. All 14 Ishihara plates shall be used in the assessment and the individual must correctly identify 13 out of 14 plates. Successful completion of a practical test in the applicable method shall be accepted as demonstrating acceptable colour contrast differentiation. This test shall be administered annually.
- 3) SHADES OF GREY - An examination, by use of a calibrated step tablet or other similar method, shall demonstrate the capability of distinguishing contrast among shades of grey used in non-destructive examination. The individual must correctly identify all the steps presented. Successful completion of a practical test in the applicable method shall be accepted as demonstrating acceptable differentiation in shades of grey. This test shall be administered upon initial certification and at no greater interval than three-years thereafter.



EMPLOYEE: Siamak Majdnia

SNT / ASNT CERTIFICATIONS		QUALIFICATION GRADES		CERTIFICATION DATES		
Method & Level	Certified By	Initial	Recert	Initial	Current	Due
MT Level II	IRISNDT	96%	NA	Oct 2013	Oct 2013	Dec 2015

OTHER CERTIFICATIONS		QUALIFICATION GRADES		CERTIFICATION DATES		
MT Level II	CGSB	Pass	NA	Oct 2013	Oct 2013	Dec 2015

EMPLOYMENT EXPERIENCE:

From	To	Employer	Methods	Months
2011	Present	IRISNDT	MT, PT, UT	18

EDUCATION: High School Successful Completion Minimum 2 years-Engineering/Science at University, College or Technical School

Date	Institution	Length	Subject/Courses
2011	CINDE	40 hours	Magnetic Particle Inspection
2011	CINDE	40 hours	Engineering Materials and Processes
2011	CINDE	40 hours	Math for NDT

EYE EXAMINATIONS:

This certifies that the employee has met the training and examination requirements of IRISNDT Qualification and Certification Manual (Work Practice) in accordance with SNT-TC-1A (2006 Edition).

CERTIFICATION:

Initial Certification and Re-certification carried out in accordance with IRISNDT Personnel Qualification and Certification Manual (Work Practice).
This certifies that the employee has met the training and examination requirements of IRISNDT Qualification and Certification Manual (Work Practice) in accordance with SNT-TC-1A (2006 Edition).

Name: Gordon Robertson Title: NDE Certifying Level 3 Signed:  Date: October, 2013

RESTRICTIONS, NOTES and COMMENTS:



The American Society for Nondestructive Testing, Inc.

Be it known that

Ohsueng Ryu

has met the established and published Requirements for Certification by ASNT as

NDT Level III

in the following Nondestructive Testing Methods:

<u>Method</u>	<u>Issue Date</u>	<u>Expiration Date</u>
Ultrasonic Testing	2/14	2/19



225365

Certificate Number

ASNT President

Certification Management Council Chair

This certificate is the property of ASNT, is not official without ASNT's raised gold seal and is subject to revocation prior to the listed expiration date.
This certificate should be verified on the ASNT website or by contacting the ASNT Technical Services Department.



Natural Resources
Canada

Ressources naturelles
Canada



Name/ **Ohsueng Ryu**
Nom
Reg. No. / **18415**
No. matricule
Issue Date/ **2014/10/30**
Date d'émission

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Cette carte n'identifie pas l'individu d'être un employé ou un représentant de Ressources naturelles Canada, Gouvernement du Canada

Corrective lenses for near far vision.
Verres correctifs pour la vision de près distance.

Signature |  Canada





Natural Resources
Canada

Ressources naturelles
Canada

Certified to / Certifié selon : CAN/CGSB-48.9712

18415

Method Méthode	Level Niveau	Sector Secteur	Cert. Date Date cert.	Date recert. Date recert.	Expires Expiration
MT	2	EMC	2014/09/08		2016/12/31
PT	2	EMC	2014/10/30		2016/12/31

For verification of certification status, policies and definitions, visit website:
<http://nrl.nrcan.gc.ca/> Pour la vérification de la certification, les politiques, et les définitions,
visitez le site web: <http://nrl.nrcan.gc.ca/>

Manager, Certifying Agency
Gestionnaire, Organisme de certification

Handwritten signature

NAME: OHSUENG RYU

NEAR VISION:

uncorrected RE J1 LE J1

corrected RE _____ LE _____

COLOUR VISION: 14/14 Pass DATE: APR 15

SHADES OF GREY: 17/17 Pass DATE: APR 15

EXAMINER: Adan Lomas [Signature]
Print Signature

REQUIREMENTS:

- 1) NEAR-VISION - The examination shall assure natural or corrected near-distance acuity in at least one eye such that the applicant is capable of reading a minimum of Jaeger Number 2 or equivalent type and size letter at a distance of not less than 30 cm (12 inches) on a standard Jaeger test chart. The ability to perceive an Ortho-Rater minimum of 10 or similar test patterns is also acceptable. This test shall be administered annually.
- 2) COLOUR-VISION - The examination, by use of Ishihara plates, or other similar method, shall demonstrate the capability of distinguishing contrast among colours used in non-destructive examination. All 14 Ishihara plates shall be used in the assessment and the individual must correctly identify 13 out of 14 plates. Successful completion of a practical test in the applicable method shall be accepted as demonstrating acceptable colour contrast differentiation. This test shall be administered annually.
- 3) SHADES OF GREY - An examination, by use of a calibrated step tablet or other similar method, shall demonstrate the capability of distinguishing contrast among shades of grey used in non-destructive examination. The individual must correctly identify all the steps presented. Successful completion of a practical test in the applicable method shall be accepted as demonstrating acceptable differentiation in shades of grey. This test shall be administered upon initial certification and at no greater interval than three-years thereafter.



SNT-TC-1A CERTIFICATION

EMPLOYEE: Ohsueng Ryu

SNT / ASNT CERTIFICATIONS		QUALIFICATION GRADES		CERTIFICATION DATES		
Method & Level	Certified By	Initial	Recert	Initial	Current	Due
UT Level II	IRISNDT	90%	N/A	Apr 2015	May 2015	Dec 2020
MT Level II	IRISNDT	97%	N/A	Apr 2015	Apr 2015	Dec 2020
PT Level II	IRISNDT	88%	N/A	Apr 2015	Apr 2015	Dec 2020

OTHER CERTIFICATIONS		QUALIFICATION GRADES		CERTIFICATION DATES		
UT Level III	ASNT	Pass	N/A	Feb 2014	Feb 2014	Feb 2019
MT Level II	CGSB	Pass	N/A	Sep 2014	Sep 2014	Dec 2016
PT Level II	CGSB	Pass	N/A	Oct 2014	Oct 2014	Dec 2016

EMPLOYMENT EXPERIENCE:

From	To	Employer	Methods	Months
2015	Present	IRISNDT	UT, MT, PT	1

EDUCATION: High School Successful Completion Minimum 2 years-Engineering/Science at University, College or Technical School

Date	Institution	Length	Subject/Courses

EYE EXAMINATIONS:

This certifies that the employee has met the training and examination requirements of IRISNDT Qualification and Certification Manual (Work Practice) in accordance with SNT-TC-1A (2006 and 2011 Editions).

CERTIFICATION:

Initial Certification and Re-certification carried out in accordance with IRISNDT Personnel Qualification and Certification Manual (Work Practice).

This certifies that the employee has met the training and examination requirements of IRISNDT Qualification and Certification Manual (Work Practice) in accordance with SNT-TC-1A (2006 and 2011 Editions).

Name: Wesley Weber	Signed: 	Date: May, 2015
Title: NDE Certifying Level 3		

RESTRICTIONS, NOTES and COMMENTS:



Natural Resources
Canada

Ressources naturelles
Canada

Registered to / Certifié selon : CAN / CGSB-48.9712

18415

Code	Level Niveau	Sector Secteur	Cert. Date Date cert.	Date receipt Date receipt	Expires Expiration
IT	2	EMC	2014/09/08		2016/12/31
PT	2	EMC	2014/10/30		2016/12/31
JT	2	EMC	2015/07/27		2016/12/31

For information on certification status, policies and definitions, visit website:
<http://ndt.nrcan.gc.ca/> Pour la vérification de la certification, les politiques, et les définitions,
le site web: <http://ndt.nrcan.gc.ca/>

Manager, Certifying Agency
Gestionnaire, Organisme de certification

Chad Edward Sear

11181

Registration Number
Numéro de matricule



is certified by the Canadian
Nuclear Safety Commission
as an Exposure Device
Operator.

est accrédité par la Commission
canadienne de sûreté nucléaire
à titre d'opérateur d'appareil
d'exposition.

2013/02/01
Issue Date
Date d'émission

2015/11/01
Expiry Date
Date d'expiration

CAM D
Designated Officer
Fonctionnaire désigné



Canadian Nuclear
Safety Commission

Commission canadienne
de sûreté nucléaire

Canada



Natural Resources
Canada

Ressources naturelles
Canada



Name/
Nom **Chad Edward Sear**
Reg. No. /
No. matricule **11181**
Issue Date/
Date d'émission **2014/02/07**

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Cette carte n'identifie pas l'individu d'être un employé ou un représentant de Ressources naturelles Canada, Gouvernement du Canada

Corrective lenses for [] near [] far vision.
Verres correctifs pour la vision de [] près [] distance.

Signature []



Natural Resources
Canada

Ressources naturelles
Canada

Certified to/Certifié selon : CAN/CGSB-48.97.12

11181

Method Méthode	Level Niveau	Sector Secteur	Cert. Date Date cert.	Date recert. Date recert.	Expires Expiration
RT	2	EMC	2007/12/11		2016/12/31

For verification of certification status, policies and definitions, visit website:
<http://ndi.nrcan.gc.ca/> Pour la vérification de la certification, les politiques, et les définitions,
visitez le site web: <http://ndi.nrcan.gc.ca/>

Manager, Certifying Agency
Gestionnaire, Organisme de certification

Handwritten initials/signature

NAME: CHAD SEAR

NEAR VISION:

uncorrected RE J1 LE J1

corrected RE _____ LE _____

COLOUR VISION: 14/14 Pass DATE: SEPT 30/14

SHADES OF GREY: 17/17 Pass DATE: SEPT 30/14

EXAMINER: ADAM LOUD [Signature]
Print Signature

REQUIREMENTS:

- 1) NEAR-VISION - The examination shall assure natural or corrected near-distance acuity in at least one eye such that the applicant is capable of reading a minimum of Jaeger Number 2 or equivalent type and size letter at a distance of not less than 30 cm (12 inches) on a standard Jaeger test chart. The ability to perceive an Ortho-Rater minimum of 10 or similar test patterns is also acceptable. This test shall be administered annually.
- 2) COLOUR-VISION - The examination, by use of Ishihara plates, or other similar method, shall demonstrate the capability of distinguishing contrast among colours used in non-destructive examination. All 14 Ishihara plates shall be used in the assessment and the individual must correctly identify 13 out of 14 plates. Successful completion of a practical test in the applicable method shall be accepted as demonstrating acceptable colour contrast differentiation. This test shall be administered annually.
- 3) SHADES OF GREY - An examination, by use of a calibrated step tablet or other similar method, shall demonstrate the capability of distinguishing contrast among shades of grey used in non-destructive examination. The individual must correctly identify all the steps presented. Successful completion of a practical test in the applicable method shall be accepted as demonstrating acceptable differentiation in shades of grey. This test shall be administered upon initial certification and at no greater interval than three-years thereafter.



EMPLOYEE: Chad Sear

SNT / ASNT CERTIFICATIONS		QUALIFICATION GRADES		CERTIFICATION DATES		
Method & Level	Certified By	Initial	Recert	Initial	Current	Due
RT Level 2	IRISNDT	87%	NA	Nov 2012	Nov 2012	Dec 2015

OTHER CERTIFICATIONS		QUALIFICATION GRADES		CERTIFICATION DATES		
RT Level 2	CGSB	Pass	NA	Dec 2007	Feb 2014	Dec 2016

EMPLOYMENT EXPERIENCE:

From	To	Employer	Methods	Months
Nov 2012	Present	IRISNDT	Radiography	15
Mar 2012	Nov 2012	Gamma-Tech	Radiography	7
Nov 2001	Mar 2012	Cave Inspection	Radiography	78

EDUCATION: High School Successful Completion Minimum 2 years-Engineering/Science at University, College or Technical School

Date	Institution	Length	Subject/Courses
2006	SAIT	120 hours	Industrial Radiography Level 1 & 2
2002	INTEG	40 hours	Radiation Safety (EDO)

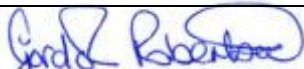
EYE EXAMINATIONS:

This certifies that the employee has met the training and examination requirements of IRISNDT Qualification and Certification Manual (Work Practice) in accordance with SNT-TC-1A (2006 Edition).

CERTIFICATION:

Initial Certification and Re-certification carried out in accordance with IRISNDT Personnel Qualification and Certification Manual (Work Practice).

This certifies that the employee has met the training and examination requirements of IRISNDT Qualification and Certification Manual (Work Practice) in accordance with SNT-TC-1A (2006 Edition).

Name: Gordon Robertson **Signed:**  **Date:** February, 2014

RESTRICTIONS, NOTES and COMMENTS:



Brody J. Smith
12569

Registration Number
Numéro de matricule

is certified by the Canadian
Nuclear Safety Commission
as an Exposure Device
Operator.

est accrédité par la Commission
canadienne de sûreté nucléaire
à titre d'opérateur d'appareil
d'exposition.

2013/02/01
Issue Date
Date d'émission

2019/09/01
Expiry Date
Date d'expiration

[Signature]
Designated Officer
Fonctionnaire désigné



Canadian Nuclear
Safety Commission

Commission canadienne
de sûreté nucléaire

Canada



Natural Resources
Canada

Ressources naturelles
Canada



Name/
Nom **Brody Smith**
Reg. No. /
No. matricule **12569**
Issue Date/
Date d'émission **2014/02/07**

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Corrective lenses for [] near [] far vision.
Verres correctifs pour la vision de [] près [] distance.

Signature]



Natural Resources
Canada

Ressources naturelles
Canada

Certified to / Certifié selon : CAN / CGSB-48.9712

12569

Method Méthode	Level Niveau	Sector Secteur	Cert. Date Date cert.	Date recert. Date recert.	Expires Expiration
RT	2	EMC	2012/05/08		2016/12/31

For verification of certification status, policies and definitions, visit website:
<http://ndt.nrcan.gc.ca/> Pour la vérification de la certification, les politiques, et les définitions,
visitez le site-web: <http://ndt.nrcan.gc.ca/>

Manager, Certifying Agency
Gestionnaire, Organisme de certification

NAME: Brody Smith

NEAR VISION:

uncorrected RE J1 LE J1

corrected RE _____ LE _____

COLOUR VISION: 14/14 Pass DATE: SEPT 30/14

SHADES OF GREY: 17/17 Pass DATE: SEPT 30/14

EXAMINER: ADAM LOUIS [Signature]
Print Signature

REQUIREMENTS:

- 1) NEAR-VISION - The examination shall assure natural or corrected near-distance acuity in at least one eye such that the applicant is capable of reading a minimum of Jaeger Number 2 or equivalent type and size letter at a distance of not less than 30 cm (12 inches) on a standard Jaeger test chart. The ability to perceive an Ortho-Rater minimum of 10 or similar test patterns is also acceptable. This test shall be administered annually.
- 2) COLOUR-VISION - The examination, by use of Ishihara plates, or other similar method, shall demonstrate the capability of distinguishing contrast among colours used in non-destructive examination. All 14 Ishihara plates shall be used in the assessment and the individual must correctly identify 13 out of 14 plates. Successful completion of a practical test in the applicable method shall be accepted as demonstrating acceptable colour contrast differentiation. This test shall be administered annually.
- 3) SHADES OF GREY - An examination, by use of a calibrated step tablet or other similar method, shall demonstrate the capability of distinguishing contrast among shades of grey used in non-destructive examination. The individual must correctly identify all the steps presented. Successful completion of a practical test in the applicable method shall be accepted as demonstrating acceptable differentiation in shades of grey. This test shall be administered upon initial certification and at no greater interval than three-years thereafter.



SNT-TC-1A CERTIFICATION

EMPLOYEE: Brody Smith

SNT / ASNT CERTIFICATIONS		QUALIFICATION GRADES		CERTIFICATION DATES		
Method & Level	Certified By	Initial	Recert	Initial	Current	Due
RT Level II	IRISNDT	89%	NA	Jun 2012	Jun 2012	Dec 2015

OTHER CERTIFICATIONS		QUALIFICATION GRADES		CERTIFICATION DATES		
RT Level II	CGSB	Pass	NA	May 2012	Feb 2014	Dec 2016

EMPLOYMENT EXPERIENCE:

From	To	Employer	Methods	Months
2006	Present	IRISNDT	RT, MT, PT	96

EDUCATION: High School Successful Completion Minimum 2 years-Engineering/Science at University, College or Technical School

Date	Institution	Length	Subject/Courses
2011	SAIT	120 hours	Radiographic Inspection Level 1 & 2
2005	SAIT	3 months	NDE Foundations Program

EYE EXAMINATIONS:

This certifies that the employee has met the training and examination requirements of IRISNDT Qualification and Certification Manual (Work Practice) in accordance with SNT-TC-1A (2006 Edition).

CERTIFICATION:

Initial Certification and Re-certification carried out in accordance with IRISNDT Personnel Qualification and Certification Manual (Work Practice).
 This certifies that the employee has met the training and examination requirements of IRISNDT Qualification and Certification Manual (Work Practice) in accordance with SNT-TC-1A (2006 Edition).

Name: Gordon Robertson **Title:** NDE Certifying Level 3 **Signed:**  **Date:** February, 2014

RESTRICTIONS, NOTES and COMMENTS:



318 Monument Place SE
 Calgary, AB T2A 1X3
 Telephone: (403) 273-5105
 Fax: (403) 248-6497
 Email: calgary@continentalstress.com

Furnace Work Order

Date: Thursday February 26, 2015

Client: DYNACORP FABRICATORS INC.
Address: 5152 - 74th AVENUE SE
 CALGARY, AB
 T2C 3C9

Owning Company:
Date Required: Friday February 27, 2015

Attention: TONY TANG
Phone: (403) 998-4206
Fax:
Email:

Client Reference: 6J141662
Purchase Order : 6P34821

Furnace Work Order Number: CF15-6335

Description	Quantity
NOZZLES	31
SHARED LOAD	

Total Overtime Hours = 0	@	\$.00	Per Hour =	\$.00	
Furnace Number: 4	@		Furnace Charges:	\$200.00	
			Other Charges(s):	\$.00	
			COST:	\$200.00	
			GST:	\$10.00	
			TOTAL COST:	\$210.00	

Heat Cycle (In Degrees Celsius)

Material: Carbon Steel (P1) <= 1.000 " **Code:** Customer Spec.
 W/T

Heat from Ambient to 425° at a Moderate Rate.
 Heat from 425° to 621° at 222° per Hour Maximum.
 Soak at 621° +/- 14° for 1 Hours.
 Cool to 425° at 277° per Hour Maximum.
 Cool from to at per Hour Maximum.
 From 425° Air Cool with furnace in place.

Comments:

- NOTE:**
1. An extra charge will apply for any additional supporting or blocking if required.
 2. Customer will not hold Continental Stress Relieving Services Ltd. responsible for any damage of distortion caused by heat treatment process.

Thank you for the opportunity of quoting.
 Continental Stress Relieving Services Ltd.

Name: Chris Hasledine

Signed: _____



HEAT TREATMENT INSTRUCTIONS

PO# 6P34821

JOB NO.: 6J141662

CUSTOMER: Natpro

DATE: Feb 26, 2015

COMPONENT DESCRIPTION: 31 parts from Natpro to build nozzles

DWG. NO. AND LINE NO.	DIAMETER	THICKNES	MATERIAL	LENGTH	WEIGHT
See email for attached pics	2"	XXH	SA-350-LF2-1 SA-333-6	3"	

TYPE OF HEAT TREATMENT: STRESS RELIEF P-No. 1

HEATING

Temperature to be raised from 800°F (427°C) to 1150°F (621°C) at a maximum rate of 400°F (222 °C) per hour. NOTE: THIS VALUE MUST NEVER EXCEED 400°F (204°C) PER HOUR.

[Calculated rate = 400 degrees F/hr. (222 degrees C/hr.) Divided by the maximum metal thickness of the shell or head plate in inches]

HOLDING

Temperature to be held at a minimum of 1150°F (621°C) for a minimum of 60 minutes.

[Holding time to be determined by Table UCS-56 for Nominal Thickness as specified in UW-40(f)]

COOLING

Temperature to be lowered from 1150°F (621°C) to 800°F (427°C) at a maximum rate of 500 °F (278°C) per hour. NOTE: THIS VALUE MUST NEVER EXCEED 500°F (278°C) PER HOUR.

[Calculated rate = 500 degrees F/hr. (278 degrees C/hr.) Divided by the maximum metal thickness of the shell or head plate in inches]

From 800°F (427°C) items may be cooled in still air.

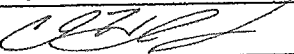
Additional requirements:

- ◆ Job number and description required on heat treatment charts along with the operator's signature & date.
- ◆ Reporting of thermocouple attachment method and location, and verification of furnace thermocouple calibration is required.
- ◆ A sufficient number of thermocouples shall be located to control and maintain uniform distribution of temperature on all vessels and parts. Thermocouples shall be directly attached to the item or provision shall be made for thermocouple placement at bottom, centre and top of the furnace charge in accordance with the ASME Code.
- ◆ During the heating period, there shall not be a greater variation in temperature throughout the portion of the vessel being heated than 250°F (140°C) within any 15 ft. (4.6 m) interval of length. An adequate number of thermocouples must be used to ensure this Code requirement is met. This limitation is also applicable to the temperature variations between the different thicknesses of various vessel components.
- ◆ During the holding period, there shall not be a greater difference than 150°F (83°C) between the highest and lowest temperature throughout the portion of the vessel being heat treated, except where the range is further limited by these instructions.
- ◆ If Capacitor Discharge welding is used to attach thermocouples an ASME Code Section IX Welding Procedure Specification is required (WPS qualification is not required), and the energy output must be limited to 125 Watt-Seconds. No other welding is permitted on vessels or parts. $[0.5 \times \text{Capacitance in farads} \times \text{Voltage}^2 = \text{W-Sec.}]$
- ◆ The method of thermocouple removal shall not damage the heat treated item.

Quality Control Inspector Signature:  Date: Feb 26, 2015

Thermocouple Attachment Method: Capacitor Discharge Location(s): TMB

Furnace Heat Number: CFIS-6335

Furnace Operator Signature:  Date: Feb 26, 2015



Calibrations – Traceable to NRC and NIST | Installation | Maintenance

**Certificate of Conformance
Multipoint Recorder**

Make:	Chino	Customer:	Continental Stress Relieving Services
Model:	AH3745-N00	Address:	318 Monument Place S.E.
Serial Number:	AH093Q001		Calgary, Alberta, T2A 1X3
Description:	24 channel Type "K" temperature recorder		
Location:	Calgary, Alberta, Canada	Calibration Date:	October 31, 2014
Tag # :	RE-103	Calibration Due:	April 30, 2015
Report Number:	CSR-311014-02	Technician:	Austin Tarrant

Comments: All 24 channels checked at 0°C, 500°C and 1000°C. See also, recorder chart

Reding Instrument Services Ltd. certifies that the above listed instrument meets or exceeds all published specifications unless otherwise indicated. This instrument has been calibrated using equipment and standards traceable to the National Research Council of Canada (NRC), the National Institute of Standards and Technology (NIST), or derived from accepted values of natural physical constants. This calibration certificate applies only to the item described and shall not be reproduced, other than in full, without approval from Reding Instrument Services Ltd.

Calibration Standards

Make	Model	Serial Number	Recall Date
Fluke	5520A	8979001	October 17, 2015

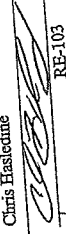
Technician

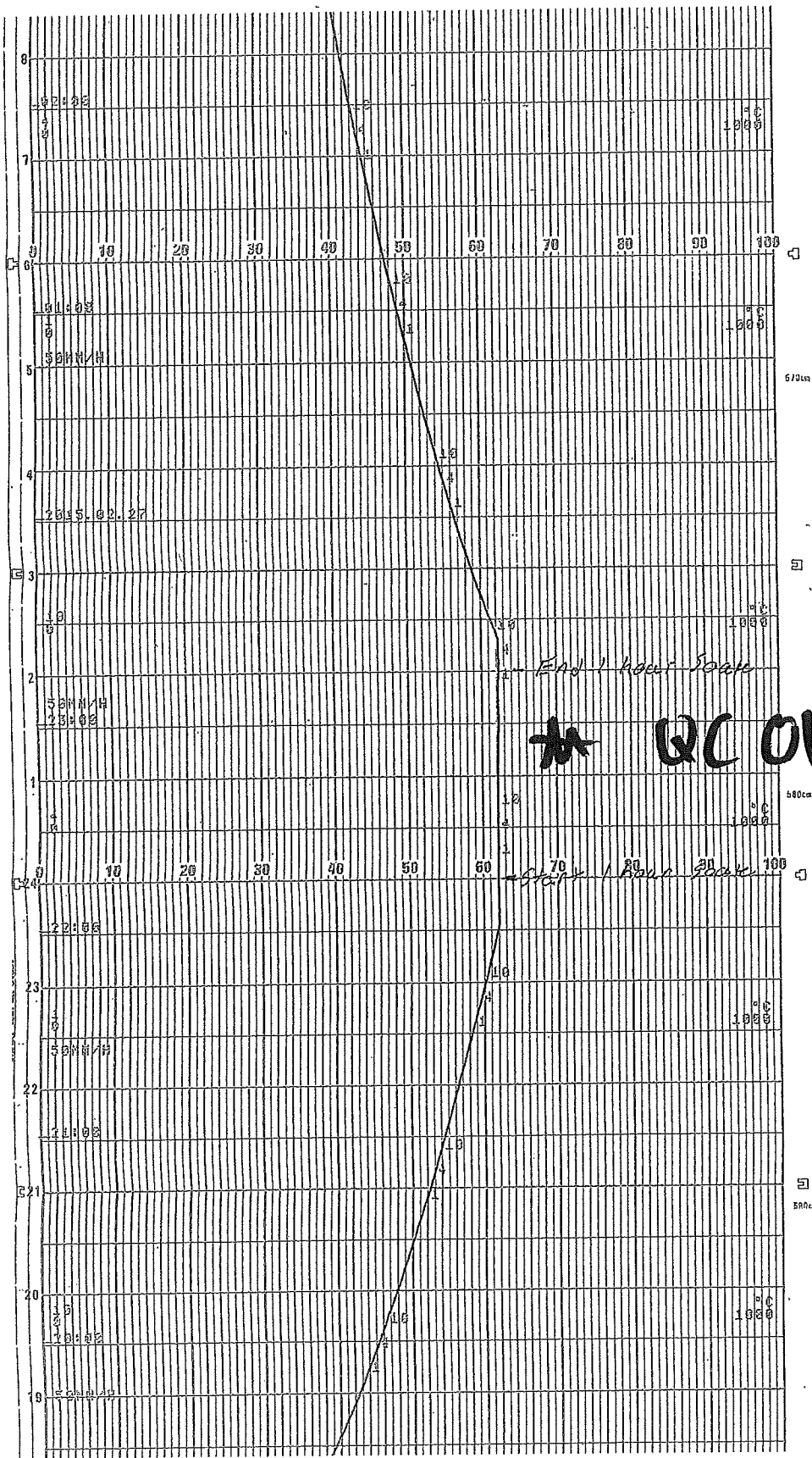
Oct. 31, 2014
Date

RC OK

CONTINENTAL STRESS RELIEVING SERVICES LTD.
Telephone: 403-273-5105

Date: February 26, 2015
Client: DynaCorp Fabricators Inc.
Owning Co.: N/A
Chart Speed: 50mm/Hours
Material: As Per Customer Specifications
Procedure: PWHT
Furnace Load #: CE15-6335
Client Job #: 61141662
P.O. #: 6P34821
Comments: 31 Nozzles

Operator Name: Chris Haselidine
Operator Signature:  RE-103
Temperature in °C: ✓ Recorder #: _____



*** QC OK**

End 1 hour 30 sec

Start 1 hour 30 sec

Furnace Work Order

Date: Tuesday March 03, 2015

Client: DYNACORP FABRICATORS INC.
Address: 5152 - 74th AVENUE SE
 CALGARY, AB
 T2C 3C9

Owning Company:
Date Required: Wednesday March 04, 2015

Attention: TONY TANG
Phone: (403) 998-4206
Fax:
Email:

Client Reference: 6J151662
Purchase Order : 6P34935

Furnace Work Order Number: CF15-6360

Description	Quantity
SPOOLS	2

Total Overtime Hours = 0 @ \$.00
 Furnace Number: 4 @

Per Hour = \$.00
 Furnace Charges: \$290.00
 Other Charges(s): \$.00

COST: \$290.00
GST: \$14.50
TOTAL COST: \$304.50

Heat Cycle (In Degrees Celsius)

Material: Carbon Steel (P1) <= 1.00 " W/T **Code:** Customer Spec.
 Heat from Ambient to 425° at a Moderate Rate.
 Heat from 425° to 621° at 222° per Hour Maximum.
 Soak at 621° +/- 14° for 1 Hours.
 Cool to 425° at 277° per Hour Maximum.
 Cool from to at per Hour Maximum.
 From 425° Air Cool with furnace in place.

Comments:

- NOTE:**
1. An extra charge will apply for any additional supporting or blocking if required.
 2. Customer will not hold Continental Stress Relieving Services Ltd. responsible for any damage of distortion caused by heat treatment process.

Thank you for the opportunity of quoting.
 Continental Stress Relieving Services Ltd.

Name: Marc Lagerquist

Signed: 



HEAT TREATMENT INSTRUCTIONS

PO# 6P34935

DATE: March 3, 2015

JOB NO.: 65151662 CUSTOMER: Natpro

COMPONENT DESCRIPTION: 2 nozzles (Nozzle 14)

DWG. NO. AND LINE NO.	DIAMETER	THICKNES	MATERIAL	LENGTH	WEIGHT
2 nozzles of nozzle 14	2"	XXH	SA-350-LF2-1 SA-333-6	3"	

TYPE OF HEAT TREATMENT: STRESS RELIEF P-No. 1

HEATING

Temperature to be raised from 800°F (427°C) to 1150°F (621°C) at a maximum rate of 400°F (222 °C) per hour. NOTE: THIS VALUE MUST NEVER EXCEED 400°F (204°C) PER HOUR.

[Calculated rate = 400 degrees F/hr. (222 degrees C/hr.) Divided by the maximum metal thickness of the shell or head plate in inches]

HOLDING

Temperature to be held at a minimum of 1150°F (621°C) for a minimum of 60 minutes.
[Holding time to be determined by Table UCS-56 for Nominal Thickness as specified in UW-40(f)]

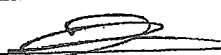
COOLING

Temperature to be lowered from 1150°F (621°C) to 800°F (427°C) at a maximum rate of 500 °F (278°C) per hour. NOTE: THIS VALUE MUST NEVER EXCEED 500°F (278°C) PER HOUR.

[Calculated rate = 500 degrees F/hr. (278 degrees C/hr.) Divided by the maximum metal thickness of the shell or head plate in inches]
From 800°F (427°C) items may be cooled in still air.

Additional requirements:

- ◆ Job number and description required on heat treatment charts along with the operator's signature & date.
- ◆ Reporting of thermocouple attachment method and location, and verification of furnace thermocouple calibration is required.
- ◆ A sufficient number of thermocouples shall be located to control and maintain uniform distribution of temperature on all vessels and parts. Thermocouples shall be directly attached to the item or provision shall be made for thermocouple placement at bottom, centre and top of the furnace charge in accordance with the ASME Code.
- ◆ During the heating period, there shall not be a greater variation in temperature throughout the portion of the vessel being heated than 250°F (140°C) within any 15 ft. (4.6 m) interval of length. An adequate number of thermocouples must be used to ensure this Code requirement is met. This limitation is also applicable to the temperature variations between the different thicknesses of various vessel components.
- ◆ During the holding period, there shall not be a greater difference than 150°F (83°C) between the highest and lowest temperature throughout the portion of the vessel being heat treated, except where the range is further limited by these instructions.
- ◆ If Capacitor Discharge welding is used to attach thermocouples an ASME Code Section IX Welding Procedure Specification is required (WPS qualification is not required), and the energy output must be limited to 125 Watt-Seconds. No other welding is permitted on vessels or parts. [0.5 X Capacitance in farads X Voltage² = W-Sec.]
- ◆ The method of thermocouple removal shall not damage the heat treated item.

Quality Control Inspector Signature:  Date: March 3, 2015

Thermocouple Attachment Method: Capacitor Discharge Location(s): TMB

Furnace Heat Number: CF15-6360

Furnace Operator Signature:  Date: Mar. 3/15



Calibrations - Traceable to NRC and NIST | Installation | Maintenance

**Certificate of Conformance
Multipoint Recorder**

Make:	Chino	Customer:	Continental Stress Relieving Services
Model:	AH3745-N00	Address:	318 Monument Place S.E.
Serial Number:	AH093Q001		Calgary, Alberta, T2A 1X3
Description:	24 channel Type "K" temperature recorder		
Location:	Calgary, Alberta, Canada	Calibration Date:	October 31, 2014
Tag # :	RE-103	Calibration Due:	April 30, 2015
Report Number:	CSR-311014-02	Technician:	Austin Tarrant

Comments: All 24 channels checked at 0°C, 500°C and 1000°C. See also, recorder chart

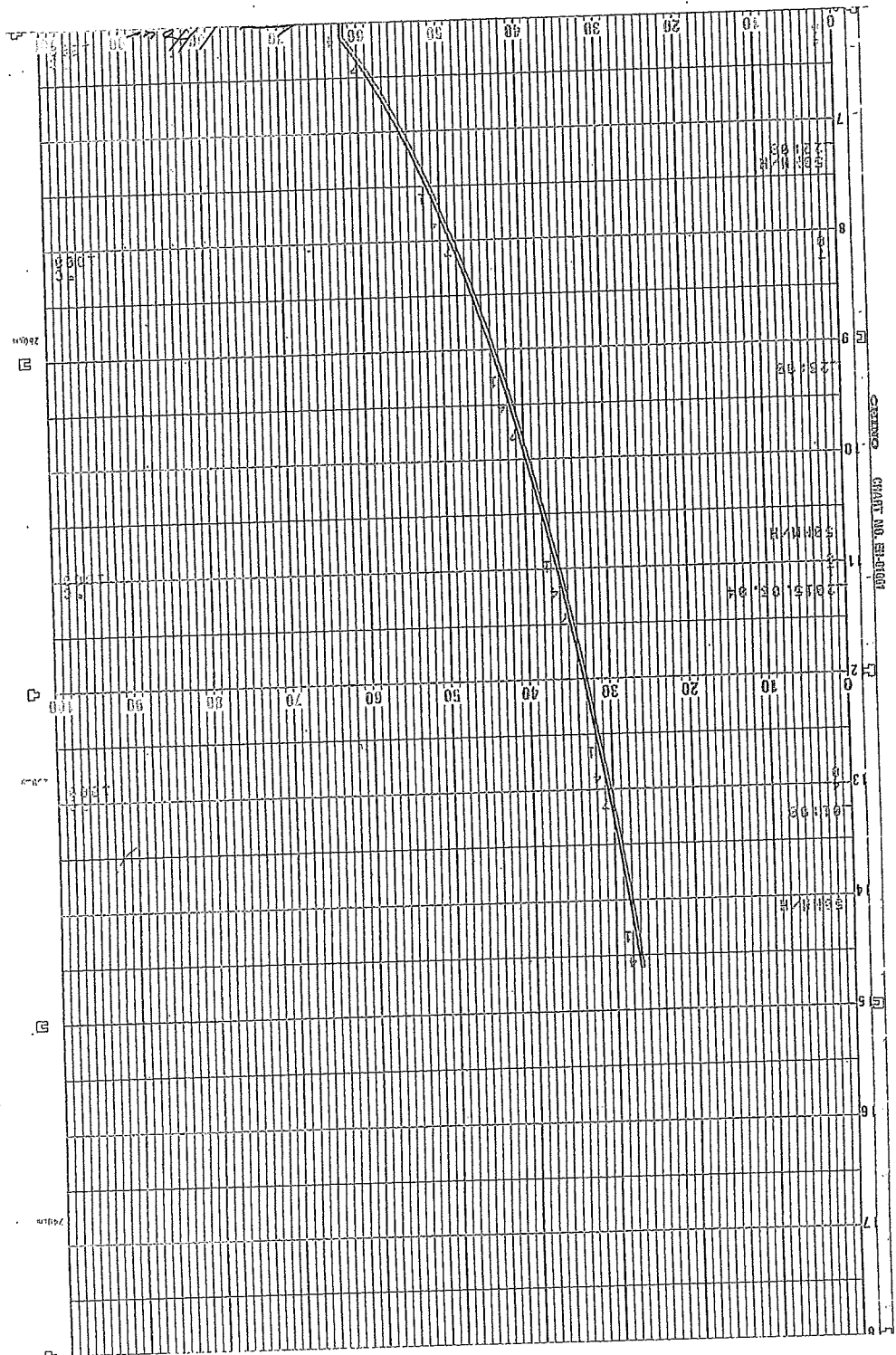
Reding Instrument Services Ltd. certifies that the above listed instrument meets or exceeds all published specifications unless otherwise indicated. This instrument has been calibrated using equipment and standards traceable to the National Research Council of Canada (NRC), the National Institute of Standards and Technology (NIST), or derived from accepted values of natural physical constants. This calibration certificate applies only to the item described and shall not be reproduced, other than in full, without approval from Reding Instrument Services Ltd.

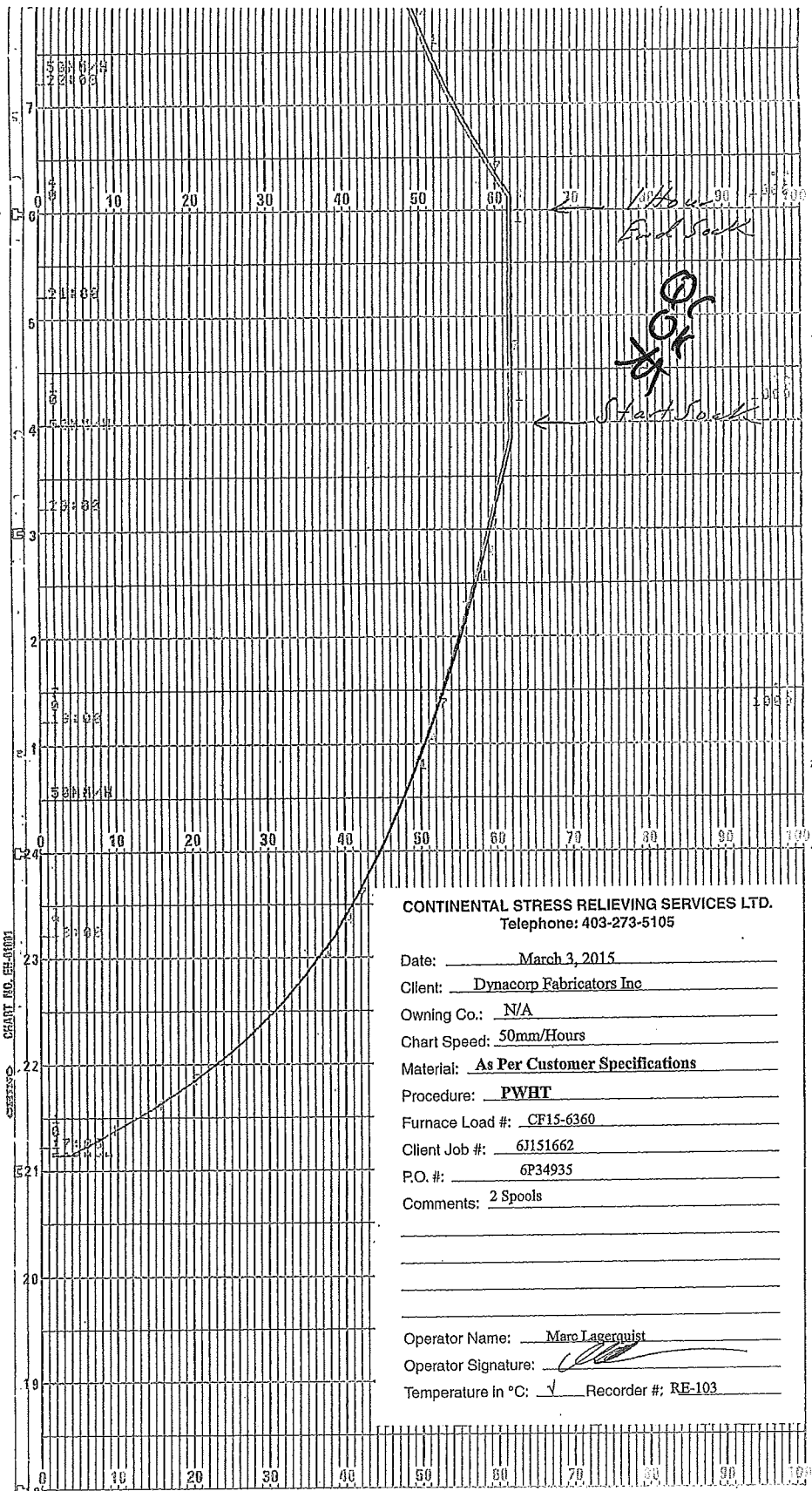
Calibration Standards

Make	Model	Serial Number	Recall Date
Fluke	5520A	8979001	October 17, 2015

Technician

Oct 31, 2014
Date





CONTINENTAL STRESS RELIEVING SERVICES LTD.
 Telephone: 403-273-5105

Date: March 3, 2015
 Client: Dynacorp Fabricators Inc
 Owning Co.: N/A
 Chart Speed: 50mm/Hours
 Material: As Per Customer Specifications
 Procedure: PWHT
 Furnace Load #: CF15-6360
 Client Job #: 61151662
 P.O. #: 6P34935
 Comments: 2 Spools

Operator Name: Mare Lagerquist
 Operator Signature: [Signature]
 Temperature in °C: ✓ Recorder #: RE-103



MAGNETIC PARTICLE INSPECTION REPORT

CA0249-MT-10 Rev.2 Page 1 of 1

Procedure: 5.0 Rev. 1 Client: NATIONAL PROCESS INC. Date: 20-May-15
Technique: MT-1V IRISNDT #: CGY1502356 Job #: 7103650 / 338716
Code: ASME B31.3 - Chp 6 - Sect 341.3.2(a) 344.6.2 Location: Calgary, Alberta PO #: 3869974
Other: Item inspected: Piping

Surface Condition: Painted [] Sandblasted [] Machined [] As Cast [] As Forged [] Weldment [x] Other []

Material: Carbon Steel Thickness: Various Heat Treatment: N/A

Magnetizing Equipment: Yoke [x] Coil [] Permanent [] IRISNDT #: 40139 Mfg: Parker Calibration Date: 24-Apr-15

Method of Magnetization: AC [x] DC [] Continuous [x]

Blacklight: Y [] N/A [x] IRISNDT #: Verification per ASME V Art 7 T.777.2 Blacklight Meter: IRISNDT #: Calibration Date: - -

Whitelight: Y [x] N/A [] Verification per ASME V Art 7 T.777.1

Magnetic Particles: Dry [] Wet [x] Red [] Grey [] Black [x] Fluorescent []
Batch #: 1397-50 Mfg: MAGNAFLUX Type: 7C

Background: [x] Batch #: 1401 Mfg: ARDROX Type: 8901W

ITEM INSPECTED ON THE FOLLOWING :

Table with 6 columns: IDENTIFICATION, SPOOL #, AREA INSPECTED, RESULT, IDENTIFICATION, SPOOL #, AREA INSPECTED, RESULT. Contains 18 rows of inspection data, all with 'ACCEPTABLE' results.

Inspection Limitation(s): N/A

Form containing personnel information, consumables (MT Min), interpretation by OHSUENGRYU, and client representative signature (Rick St-Louis).

5311- 86 St. Edmonton, Alberta T6E 5T8 Phone: (780) 437-2022 fax: (780) 439-4873
Calgary (403) 279-6121 Cold Lake (780) 826-6105
Lloydminster (780) 875-6455 Fort McMurray (780) 743-1536
Barthhead (780) 674-3018 Red Deer (403) 347-1742
Nisku (780) 955-7616 www.irisndt.com Engineering, Calgary (403) 217-9684
Engineering, Edmonton (780) 437-2022
Rope Access Services (780) 437-2022
Offices also located in USA and UK

IRIS NDT

RADIOGRAPHIC INSPECTION REPORT

CA0118-RT-2011
Page 1 of 1

Exposure Device #: D5819 Source #: 13431G
Gamma Type: IR 192 EFSS: .163
Film Brand: AGFA #Film/cassette: 1
Code: ASME B31.3 N - Table 341.3.2

Client: NATIONAL PROCESS
IRISNDT #: CGY1502370
Location: CALGARY ALBERTA
Item Inspected: Piping

Date: 19-May-15
Job #: 338716
PO #: 3869974
Material: C.S

Film #	Size, Location, Thickness	Welder ID	Tech.	S.O.D. Inches	O.F.D. Inches	# of Exp.	Work Loc.	Film Type	Type and Location of Discontinuities (rejectable discontinuities in square brackets [])	(A)cept (R)ject
G1	1"XH	A	RT 8	19	.179	1	1	D7		A
G2	1"XH	C2	RT 8	19	.179	1	1	D7		A
G3	1"XH	A	RT 8	19	.179	1	1	D7		A
G4	1"XH	A	RT 8	19	.179	1	1	D7		A
G5	1"XH	C2	RT 8	19	.179	1	1	D7		A
G6	1"XH	C2	RT 8	19	.179	1	1	D7		A
G7	1"XH	C2	RT 8	19	.179	1	1	D7		A
G8	1"XH	C2	RT 8	19	.179	1	1	D7		A
G9	1"XH	C2	RT 8	19	.179	1	1	D7		A
G10	1"XH	C2	RT 8	19	.179	1	1	D7		A
G11	1"XH	A	RT 8	19	.179	1	1	D7		A
G12	3/4"XH	C2	RT 8	19	.154	1	1	D7		A
G13	3/4"XH	C2	RT 8	19	.154	1	1	D7		A
G14	3/4"XH	C2	RT 8	19	.154	1	1	D7		A
G15	3/4"XH	A	RT 8	19	.154	1	1	D7		A
G16	3/4"XH	L1	RT 8	19	.154	1	1	D7		A
G17	3/4"XH	L1	RT 8	19	.154	1	1	D7		A
G18	3/4"XH	L1	RT 8	19	.154	1	1	D7		A
G19	3/4"XH	A	RT 8	19	.154	1	1	D7		A
G20	3/4"XH	A	RT 8	19	.154	1	1	D7		A
G21	3/4"XH	A	RT 8	19	.154	1	1	D7		A
G22	1"XH	A	RT 8	19	.179	1	1	D7		A
G23	1"XH	A	RT 8	19	.179	1	1	D7	13-1"XH GAPS /// 10-3/4"XH GAPS	A

Number of Radiation Barrier Warning Signs Erected: 5 Number of Radiation Barrier Warning Signs 5

Work Location Legend: [1] Inside Fab. Shop [2] Yard/Lay-down Area [3] Piping/Modular Fab. Area [4] N/A (Other)

RT Techniques: Exposure Viewing Technique S.W.E G.W.V 1,2,2A,6,7 D.W.E S.W.V 3,3A D.W.E D.W.V 4,5,8	S.O.D. = Source-to-object distance (D) O.F.D. = Distance from source side of object to film (d) Lead Screens - Front & Back 0.01" / .25mm Thk.	AB - Arc Burns BT - Burn Through CK - Crack EP - Excessive Penetration P - Porosity FI - Flanged Indication	EUC - External Undercut IUC - Internal Undercut HB - Hollow Head IP - Incomplete Penetration S - Slag	IC - Internal Concavity LF - Lack of Fusion LC - Low Cover MA - Misalignment TI - Tungsten Inclusion
---	--	--	---	--

Unit#: 771 In: _____ Out: _____ Hrs: 2.25 In: _____ Out: _____ Hrs: _____ Personnel: B. SMITH R. SLEEMAN	Kilometers: _____	Film Quantity: <table border="1"> <tr><td>(2 ¼ x 5 ½)</td><td>D4</td></tr> <tr><td>(2 ¾ x 8 ½)</td><td>D5</td></tr> <tr><td>16 (3 ½ x 8 ½)</td><td>D7</td></tr> <tr><td>(3 ½ x 17)</td><td>D7</td></tr> <tr><td>(4 ½ x 17)</td><td>D7</td></tr> </table>	(2 ¼ x 5 ½)	D4	(2 ¾ x 8 ½)	D5	16 (3 ½ x 8 ½)	D7	(3 ½ x 17)	D7	(4 ½ x 17)	D7	Interpretation by: BRODY SMITH SNT-TC-1A II (Print) f C.G.S.B.: II (Level) C.G.S.B. #: 12569 (Signature) Client Representative: (Print) <u>RICK ST. LOUIS</u> I am in full agreement with report contents (Sign) _____
(2 ¼ x 5 ½)	D4												
(2 ¾ x 8 ½)	D5												
16 (3 ½ x 8 ½)	D7												
(3 ½ x 17)	D7												
(4 ½ x 17)	D7												

5311 - 86 Street, Edmonton, Alberta T6E 6T8 Phone: (780) 437-2022 fax: (780) 436-4873
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Barrhead (780) 674-3018
Nisku (780) 955-7616

Cold Lake (780) 826-6105
Fort McMurray (780) 743-1536
Red Deer (403) 347-1742

Engineering, Calgary (403) 217-9684
Engineering, Edmonton (780) 437-2022
Rope Access Services (780) 437-2022

www.irisndt.com

Offices also located in USA and UK

IRISNDT-E-20040



RADIOGRAPHIC INSPECTION REPORT

CA0118-RT-2010

Page 1 of 1

Exposure Device #: D5819 Source #: 13431G
 Gamma Type: IR 192 EFSS: .163
 Film Brand: AGFA #Film/cassette: 1
 Code: ASME B31.3 N - Table 341.3.2

Client : NATIONAL PROCESS
 IRISNDT #: CGY1502370
 Location: CALGARY ALBERTA
 Item Inspected: Piping

Date: 19-May-15
 Job #: 338716
 PO #: 3869974
 Material: C.S

Film #	Size, Location, Thickness	Welder ID	Tech.	S.O.D. Inches	O.F.D. Inches	# of Exp.	Work Loc.	Film Type	Type and Location of Discontinuities (rejectable discontinuities in square brackets [])	(A)cept (R)ect
X70	2"XH	A	RT 3	2.1	.218	3	1	D4		A
X71	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X72	2"XH	A	RT 3	2.1	.218	3	1	D4	IC	A
X73	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X74	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X75	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X76	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X77	2"XH	C2	RT 3	2.1	.218	3	1	D4	IC	A
X78	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X79	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X80	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X81	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X82	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
13-2"XH										

Number of Radiation Barrier Warning Signs Erected: 5

Number of Radiation Barrier Warning Signs 5

Work Location Legend: [1] Inside Fab. Shop [2] Yard/Lay-down Area [3] Piping/Modular Fab. Area [4] N/A (Other)

RT Techniques: Exposure Viewing Technique S.W.E S.W.V 1,2,2A,6,7 D.W.E S.W.V 3,3A D.W.E D.W.V 4,5,8	S.O.D. = Source-to-object distance (D) O.F.D. = Distance from source side of object to film (d) Lead Screens – Front & Back 0.01" / .25mm Thk.	AB - Arc Burns BT - Burn Through CK - Crack EP - Excessive Penetration P - Porosity CI - Elongated Indication	EUC - External Undercut IUC - Internal Undercut HB - Hollow Bead IP - Incomplete Penetration S - Slag	IC - Internal Concavity LF - Lack of Fusion LC - Low Cover MA - Misalignment TI - Tungsten Inclusion
--	--	--	--	---

Unit#: 771 Kilometers: --- In: _____ Out: _____ Hrs: 2 In: _____ Out: _____ Hrs: _____ Personnel: B. SMITH R. SLEEMAN	Film Quantity: <table border="1"> <tr> <td>39</td> <td>(2 ¾ x 5 ½)</td> <td>D4</td> </tr> <tr> <td></td> <td>(2 ¾ x 8 ½)</td> <td>D5</td> </tr> <tr> <td></td> <td>(3 ½ x 8 ½)</td> <td>D7</td> </tr> <tr> <td></td> <td>(3 ½ x 17)</td> <td>D7</td> </tr> <tr> <td></td> <td>(4 ½ x 17)</td> <td>D7</td> </tr> </table>	39	(2 ¾ x 5 ½)	D4		(2 ¾ x 8 ½)	D5		(3 ½ x 8 ½)	D7		(3 ½ x 17)	D7		(4 ½ x 17)	D7	Interpretation by: BRODY SMITH SNT-TC-1A II (Print) _____ _____ C.G.S.B.: II _____ C.G.S.B. #: 12569 (Signature) _____ Client Representative: <i>BICK ST. LOUIS</i> (Print) _____ I am in full agreement with report contents _____ (Sign) _____
39	(2 ¾ x 5 ½)	D4															
	(2 ¾ x 8 ½)	D5															
	(3 ½ x 8 ½)	D7															
	(3 ½ x 17)	D7															
	(4 ½ x 17)	D7															

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IRISNDT-E-20040

IRIS NDT

MAGNETIC PARTICLE INSPECTION REPORT

CA0117-MT-15

Page 1 of 1

Procedure: 5.0 EDITION 5.0 REV. 1
Technique: MT-2V
Code: ASME B31.3 - Chp 6 - Sect 341.3.2(a) 344.6.2
Other:

Client: NATIONAL PROCESS EQUIP. LTD. Date: 28-Jul-15
IRISNDT #: CGY1503423 Job #: 7103650
Location: CALGARY ALBERTA PO #: 3869974
Item Inspected: Piping

Surface Condition: Painted Sandblasted Machined As Cast As Forged Weldment Other

Material: C.S. Thickness: Various Heat Treatment: N/A

Magnetizing Equipment: Yoke Coil Permanent IRISNDT #: 40198 Mfg: PARKER Calibration Date: 19-Jul-15

Method of Magnetization: AC DC Continuous

Blacklight: Y N/A IRISNDT #: Blacklight Meter: IRISNDT #:
Verification per ASME V Art 7 T.777.2 Calibration Date: - -

Whitelight: Y N/A Verification per ASME V Art 7 T.777.1

Magnetic Particles: Dry Wet Red Grey Black Fluorescent
Batch #: 1397-12 Mfg: MAGNAFLUX Type: 7C

Background: Batch #: 1421 Mfg: ARDROX Type: 8901W

Inspection Results:

WET BLACK MAGNETIC PARTICLE TESTING WAS CARRIED OUT ON THE FOLLOWING:

JOB# 7103650
MT-42 SPOOL 464
MT-43 SPOOL 466
MT-44 SPOOL 442
MT-45 SPOOL 456

NO REJECTABLE INDICATIONS AT TIME OF INSPECTION.

ACCEPTABLE TO CODE.




Inspection Limitation(s):

Unit#: 257 Kilometers: N/A
In: _____ Out: _____ Hrs: 1.0
In: _____ Out: _____ Hrs: _____

Personnel:
DC

Consumables:
mt min.

Interpretation by:

DEREK CLAYTON SNT-TC-1A: II
(Print)
 C.G.S.B.: II
(Level)
(Signature) C.G.S.B. #: 13230
Client Representative: 
(Print) Rick St. Louis
I am in full agreement with report contents
(Sign) 

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IRISNDT-E-2003G

Exposure Device #: D5939 Source #: 10520G
Gamma Type: IR 192 EFSS: .124
Film Brand: AGFA #Film/cassette: 1
Code: ASME B31.3 N - Table 341.3.2

Client: NATIONAL PROCESS EQUIPMENT INC Date: 27-Jul-15
IRISNDT #: CGY1503415 Job #: 7103650
Location: Calgary, Alberta PO #: 3869974
Item Inspected: Piping Material: CS

Film #	Size, Location, Thickness	Welder ID	Tech.	S.O.D. Inches	O.F.D. Inches	# of Exp.	Work Loc.	Film Type	Type and Location of Discontinuities (rejectable discontinuities in square brackets [])	(A)ccept (R)reject
PIPE										
X-85	3"STD	C2	RT 3	3.284	.216	3	4	D4	P	A
X-86	3"STD	C2	RT 3	3.284	.216	3	4	D4		A
X-87	2"XH	C2	RT 3	2.157	.218	3	4	D4	P	A
X-88	2"XH	C2	RT 3	2.157	.218	3	4	D4		A
GAP SHOTS										
G-34	1/2"XH	C2	RT 8	15.00	.147	1	4	D4		A
G-35	1"XH	C2	RT 8	15.00	.179	1	4	D4		A
G-36	1"XH	C2	RT 8	15.00	.179	1	4	D4		A
G-37	1"XH	C2	RT 8	15.00	.179	1	4	D4		A
1- 1/2"XH GAP SHOT										
3- 1"XH GAP SHOTS										
2-2"XH										
2-3"STD										


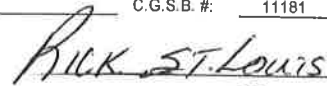

Number of Radiation Barrier Warning Signs Erected: 5 Number of Radiation Barrier Warning Signs: 5

Work Location Legend: [1] Inside Fab. Shop [2] Yard/Lay-down Area [3] Piping/Modular Fab. Area [4] N/A (Other)

RT Techniques: Exposure Viewing Technique S.W.E S.W.V 1,2,2A,6,7 D.W.E S.W.V 3,3A D.W.E D.W.V 4,5,8	S.O.D. = Source-to-object distance (D) O.F.D. = Distance from source side of object to film (d) Lead Screens - Front & Back 0.01" / 25mm Thk.	AB - Arc Burns BT - Burn Through CK - Crack EP - Excessive Penetration P - Porosity EI - Elongated Indication	EUC - External Undercut IUC - Internal Undercut HB - Hollow Boad IP - Incomplete Penetration S - Slag	IC - Internal Concavity LF - Lack of Fusion LC - Low Cover MA - Misalignment TI - Tungsten Inclusion
---	---	--	---	--

Unit#: 834 Kilometers: _____
In: _____ Out: _____ Hrs: 2
In: _____ Out: _____ Hrs: _____
Personnel:
C. SEAR
J. NASEDKIN

Film Quantity	Size	D
16	(2 3/4 x 5 1/2)	D4
	(2 3/4 x 8 1/2)	D5
	(3 1/2 x 8 1/2)	D7
	(3 1/2 x 17)	D7
	(4 1/2 x 17)	D7
	(7 x 17)	D7
	(2 3/4 x 17)	D5

Interpretation by:
CHAD SEAR SNT-TC-1A 2
(Print)
C.G.S.B.: 2
(Level)
C.G.S.B. #: 11181
(Signature) 
Client Representative: 
(Print) RICK ST. LOUIS
I am in full agreement with report contents
(Sign) 

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RADIOGRAPHIC INSPECTION REPORT

CG22 - RT5773

Page 1 of 1

Exposure Device #: D5820 Source #: 14635G

Job / P.O. #: 338716 IRISNDT #: CGY1502290 Date: 12-May-15

Cobalt 60 IR 192 X-Ray EFSS: .122

Client: NATIONAL PROCESS

Film Brand: AGFA #Film/cassette: 1

Location: CALGARY

Code: ASME B31.3 N

Item Inspected: Piping

Material: CS

Film #	Size, Location, Thickness	Welder ID	IRISNDT Proc.	S.O.D. Inches	O.F.D. Inches	# of Exp.	Work Loc.	Film Type	Type and Location of Discontinuities (rejectable discontinuities in square brackets []))	(A)cept (R)ject
X41	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X42	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X43	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X44	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X45	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X46	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X47	2"XH	L1	RT 3	2.1	.218	3	1	D4		A
X48	2"XH	L1	RT 3	2.1	.218	3	1	D4	P	A
X49	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X50	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X51	2"XH	C2	RT 3	2.1	.218	3	1	D4	P	A
X52	2"XH	C2	RT 3	2.1	.218	3	1	D4	P	A
X53	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X54	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X55	2"XH	A	RT 3	2.1	.218	3	1	D4		A
X56	2"XH	A	RT 3	2.1	.218	3	1	D4	IC	A
									16-2"XH	
									PO#3869974	

Number of Radiation Barrier Warning Signs Erected: 5

Number of Radiation Barrier Warning Signs Returned: 5

Work Location Legend: [1] Inside Fab. Shop [2] Yard/Lay-down Area [3] Piping/Modular Fab. Area [4] N/A (Other)

IRIS Procedure: Single Wall Exposure: RT 1, 2, 2A, 6, 7 Double Wall Exposure RT 3, 3A, 4, 5, 8	S.O.D. = Source-to-object distance (D) O.F.D. = Source-object-distance (D in T-274.1)	AB - Arc Burns BT - Burn Through CK - Crack EP - Excessive Penetration P - Porosity	EUC - External Undercut IUC - Internal Undercut HB - Hollow Bead IP - Incomplete Penetration S - Slag	IC - Internal Concavity LF - Lack of Fusion LC - Low Cover MA - Misalignment
--	--	---	---	---

Unit#: 568 Kilometers: -

Film Quantity	
48	(2 3/4 x 5 1/2) D4
	(2 3/4 x 8 1/2) D5
	(3 1/2 x 17) D5
	(3 1/2 x 8 1/2) D7
	(7 x 17) D7
	(4 1/2 x 17) D7
	(14 x 17) D7
	(4 1/2 x 8 1/2) D7

Interpretation by:
CHAD SEAR

SNT-TC-1A 2
C.G.S.B. 2
(Level)
C.G.S.B. # 11181

In: _____ Out: _____ Hrs: 2.5

Personnel:
C STEWART, J.BOLAND

(Signature)
Client Representative: Rick St. Louis
(Print)
I am in full agreement with report contents
(Sign)

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Deer Park, TX (281) 476-4444
Matrix, Houston, TX (713) 722-7177
Texas City, TX (409) 945-2262
Tulsa, OK (918) 446-8773

IRISNDT E-2004N

Exposure Device #: D5820 Source #: 14635G Job / P.O. #: 338716 IRISNDT #: CGY1502290 Date: 12-May-15
 Cobalt 60 IR 192 X-Ray EFSS: .122 Client: NATIONAL PROCESS
 Film Brand: AGFA #Film/cassette: 1 Location: CALGARY
 Code: ASME B31.3 N Item Inspected: Piping Material: CS

Film #	Size, Location, Thickness	Welder ID	IRISNDT Proc.	S.O.D. Inches	O.F.D. Inches	# of Exp.	Work Loc.	Film Type	Type and Location of Discontinuities (rejectable discontinuities in square brackets [])	(A)accept (R)reject
X21	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X22	2"XH	C2	RT 3	2.1	.218	3	1	D4	P	A
X23	2"XH	C2	RT 3	2.1	.218	3	1	D4	P	A
X24	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X25	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X26	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X27	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X28	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X29	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X30	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X31	2"XH	C2	RT 3	2.1	.218	3	1	D4	P	A
X32	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X33	2"XH	L1	RT 3	2.1	.218	3	1	D4		A
X34	2"XH	L1	RT 3	2.1	.218	3	1	D4		A
X35	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X36	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X37	2"XH	C2	RT 3	2.1	.218	3	1	D4	P	A
X38	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X39	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X40	2"XH	L1	RT 3	2.1	.218	3	1	D4		A
20-2"XH										
PO#3869974										

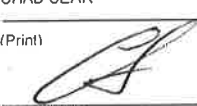
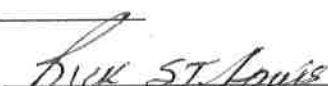

Number of Radiation Barrier Warning Signs Erected: 5 Number of Radiation Barrier Warning Signs Returned: 5

Work Location Legend: [1] Inside Fab. Shop [2] Yard/Lay-down Area [3] Piping/Modular Fab. Area [4] N/A (Other)

IRIS Procedure:
 Single Wall Exposure: RT 1, 2, 2A, 6, 7
 Double Wall Exposure: RT 3, 3A, 4, 5, 8

S.O.D. = Source-to-object distance (D)
 O.F.D. = Source-object-distance (D in T-274.1)

AB - Arc Burns EUC - External Undercut IC - Internal Concavity
 BT - Burn Through IUC - Internal Undercut LF - Lack of Fusion
 CK - Crack HB - Hollow Bead LC - Low Cover
 EP - Excessive Penetration IP - Incomplete Penetration MA - Misalignment
 P - Porosity S - Slag

Unit#: 568 Kilometers: _____	Film Quantity 60 (2 ¼ x 5 ½) D4 _____ (2 ¼ x 8 ½) D5 _____ (3 ½ x 17) D5 _____ (3 ½ x 8 ½) D7 _____ (7 x 17) D7 _____ (4 ½ x 17) D7 _____ (14 x 17) D7 _____ (4 ½ x 8 ½) D7	Interpretation by: CHAD SEAR SNT-TC-1A <u>2</u>
In: _____ Out: _____ Hrs: <u>3</u>		(Print)  C.G.S.B. <u>2</u> C.G.S.B. # (Level) <u>11181</u>
Personnel: C. STEWART, J. BOLAND		Client Representative:  (Print) I am in full agreement with report contents (Sign) 

Exposure Device #: D5820 Source #: 14635G Job / P.O. #: 338716 IRISNDT #: CGY1502290 Date: 12-May-15
 Cobalt 60 IR 192 X-Ray EFSS: .122 Client: NATIONAL PROCESS
 Film Brand: AGFA #Film/cassette: 1 Location: CALGARY
 Code: ASME B31.3 N Item Inspected: Piping Material: CS

Film #	Size, Location, Thickness	Welder ID	IRISNDT Proc.	S.O.D. Inches	O.F.D. Inches	# of Exp.	Work Loc.	Film Type	Type and Location of Discontinuities (rejectable discontinuities in square brackets [])	(A)cept (R)ect
X1	1.5"XH	C2	RT 5	19	.2	3	1	D4		A
X2	3"STD	C2	RT 3	3.3	.216	3	1	D4		A
X3	3"STD	C2	RT 3	3.3	.216	3	1	D4	P	A
X4	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X5	2"XH	L1	RT 3	2.1	.218	3	1	D4		A
X6	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X7	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X8	2"XH	L1	RT 3	2.1	.218	3	1	D4		A
X9	2"XH	L1	RT 3	2.1	.218	3	1	D4		A
X10	2"XH	L1	RT 3	2.1	.218	3	1	D4	IC	A
X11	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X12	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X13	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X14	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X15	2"XH	A	RT 3	2.1	.218	3	1	D4		A
X16	2"XH	A	RT 3	2.1	.218	3	1	D4	P	A
X17	2"XH	A	RT 3	2.1	.218	3	1	D4		A
X18	2"XH	A	RT 3	2.1	.218	3	1	D4		A
X19	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
X20	2"XH	C2	RT 3	2.1	.218	3	1	D4		A
1-1.5"XH, 2-3"STD, 17-2"XH										
PO#3869974										

Number of Radiation Barrier Warning Signs Erected: 5 Number of Radiation Barrier Warning Signs Returned: 5

Work Location Legend: [1] Inside Fab. Shop [2] Yard/Lay-down Area [3] Piping/Modular Fab. Area [4] N/A (Other)

IRIS Procedure:
 Single Wall Exposure: RT 1, 2, 2A, 6, 7 S.O.D. = Source-to-object distance (D)
 Double Wall Exposure: RT 3, 3A, 4, 5, 8 O.F.D. = Source-object-distance (D in T-274.1)
 AB - Arc Burns EUC - External Undercut IC - Internal Concavity
 BT - Burn Through IUC - Internal Undercut LF - Lack of Fusion
 CK - Crack HB - Hollow Bead LC - Low Cover
 EP - Excessive Penetration IP - Incomplete Penetration MA - Misalignment
 P - Porosity S - Slag

Unit#: 568 Kilometers: -
 In: _____ Out: _____ Hrs: 3
 In: _____ Out: _____ Hrs: _____

Personnel:
 C. STEWART, J. BOLAND

Film Quantity:	
60	(2 3/4 x 5 1/2) D4
	(2 3/4 x 8 1/2) D5
	(3 1/2 x 17) D5
	(3 1/2 x 8 1/2) D7
	(7 x 17) D7
	(4 1/2 x 17) D7
	(14 x 17) D7
	(4 1/2 x 8 1/2) D7

Interpretation by:
 CHAD SEAR SNT-TC-1A 2
 (Print) C.G.S.B. 2
 (Signature) (Level)
 Client Representative: C.C.&B. # 11101
 (Print) *DICK ST. LOUIS*
 I am in full agreement with report contents (Sign) *[Signature]*

IRISNDT

MAGNETIC PARTICLE INSPECTION REPORT

CA0249-MT-7
Page 1 of 1


Procedure: 5.0 Technique: MT-1V Code: ASME B31.3 - Chp 6 - Sect 341.3.2(a) 344.6.2 Other:	Rev. 1	Client: NATIONAL PROCESS INC. IRISNDT #: CGY1502353 Location: Calgary, Alberta Item Inspected: Piping	Date: 19-May-15 Job #: 7103650 PO #: 3869974
--	---------------	--	---

Surface Condition: Painted <input type="checkbox"/> Sandblasted <input type="checkbox"/> Machined <input type="checkbox"/> As Cast <input type="checkbox"/> As Forged <input type="checkbox"/> Weldment <input checked="" type="checkbox"/> Other <input type="checkbox"/>
Material: Carbon Steel Thickness: Various Heat Treatment: N/A
Magnetizing Equipment: Yoke <input checked="" type="checkbox"/> Coil <input type="checkbox"/> Permanent <input type="checkbox"/> IRISNDT #: 40139 Mfg: Parker Calibration Date: 24-Apr-15
Method of Magnetization: AC <input checked="" type="checkbox"/> DC <input type="checkbox"/> Continuous <input checked="" type="checkbox"/>
Blacklight: Y <input type="checkbox"/> N/A <input checked="" type="checkbox"/> IRISNDT #: _____ Verification per ASME V Art 7 T.777.2
Blacklight Meter: IRISNDT #: _____ Calibration Date: - -
Whitelight: Y <input checked="" type="checkbox"/> N/A <input type="checkbox"/> Verification per ASME V Art 7 T.777.1
Magnetic Particles: Dry <input type="checkbox"/> Wet <input checked="" type="checkbox"/> Red <input type="checkbox"/> Grey <input type="checkbox"/> Black <input checked="" type="checkbox"/> Fluorescent <input type="checkbox"/> Batch #: 1397-50 Mfg: MAGNAFLUX Type: 7C
Background: <input checked="" type="checkbox"/> Batch #: 1401 Mfg: ARDROX Type: 8901W

ITEM INSPECTED ON THE FOLLOWING :

INDENTIFICATION, SPOOL #	AREA INSPECTED	RESULT
338716 - 412	1 X OUTLET	- ACCEPTABLE -
338716 - 414	1 X OUTLET	- ACCEPTABLE - 1 INDICATION FOUND. REPAIRED AT THE TIME OF INSPECTION
338716 - 415	1 X OUTLET	- ACCEPTABLE -
338716 - 416	1 X OUTLET	- ACCEPTABLE -
338716 - 417	1 X OUTLET	- ACCEPTABLE -
338716 - 421	1 X OUTLET	- ACCEPTABLE - 1 INDICATION FOUND. REPAIRED AT THE TIME OF INSPECTION
338716 - 422	1 X OUTLET	- ACCEPTABLE -
338716 - 425	1 X OUTLET	- ACCEPTABLE -

Inspection Limitation(s): N/A

Unit#: 391 In: _____ Out: _____ Hrs: 2 In: _____ Out: _____ Hrs: _____ Personnel: R.J.	Kilometers: _____ Consumables: MT Min.	Interpretation by: OHSUENG RYU (Print) _____  (Signature) _____ Client Representative: (Print) Rick J. Louis I am in full agreement with report contents (Sign) _____	SNT-TC-1A: 2 C.G.S.B.: 2 (Level) C.G.S.B. #: 18415
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5311-86 Steet, Edmonton, Alberta T6E 5T8 Phone: (780) 437-2022 fax: (780) 436-4873
 Calgary (403) 279-6121 Cold Lake (780) 826-6105
 Lloydminster (780) 875-6455 Fort McMurray (780) 743-1536
 Barrhead (780) 674-3018 Red Deer (403) 347-1742
 Nisku (780) 955-7616
 www.irisndt.com
 Engineering, Calgary (403) 217-9684
 Engineering, Edmonton (780) 437-2022
 Rope Access Services (780) 437-2022
 Offices also located in USA and UK

Exposure Device #: D5939 Source #: 17768G Job / P.O. #: 338716 IRISNDT #: CGY1502983 Date: 29-Jun-15
 Cobalt 60 IR 192 X-Ray EFSS: .156 Client: NATIONAL PROCESS
 Film Brand: AGFA #Film/cassette: 1 Location: CALGARY
 Code: ASME B31.3 N Item Inspected: Piping /GAPS Material: CS

Film #	Size, Location, Thickness	Welder ID	IRISNDT Proc.	S.O.D. Inches	O.F.D. Inches	# of Exp.	Work Loc.	Film Type	Type and Location of Discontinuities (rejectable discontinuities in square brackets [])	(A)cccept (R)eject
X83	2"XH	A	RT 3	2.1	.218	3	1	D4		A
X84	2"XH	A	RT 3	2.1	.218	3	1	D4		A
G24	1"XH	C2	RT 8	16	.179	1	1	D7		A
G25	1"XH	C2	RT 8	16	.179	1	1	D7		A
G26	1"XH	A	RT 8	16	.179	1	1	D7		A
G27	1"XH	A	RT 8	16	.179	1	1	D7		A
G28	1"XH	C2	RT 8	16	.179	1	1	D7		A
G29	1"XH	C2	RT 8	16	.179	1	1	D7		A
G30	1"XH	C2	RT 8	16	.179	1	1	D7		A
G31	1"XH	A	RT 8	16	.179	1	1	D7		A
G32	1"XH	A	RT 8	16	.179	1	1	D7		A
G33	1"XH	C2	RT 8	16	.179	1	1	D7		A
2-2"XH,10-GAP SHOTS										

Number of Radiation Barrier Warning Signs Erected: 5 Number of Radiation Barrier Warning Signs Returned: 5

Work Location Legend: [1] Inside Fab. Shop [2] Yard/Lay-down Area [3] Piping/Modular Fab. Area [4] N/A (Other)

IRIS Procedure:
 Single Wall Exposure: RT 1, 2, 2A, 6, 7 S.O.D. = Source-to-object distance (D)
 Double Wall Exposure: RT 3, 3A, 4, 5, 8 O.F.D. = Source-object-distance (D in T-274.1)

AB - Arc Burns EUC - External Undercut IC - Internal Concavity
 BT - Burn Through IUC - Internal Undercut LF - Lack of Fusion
 CK - Crack HB - Hollow Bead LC - Low Cover
 EP - Excessive Penetration IP - Incomplete Penetration MA - Misalignment
 P - Porosity S - Slag

Unit#: 568 Kilometers: -
 In: _____ Out: _____ Hrs: **1.5**
 In: _____ Out: _____ Hrs: _____
 Personnel:
 C. STEWART, J BOLAND

Film Quantity:

6	(2 3/4 x 5 1/2)	D4
	(2 3/4 x 8 1/2)	D5
	(3 1/2 x 17)	D5
10	(3 1/2 x 8 1/2)	D7
	(7 x 17)	D7
	(4 1/2 x 17)	D7
	(14 x 17)	D7
	(4 1/2 x 8 1/2)	D7

Interpretation by: Rev. Lewis SNF-TC-1A 2
 (Print) C.G.S.B. 2
 (Signature) C.G.S.B. # 5359
 Client Representative: Rick St. Louis
 (Print) (Sign) [Signature]
 I am in full agreement with report contents

Procedure: 5.0 **Rev 1.0** **Client:** National Process Equipment Inc. **Date:** 30-Jun-15
Technique: MT-2V **IRISNDT #:** CGY1502971 **Job #:** 338716
Code: ASME B31.3 - Chp 6 - Sect 341.3.2(a) 344.6.2 **Location:** Calgary, Alberta **PO #:** 3869974
Other: **Item Inspected:** Piping See Below

Surface Condition: Painted Sandblasted Machined As Cast As Forged Weldment Other

Material: CS **Thickness:** Various **Heat Treatment:** N/A

Magnetizing Equipment: Yoke Coil Permanent **IRISNDT #:** 40300 **Mfg:** Contour **Calibration Date:** 23-Jun-15

Method of Magnetization: AC DC Continuous

Blacklight: Y N/A **IRISNDT #:** 41094 **Blacklight Meter:** IRISNDT #:
 Verification per ASME V Art 7 T.777.2 Calibration Date: - -

Whitelight: Y N/A Verification per ASME V Art 7 T.777.1

Magnetic Particles: Dry Wet Red Grey Black Fluorescent
 Batch #: 1397-26 Mfg: Magnaflux Type: 7C

Background: Batch #: 1393 Mfg: ARDROX Type: 8901W

INSPECTION SCOPE: A WET VISIBLE MAGNETIC PARTICLE INSPECTION WAS PERFORMED ON:

PIPING, JOB# 338716

IDENTIFICATION SPOOL#	AREA INSPECTED	RESULT	IDENTIFICATION SPOOL#	AREA INSPECTED	RESULT
338716-421-MT24	1X SOCKET WELD	ACCEPTABLE TO CODE	338716-456-MT33	1X SOCKET WELD	ACCEPTABLE TO CODE
338716-422-MT25	1X SOCKET WELD	ACCEPTABLE TO CODE	338716-457-MT34	1X SOCKET WELD	ACCEPTABLE TO CODE
338716-430-MT26	1X SOCKET WELD	ACCEPTABLE TO CODE	338716-458-MT35	1X SOCKET WELD	ACCEPTABLE TO CODE
338716-432-MT27	1X SOCKET WELD	ACCEPTABLE TO CODE	338716-461-MT36	1X SOCKET WELD	ACCEPTABLE TO CODE
338716-437-MT28	1X SOCKET WELD	ACCEPTABLE TO CODE	338716-463-MT37	1X SOCKET WELD	ACCEPTABLE TO CODE
338716-439-MT29	1X SOCKET WELD	ACCEPTABLE TO CODE	338716-465-MT38	1X SOCKET WELD	ACCEPTABLE TO CODE
338716-440-MT30	1X SOCKET WELD	ACCEPTABLE TO CODE	338716-466-MT39	1X SOCKET WELD	ACCEPTABLE TO CODE
338716-442-MT31	1X SOCKET WELD	ACCEPTABLE TO CODE	338716-467-MT40	1X SOCKET WELD	ACCEPTABLE TO CODE
338716-455-MT32	1X SOCKET WELD	ACCEPTABLE TO CODE	338716-468-MT41	1X SOCKET WELD	ACCEPTABLE TO CODE
338716-443-MT42	1X SOCKET WELD	ACCEPTABLE TO CODE			

Inspection Limitation(s):

Unit#: 341 Kilometers: _____ In: _____ Out: _____ Hrs: 2 In: _____ Out: _____ Hrs: _____ Personnel: S.M.	Consumables: MT-MIN	Interpretation by: SIAMAK MAJDNIA SNT-TC-1A: 2 (Print) C.G.S.B.: 2 (Level) C.G.S.B. #: 18202 (Signature) Client Representative: <i>RICK ST. LOUIS</i> (Print) I am in full agreement with report contents (Sign)
---	------------------------	---

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PUMP & COMPRESSOR SPECIALISTS

Call Toll Free

1-800-992-5558

VANCOUVER - CALGARY - EDMONTON - SASKATOON
WINNIPEG - TORONTO - MONTREAL - HALIFAX

NATPRO SLS: 338716

SHELL TAG: 0735A-08030

SHELL PROJECT: CARMON CREEK

SHELL PO: 4512109130

MANUFACTURED: OCT 2015 BY NATPRO

CAMP-NG PRESSURE REDUCTION PACKAGE

FILTER SOLUTIONS INC.

MAWP 1440 PSI AT 133°F

MDMT -50°F AT 1440 PSI

SERIAL NO. 15946A

YEAR BUILT 2014

CRN T5937.213

MADE IN CANADA

Jonell CANADA INC

MODEL JVC 3 B 1440 336

ELEMENT JPMG 336 R CE

SERIAL NO. 15946A

JOB NO.

TAG / PO COALESCER FILTER S-08070

USE JONELL REPLACEMENT ELEMENTS ONLY TO ENSURE OPTIMUM PERFORMANCE
TEL: 403-313-1532 (CALGARY, AB)

CERTIFIED BY
FILTER SOLUTIONS INC.

9928 KPA G AT 54 °C
(MAX ALLOWABLE WORKING PRESSURE)

-46 °C AT 9928 KPA G
(MIN DESIGN METAL TEMPERATURE)

SERIAL NUMBER 15946A

YEAR BUILT 2014

CRN CIN

MADE IN CANADA



14031

MANUFACTURED BY

KingTool
COMPANY

LONGVIEW, TEXAS

CERTIFIED BY

U

M.A.W.P.

300

PSI @

150

°F

W

M.D.M.T.

-49

°F @

@

300

PSI

RT1

SER. NO.

15,101

DIA.

1.6 OD.

INCHES

DATE BUILT:

2014

MODEL

3-B ODORIZER

JOB NO. 14-567

CRN NO. L3956.52

MERCAPTAN GAS ODORIZER
V-08116

CONSULT THE
HAVING JURISDICTION
PRIOR TO INSTALLATION
Consultez une autorité
compétente l'installation

CONDENSATE STORAGE TANK
V-08069

ULC ABOVEGROUND STEEL TANK FOR FLAMMABLE AND COMBUSTIBLE LIQUID
CAN/ULC-S601-07 - UTILITY

LISTED 22LH MFR'S SERIAL NO. U-004066 YEAR MFD. 2015

FACTORY I.D. O A SINGLE WALL DOUBLE WALL INTEGRAL CONTAINED

MAXIMUM OPERATING PRESSURE 7 kPa MAXIMUM OPERATING VACUUM 300 Pa

MAXIMUM TEST PRESSURE 33 kPa TOTAL VENTING CAPACITY 33.5 m³/min PRIMARY TANK NOMINAL CAPACITY 455 L

STEELCRAFT INC. CLEMMER DIVISION WATERLOO, ONT. WWW.STEELCRAFTING.COM

SKID TAG
0735A-08030

NATURAL GAS ELECTRIC HEATER
H-08071

Certified by



Vessco Engineering Ltd., 11 Kingsway Buildings, Bridgend Ind. Est.
Bridgend CF31 3YH South Wales Tel: 01656 750262 www.vessco.co.uk

U
PART
W

PRESSURE 9930 KPa.g AT 93 °C

Max. Allowable Working Pressure

PRESSURE 1034 KPa.g AT 93 °C

Max. Allowable External Working Pressure

TEMPERATURE -45 °C AT 9930 KPa.g

Minimum Design Metal Temperature

UJ0404-1

Manufacturers Serial No.

2014

Web-Stamp

EXHEAT LTD
NORFOLK ENGLAND

www.exheat.com

EX
HEAT

DESCRIPTION 4.4kW / 600V NATURAL GAS HEATER
PURCHASER NATIONAL PROCESS EQUIPMENT INC
P.O. No. PUR630251
P.O. DATE 17/06/14
EXHEAT SERIAL No 146520
YEAR OF MANUFACTURE 2014
TAG No H-01

VESSEL MANUFACTURER VESSCO ENGINEERING LTD
VESSEL SERIAL No UJ0404-1
DESIGN CODE ASME VIII DIV.1 EDITION 2013 'U' STAMPED
DESIGN TEMPERATURE -45°C / 93°C
DESIGN PRESSURE 99.3 Bar.G
IN SERVICE HYDROTEST PRESSURE 129.09 Bar.G
INITIAL HYDROTEST PRESSURE 129.09 Bar.G
P.W.H.T. NIL
RADIOGRAPHY FULL MPI LIFT DPI NIL
ULTRASONICS NOZZLE TO SHELL WELDS
CORROSION ALLOWANCE 1.5MM
SERVICE NATURAL GAS
VOLUME 30 LITRES
WEIGHT 365 KG
INSPECTOR'S STAMP

CRN: W8598.2

18 161

Certified by
Exheat Limited

9930 kPa @ +93°C
U MAWP
W -45°C @ 9930 kPa
RT1 MDMT

Serial number : 146520
Year built : 2014

CRN: W 8598.2

Hydrostatic <input checked="" type="checkbox"/> Pneumatic <input type="checkbox"/> Leak <input type="checkbox"/>	Chart Recorder: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Sales Order #:	338716 (Shell Gas package)
Chart Recorder Range:		Client Reference:	
Test Gauge #:	235-0384 235-0406	Drawing No.:	150# spools
Test Gauge Range:	0-1000 0-1000	Date tested:	May 15 th 2015
Test Pressure:	413 PSI	Test Duration:	60 mins

TOTAL UNITS: 1

ITEM IDENTIFICATION:	
424	416 415 427 419 429 425 459
417	453 428 420 454 431 423
426	
IMPORTANT: EMPTY SYSTEM OF FLUID AFTER TEST BLOW DRY.	
TESTED BY: <u>I. M. Indyre</u>	Signature: <u>[Signature]</u> Testor
WITNESSED BY: <u>RICK ST LOUIS</u>	Signature: <u>[Signature]</u> NPE Representative
INSPECTOR: <u>PETER A HODGE</u>	Signature: <u>[Signature]</u> Inspector
TAGGING / ROUTING INSTRUCTIONS:	

ISSUED FOR CONSTRUCTION

2015 05/13 [Signature]
DATE:YY/MM/DD SIGNATURE



FORM # QAF-036e	PRESSURE/LEAK TEST REPORT	REV # 1	DATE May 24/05	ORIGINATOR QA	REVIEW SERVICE/ PRODUCTION	APPROVAL QA
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Hydrostatic <input checked="" type="checkbox"/> Pneumatic <input type="checkbox"/>	Chart Recorder: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Sales Order #:	338716 (Shell Gas package)
Leak <input type="checkbox"/>		Client Reference:	
Chart Recorder Range:		Drawing No.:	600# spools
Test Gauge #:	523-0254 923-0246	Date tested:	May 15 2015
Test Gauge Range:	0 - 5000 0-5000	Test Duration:	60 mins
Test Pressure:	2220 PSI		

TOTAL UNITS: 1

ITEM IDENTIFICATION:	
409 408 401 404 403 444	
IMPORTANT: EMPTY SYSTEM OF FLUID AFTER TEST BLOW DRY.	
TESTED BY: I. McIntyre	Signature: <u>[Signature]</u> Testor
WITNESSED BY: Rick St. Louis	Signature: <u>[Signature]</u> NPE Representative
INSPECTOR: Peter A. Hodge	Signature: <u>[Signature]</u> Inspector
TAGGING / ROUTING INSTRUCTIONS:	

CONSTRUCTION
 2015/05/13 [Signature]
 SIGNATURE
 PRO

FORM # QAF-036e	PRESSURE/LEAK TEST REPORT	REV # 1	DATE May 24/05	ORIGINATOR QA	REVIEW SERVICE/ PRODUCTION	APPROVAL QA
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Hydrostatic <input checked="" type="checkbox"/> Pneumatic <input type="checkbox"/> Leak <input type="checkbox"/>	Chart Recorder: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Sales Order #:	338716 (Shell Gas package)
Chart Recorder Range:		Client Reference:	
Test Gauge #:	235-0419	Drawing No.:	900# spools
Test Gauge Range:	0-10,000	Date tested:	May 15 2015
Test Pressure:	3330 PSI	Test Duration:	60 mins

TOTAL UNITS: 1

ITEM IDENTIFICATION:	
411	412 413 402 405 406 407 451
IMPORTANT: EMPTY SYSTEM OF FLUID AFTER TEST BLOW DRY.	
TESTED BY: <u>I. McIntyre</u>	Signature: <u>[Signature]</u> Testor
WITNESSED BY: <u>Rick Stilouis</u>	Signature: <u>[Signature]</u> NPE Representative
INSPECTOR: <u>PETER A HODGE</u>	Signature: <u>[Signature]</u> Inspector
TAGGING / ROUTING INSTRUCTIONS:	

CONSTRUCTION
 2015/05/13 [Signature]
 SIGNATURE
 DPO

FORM # QAF-036e	PRESSURE/LEAK TEST REPORT	REV # 1	DATE May 24/05	ORIGINATOR QA	REVIEW SERVICE/ PRODUCTION	APPROVAL QA
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Hydrostatic <input type="checkbox"/> Pneumatic <input type="checkbox"/>	Chart Recorder: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Sales Order #:	7103650
Leak <input type="checkbox"/>		Client Reference:	338716
Chart Recorder Range:	N/A	Drawing No.:	400-1
Test Gauge(s) #:	523-0266/523-0276	Date tested:	July 2/2015
Test Gauge Range:	0-5000 PSI	Test Duration:	60 min
Test Pressure:	2220 PSI		

TOTAL UNITS: 7

ITEM IDENTIFICATION	
Spools 437, 439, 440, 442, 443, 461, 463	
Hydro Start Time 9:00 AM	

IMPORTANT: EMPTY SYSTEM OF FLUID AFTER TEST

TESTED BY: <u>Jeff Sheffield</u>	Signature: _____ Testor
WITNESSED BY: <u>Rick St. Louis</u>	Signature: _____ NPE Representative
INSPECTOR: <u>Aibek YERMEGALIYEV</u>	Signature: _____ Inspector
TAGGING / ROUTING INSTRUCTIONS:	



FORM #	PRESSURE/LEAK TEST	REV #	DATE	ORIGINATOR	REVIEW	APPROVAL
QAF-036e	REPORT	1	May 24/05	QA	SERVICE/ PRODUCTION	QA

Hydrostatic <input type="checkbox"/> Pneumatic <input type="checkbox"/>	Chart Recorder: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Sales Order #:	7103650
Leak <input type="checkbox"/>		Client Reference:	338716
Chart Recorder Range:	N/A	Drawing No.:	400-t
Test Gauge(s) #:	235-0376/235-0386	Date tested:	July 2nd 2015
Test Gauge Range:	0-1000 PSI	Test Duration:	60min
Test Pressure:	413 PSI		

TOTAL UNITS: 12




ITEM IDENTIFICATION	
Spools 421, 422, 430, 432, 455, 456, 457, 458, 465 466, 467, 468	
Hydro Start Time 9:05 AM	
IMPORTANT: EMPTY SYSTEM OF FLUID AFTER TEST	
TESTED BY: <u>Jeff Sheffield</u>	Signature: <u>[Signature]</u> Tester
WITNESSED BY: <u>Rick St. Louis</u>	Signature: <u>[Signature]</u> NPE Representative
INSPECTOR: <u>Aiber Termezayev</u>	Signature: <u>[Signature]</u> Inspector
TAGGING / ROUTING INSTRUCTIONS:	



FORM # QAF-036e	PRESSURE/LEAK TEST REPORT	REV # 1	DATE May 24/05	ORIGINATOR QA	REVIEW SERVICE/ PRODUCTION	APPROVAL QA
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Hydrostatic <input checked="" type="checkbox"/> Pneumatic <input type="checkbox"/>	Chart Recorder: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Sales Order #:	338716
Leak <input type="checkbox"/>			(Shell Gas package)
Chart Recorder Range:	N/A	Client Reference:	
Test Gauge #:	523/0246 - 523/0256	Drawing No.:	900# spools
Test Gauge Range:	0-5000 PSI	Date tested:	June 23/2015
Test Pressure:	3330 PSI	Test Duration:	60 mins

TOTAL UNITS: 1

ITEM IDENTIFICATION:	
412	Hydro Start Time 8:00 AM
IMPORTANT: EMPTY SYSTEM OF FLUID AFTER TEST BLOW DRY.	
TESTED BY: Jeff Sheffield	Signature:  Testor
WITNESSED BY: Rick St. Louis	Signature:  NPE Representative
INSPECTOR: Alben Yermegalien	Signature:  Inspector
TAGGING / ROUTING INSTRUCTIONS:	



ISSUED FOR CONSTRUCTION

DATE: YY/MM/DD




SIGNATURE



FORM #	PRESSURE/LEAK TEST	REV #	DATE	ORIGINATOR	REVIEW	APPROVAL
QAF-036e	REPORT	1	May 24/05	QA	SERVICE/ PRODUCTION	QA

Hydrostatic <input checked="" type="checkbox"/> Pneumatic <input type="checkbox"/>	Chart Recorder: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Sales Order #:	338716
Leak <input type="checkbox"/>			(Shell Gas package)
Chart Recorder Range:	N/A	Client Reference:	
Test Gauge #:	235-0326/235-0316	Drawing No.:	300# spools
Test Gauge Range:	0-2000 PSI	Date tested:	June 23/2015
Test Pressure:	1110 PSI	Test Duration:	60 mins

TOTAL UNITS: 1

ITEM IDENTIFICATION:	
414	Hydro Start Time 8:05 PM
IMPORTANT: EMPTY SYSTEM OF FLUID AFTER TEST BLOW DRY.	
TESTED BY: Jeff Sheffield	Signature:  Tester
WITNESSED BY: Rick St. Louis	Signature:  NPE Representative
INSPECTOR: Alex Yermegaliyev	Signature:  Inspector
TAGGING / ROUTING INSTRUCTIONS:	



ISSUED FOR CONSTRUCTION

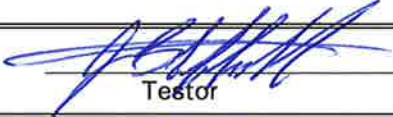
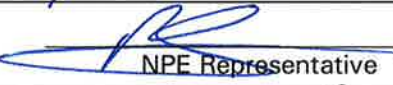
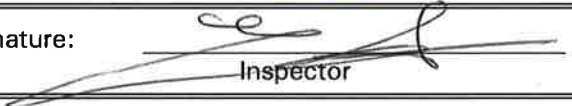
5/10/15
 DATE:YY/MM/DD
 SIGNATURE: 



FORM #	PRESSURE/LEAK TEST	REV #	DATE	ORIGINATOR	REVIEW	APPROVAL
QAF-036e	REPORT	1	May 24/05	QA	SERVICE/ PRODUCTION	QA


Hydrostatic <input checked="" type="checkbox"/> Pneumatic <input type="checkbox"/>	Chart Recorder: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Sales Order #:	338716
Leak <input type="checkbox"/>			(Shell Gas package)
Chart Recorder Range:	N/A	Client Reference:	
Test Gauge #:	523-0266 / 523-0276	Drawing No.:	600# Spools
Test Gauge Range:	0-5000 PSI	Date tested:	June 23/2015
Test Pressure:	2220 PSI	Test Duration:	60 mins

TOTAL UNITS: ~~8~~ 15

ITEM IDENTIFICATION:	
403, 405, 407 , 410, 435, 436, 438, 441, 445-450, 452	
401	
Hydro Start Time 7:55 AM	
405 Bleed Rings 410 Bleed Ring	
403 Bleed Ring 401 Bleed Ring	
IMPORTANT: EMPTY SYSTEM OF FLUID AFTER TEST BLOW DRY.	
TESTED BY: Jeff Sheffield	Signature:  Testor
WITNESSED BY: Rick St. Louis	Signature:  NPE Representative
INSPECTOR: Alben Lermogajiz	Signature:  Inspector
TAGGING / ROUTING INSTRUCTIONS:	



ISSUED FOR CONSTRUCTION

15/06/15
 DATE: YY/MM/DD

 SIGNATURE



FORM #	PRESSURE/LEAK TEST	REV #	DATE	ORIGINATOR	REVIEW	APPROVAL
QAF-036e	REPORT	1	May 24/05	QA	SERVICE/ PRODUCTION	QA

Hydrostatic <input checked="" type="checkbox"/> Pneumatic <input type="checkbox"/>	Chart Recorder: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Sales Order #:	338716
Leak <input type="checkbox"/>			(Shell Gas package)
Chart Recorder Range:		Client Reference:	
Test Gauge #: <i>235-018G</i>	<i>235-018G^{038G}/235-019G^{017G}</i>	Drawing No.:	150# spools
Test Gauge Range:	<i>0-11000 PSI</i>	Date tested:	<i>JULY 28/15</i>
Test Pressure:	413 PSI	Test Duration:	60 mins

TOTAL UNITS: 1

ITEM IDENTIFICATION:
<i>466, 456, 457, 469</i>

IMPORTANT: EMPTY SYSTEM OF FLUID AFTER TEST BLOW DRY.

TESTED BY: <i>Birhanu</i>	Signature: <i>[Signature]</i> Testor
WITNESSED BY: <i>BUK ST. LOUIS</i>	Signature: <i>[Signature]</i> NPE Representative
INSPECTOR: <i>LARRY MCKINLEY</i>	Signature: <i>[Signature]</i> Inspector

TAGGING / ROUTING INSTRUCTIONS:

*revised
27-JUL-15
a*

ISSUED FOR CONSTRUCTION

15/07/15 *[Signature]*
DATE:YY/MM/DD SIGNATURE

natpro

FORM # QAF-036e	PRESSURE/LEAK TEST REPORT	REV # 1	DATE May 24/05	ORIGINATOR QA	REVIEW SERVICE/ PRODUCTION	APPROVAL QA
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Hydrostatic <input checked="" type="checkbox"/> Pneumatic <input type="checkbox"/>	Chart Recorder: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Sales Order #:	338716
Leak <input type="checkbox"/>			(Shell Gas package)
Chart Recorder Range:		Client Reference:	
Test Gauge #:	523-027G/523-026G	Drawing No.:	600# Spools
Test Gauge Range:	0 - 5000 PSI	Date tested:	July 28/15
Test Pressure:	2220 PSI	Test Duration:	60 mins

TOTAL UNITS: 1

ITEM IDENTIFICATION:
461, 463, 403, 404, 464, 437, 442, 440

IMPORTANT: EMPTY SYSTEM OF FLUID AFTER TEST BLOW DRY.	
TESTED BY: Birhanu	Signature: <u>[Signature]</u> Testor
WITNESSED BY: Rick St Louis	Signature: <u>[Signature]</u> NPE Representative
INSPECTOR: LARRY MCKINLEY	Signature: <u>[Signature]</u> Inspector
TAGGING / ROUTING INSTRUCTIONS:	

ISSUED FOR CONSTRUCTION

15/07/15 [Signature]
DATE:YY/MM/DD SIGNATURE



FORM #	PRESSURE/LEAK TEST REPORT	REV #	DATE	ORIGINATOR	REVIEW	APPROVAL
QAF-036e		1	May 24/05	QA	SERVICE/ PRODUCTION	QA

Hydrostatic <input checked="" type="checkbox"/> Pneumatic <input type="checkbox"/>	Chart Recorder: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Sales Order #:	338716 (Shell Gas package)
Leak <input type="checkbox"/>		Client Reference:	
Chart Recorder Range:		Drawing No.:	900# spools
Test Gauge #:	235-041G/235-042G	Date tested:	JULY 28/15
Test Gauge Range:	0 - 10,000 PSI	Test Duration:	60 mins
Test Pressure:	3330 PSI		

TOTAL UNITS: 1

ITEM IDENTIFICATION:	
412	
IMPORTANT: EMPTY SYSTEM OF FLUID AFTER TEST BLOW DRY.	
TESTED BY: Birhanu	Signature: <u>Birhanu</u> Testor
WITNESSED BY: ROCK ST. LOUIS	Signature: <u>[Signature]</u> NPE Representative
INSPECTOR: LARRY McMINLEY	Signature: <u>[Signature]</u> Inspector
TAGGING / ROUTING INSTRUCTIONS:	

ISSUED FOR CONSTRUCTION

15/07/27, NA
DATE:YY/MM/DD SIGNATURE



FORM # QAF-036e	PRESSURE/LEAK TEST REPORT	REV # 1	DATE May 24/05	ORIGINATOR QA	REVIEW SERVICE/ PRODUCTION	APPROVAL QA
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Hydrostatic <input type="checkbox"/> Pneumatic <input type="checkbox"/> Leak <input type="checkbox"/>	Chart Recorder: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Sales Order #:	
Chart Recorder Range:	N/A	Client Reference:	338716
Test Gauge(s) #:	235-0356 / 235-0406	Drawing No.:	466
Test Gauge Range:	0-1000 PSI	Date tested:	Sept 3/2015
Test Pressure:	413 PSI	Test Duration:	60min

TOTAL UNITS: 1

ITEM IDENTIFICATION	
Spool 466 Reworked Spool	
IMPORTANT: EMPTY SYSTEM OF FLUID AFTER TEST	
TESTED BY: <u>Jeff Sheffield</u>	Signature: <u>[Signature]</u> Testor
WITNESSED BY: <u>Rick St. Louis</u>	Signature: <u>[Signature]</u> NPIE Representative
INSPECTOR: <u>Shell Witness: Jamie Barefoot</u>	Signature: <u>[Signature]</u> Inspector <u>Shell Witness</u>
TAGGING / ROUTING INSTRUCTIONS:	

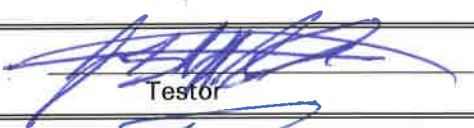
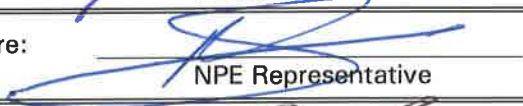
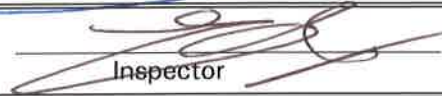
FORM # QAF-036e	PRESSURE/LEAK TEST REPORT	REV # 1	DATE May 24/05	ORIGINATOR QA	REVIEW SERVICE/ PRODUCTION	APPROVAL QA
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Hydrostatic <input checked="" type="checkbox"/> Pneumatic <input type="checkbox"/>	Chart Recorder: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Sales Order #:	338716
Leak <input type="checkbox"/>			(Shell Gas package)
Chart Recorder Range:	N/A	Client Reference:	
Test Gauge #:	235-0396 / 235-040G	Drawing No.:	150# spools 425
Test Gauge Range:	0-1000 PSI	Date tested:	Sept 18 / 2015
Test Pressure:	413 PSI	Test Duration:	60 mins

TOTAL UNITS: 1

ITEM IDENTIFICATION:

IMPORTANT: EMPTY SYSTEM OF FLUID AFTER TEST BLOW DRY.

TESTED BY: Jeff Sheffield	Signature:  Testor
WITNESSED BY: Rick St. Louis	Signature:  NPE Representative
INSPECTOR: Albert Lermegally	Signature:  Inspector
TAGGING / ROUTING INSTRUCTIONS:	

Intertek
 Reviewed
 Witnessed
 Initial:
 Date:
 CA - 0080

ISSUED FOR CONSTRUCTION
 15/09/16 
 DATE (YYYY/MM/DD) SIGNATURE
natpro

FORM # QAF-036e	PRESSURE/LEAK TEST REPORT	REV # 1	DATE May 24/05	ORIGINATOR QA	REVIEW SERVICE/ PRODUCTION	APPROVAL QA
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FARRIS PRESSURE MANAGEMENT

EDMONTON FACILITY INSPECTION TEST REPORT

Farris Pressure Management
a Division of Spartan Controls

CUSTOMER	ORDER#	Farris WO#	Metal Tag:
National Process Equipment	2381449	2381449-001	PSV-08116A
PO: PUR633755			
Req# SLS338715-16			Sup. Tag:

MODEL:	TYPE:	VALVE SIZE:	ORIFICE	FactorySerial#	CRN#
26DA10-120/LC	2600	1"150RFx2"150RF	D	828009-1-A10	0G8442.5R2CL

SERVICE:

SERVICE: Gas StampSymbol: UV NB

CAPACITY: 722 SCFM Metric Only: No

<u>Set Pressure</u>	<u>Back Pressure</u>	<u>Diff</u>	<u>Cold Diff</u>	<u>Temp. Corr.</u>	<u>Temperature</u>
265 PSIG	0 PSIG	265 PSIG	265 PSIG	0 PSIG	100 F (38 C)

MATERIAL/HEAT NUMBER ASSIGNMENT:

Body ZL47054 Nozzle 94922 Valve Inspected for Hydro Tested Parts

Bonnet T4088 Disc K8P9

PERFORMANCE TEST DATA:

TEST FLUID Air Water Air Over Water Saturated Steam

Final Test Pressure 265 PSIG KPAG

Upper B.D.R. Setting: - N/A - Notches
Lower B.D.R. Setting: - 6 - Notches
Shop Test Gauges Used: 1. SIK 2. SIN

BACK PRESSURE TEST:

Not Applicable, (Open Bonnet / Cap Design)

30 PSIG Air

SEAT TIGHTNESS TEST: API-527

TEST FLUID Air Water Air Over Water Saturated Steam

Req'd At 90% 95%

Leak Test Pressure 239 PSIG KPAG

No Visible Leaks Leak Rate 1 B.P.M.

Final Inspection / Tech Tested TSD/BB
Date Tested M-4/2-015

FOR WITNESS TESTING ONLY

Tested By: _____ Date: _____

Customer Witness: _____ Farris Witness: _____

FARRIS PRESSURE MANAGEMENT

EDMONTON FACILITY INSPECTION TEST REPORT

Farris Pressure Management
a Division of Spartan Controls

CUSTOMER		ORDER#	Farris WO#	Metal Tag:	
National Process Equipment		2285391	2285391-001	PSV-08071B	
PO:	PUR631422				
Req#	CGY14-85	Sup. Tag:			
MODEL:	TYPE:	VALVE SIZE:	ORIFICE	FactorySerial#	CRN#
26DA12-120/LC	2600	1"300RFx2"150RF	D	823353-1-A10	OG8442.5R2CL
SERVICE:					
SERVICE:	Gas	StampSymbol: UV NB			
CAPACITY:	45 M3/MIN	Metric Only: Yes (Per CC:2116)			
<u>Set Pressure</u>	<u>Back Pressure</u>	<u>Diff</u>	<u>Cold Diff</u>	<u>Temp. Corr.</u>	<u>Temperature</u>
4137 KPAG	0 KPAG	4137 KPAG	4137 KPAG	0 KPAG	104 F (40 C)
MATERIAL/HEAT NUMBER ASSIGNMENT:					
Body	T2484	Nozzle	N4H1	Valve Inspected for Hydro Tested Parts MP11L	
Bonnet	T2992	Disc	K8P9		
PERFORMANCE TEST DATA:					
TEST FLUID	<input checked="" type="checkbox"/> Air	Final Test Pressure		Upper B.D.R. Setting:	
	<input type="checkbox"/> Water		PSIG	Lower B.D.R. Setting:	9 Notches
	<input type="checkbox"/> Air Over Water	4137	KPAG	Shop Test Gauges Used:	1.5" 2.5" 11"
	<input type="checkbox"/> Saturated Steam				
BACK PRESSURE TEST:					
<input type="checkbox"/> Not Applicable, (Open Bonnet / Cap Design)					
<input checked="" type="checkbox"/> 30 PSIG Air					
SEAT TIGHTNESS TEST: API-527					
TEST FLUID	Req'd At	Leak Test Pressure		PSIG	3733 KPAG
<input checked="" type="checkbox"/> Air	<input checked="" type="checkbox"/> 90%	No Visible Leaks	<input type="checkbox"/>		
<input type="checkbox"/> Water	<input type="checkbox"/> 95%	Leak Rate	12	B.P.M.	
<input type="checkbox"/> Air Over Water	<input type="checkbox"/> 5 PSIG < Set			Final Inspection / Tech Tested	[Signature]
<input type="checkbox"/> Saturated Steam				Date Tested	Jan 13/2015
FOR WITNESS TESTING ONLY					
Tested By: _____			Date: _____		
Customer Witness: _____			Farris Witness: _____		

FARRIS PRESSURE MANAGEMENT

EDMONTON FACILITY INSPECTION TEST REPORT

Farris Pressure Management
a Division of Spartan Controls

CUSTOMER	ORDER#	Farris WO#	Metal Tag:
National Process Equipment	2285391	2285391-002	PSV-08071C
PO: PUR631422			
Req# CGY14-85			Sup. Tag:

MODEL:	TYPE:	VALVE SIZE:	ORIFICE	FactorySerial#	CRN#
26DA10-120/LC	2600	1"150RFx2"150RF	D	818159-4-A10	0G8442.5R2CL

SERVICE:

SERVICE: Gas StampSymbol: UV NB

CAPACITY: 14.2 M3/MIN Metric Only: Yes (Per CC:2116)

<u>Set Pressure</u>	<u>Back Pressure</u>	<u>Diff</u>	<u>Cold Diff</u>	<u>Temp. Corr.</u>	<u>Temperature</u>
1240 KPAG	0 KPAG	1240 KPAG	1240 KPAG	0 KPAG	158 F (70 C)

MATERIAL/HEAT NUMBER ASSIGNMENT:

Body T2940 Nozzle 425031 Valve Inspected for Hydro Tested Parts *marked*

Bonnet V4799 Disc K8P9

PERFORMANCE TEST DATA:

TEST FLUID Air Water Air Over Water Saturated Steam

Final Test Pressure 1240 KPAG

Upper B.D.R. Setting: _____ Notches

Lower B.D.R. Setting: 2 Notches

Shop Test Gauges Used: 1. 5115 2. 5111

BACK PRESSURE TEST:

Not Applicable, (Open Bonnet / Cap Design)

30 PSIG Air

SEAT TIGHTNESS TEST: API-527

TEST FLUID Air Water Air Over Water Saturated Steam

Req'd At 90% 95%

Leak Test Pressure 1116 PSIG 1116 KPAG

No Visible Leaks

Leak Rate 0 B.P.M.

Final Inspection / Tech Tested CR...

Date Tested 11/13/2014

FOR WITNESS TESTING ONLY

Tested By: _____ Date: _____

Customer Witness: _____ Farris Witness: _____

FARRIS PRESSURE MANAGEMENT

EDMONTON FACILITY INSPECTION TEST REPORT

Farris Pressure Management
a Division of Spartan Controls

CUSTOMER	ORDER#	Farris WO#	Metal Tag:
National Process Equipment	2285391	2285391-003	PSV-08071D
PO:	PUR631422		
Req#	CGY14-85		Sup. Tag:

MODEL:	TYPE:	VALVE SIZE:	ORIFICE	FactorySerial#	CRN#
26DA10-120/LC	2600	1"150RFx2"150RF	D	821971-1-A10	0G8442.5R2CL

SERVICE:

SERVICE:	Gas	Stamp Symbol:	UV NB
CAPACITY:	7.5 M3/MIN	Metric Only:	Yes (Per CC:2116)

<u>Set Pressure</u>	<u>Back Pressure</u>	<u>Diff</u>	<u>Cold Diff</u>	<u>Temp. Corr.</u>	<u>Temperature</u>
620 KPAG	0 KPAG	620 KPAG	620 KPAG	0 KPAG	158 F (70 C)

MATERIAL/HEAT NUMBER ASSIGNMENT:

Body	V4906	Nozzle	L8A0	Valve Inspected for Hydro Tested Parts None
Bonnet	T2754	Disc	K8P9	

PERFORMANCE TEST DATA:

TEST FLUID	<input checked="" type="checkbox"/> Air <input type="checkbox"/> Water <input type="checkbox"/> Air Over Water <input type="checkbox"/> Saturated Steam	Final Test Pressure	Upper B.D.R. Setting: _____ Notches Lower B.D.R. Setting: <u>3</u> Notches Shop Test Gauges Used: <u>1.5/15</u> <u>2.5/10</u>
		_____ PSIG	
		<u>620</u> KPAG	

BACK PRESSURE TEST:

Not Applicable, (Open Bonnet / Cap Design)

3.50 PSIG Air

SEAT TIGHTNESS TEST: API-527

TEST FLUID	Req'd At	Leak Test Pressure	_____ PSIG <u>555</u> KPAG
<input checked="" type="checkbox"/> Air	<input checked="" type="checkbox"/> 90%	No Visible Leaks	<input type="checkbox"/>
<input type="checkbox"/> Water	<input type="checkbox"/> 95%	Leak Rate	<u>0</u> B.P.M.
<input type="checkbox"/> Air Over Water	<input type="checkbox"/> 5 PSIG < Set	Final Inspection / Tech Tested [Signature]	
<input type="checkbox"/> Saturated Steam		Date Tested 11/13/2011	

FOR WITNESS TESTING ONLY

Tested By: _____	Date: _____
Customer Witness: _____	Farris Witness: _____

FARRIS PRESSURE MANAGEMENT

EDMONTON FACILITY INSPECTION TEST REPORT

Farris Pressure Management
a Division of Spartan Controls

CUSTOMER	ORDER#	Farris WO#	Metal Tag:
National Process Equipment	2285391	2285391-004	PSV-08071A
PO:	PUR631422		
Req#	CGY14-85		Sup. Tag:

MODEL:	TYPE:	VALVE SIZE:	ORIFICE	FactorySerial#	CRN#
26DA14-120/LC	2600	1.5"900RFx2"300RF	D	805417-5-A10	0G8442.5R2CL

SERVICE:

SERVICE: Gas StampSymbol: UV NB

CAPACITY: 103.2 M3/MIN Metric Only: Yes (Per CC:2116)

<u>Set Pressure</u>	<u>Back Pressure</u>	<u>Diff</u>	<u>Cold Diff</u>	<u>Temp. Corr.</u>	<u>Temperature</u>
9600 KPAG	0 KPAG	9600 KPAG	9600 KPAG	0 KPAG	104 F (40 C)

MATERIAL/HEAT NUMBER ASSIGNMENT:

Body HT058 Nozzle T2533 Valve Inspected for Hydro Tested Parts MPTZ

Bonnet W323 Disc L5Y6

PERFORMANCE TEST DATA:

TEST FLUID Air Water Air Over Water Saturated Steam

Final Test Pressure 9600 PSIG 9600 KPAG

Upper B.D.R. Setting: _____ Notches

Lower B.D.R. Setting: -10 Notches

Shop Test Gauges Used: 1.5/11K 2.5/11K

BACK PRESSURE TEST:

Not Applicable, (Open Bonnet / Cap Design)

30 PSIG Air

SEAT TIGHTNESS TEST: API-527

TEST FLUID Air Water Air Over Water Saturated Steam

Req'd At 90% 95%

Leak Test Pressure 9600 PSIG 9600 KPAG

No Visible Leaks

Leak Rate 1/10 B.P.M.

Final Inspection / Tech Tested MPTZ

Date Tested 11/13/11

FOR WITNESS TESTING ONLY

Tested By: _____ Date: _____

Customer Witness: _____ Farris Witness: _____

FARRIS PRESSURE MANAGEMENT

EDMONTON FACILITY INSPECTION TEST REPORT

Farris Pressure Management
a Division of Spartan Controls

CUSTOMER	ORDER#	Farris WO#	Metal Tag:
National Process Equipment	2285391	2285391-005	PSV-08070A
PO: PUR631422			
Req# CGY14-85			Sup. Tag:

MODEL:	TYPE:	VALVE SIZE:	ORIFICE	FactorySerial#	CRN#
26DA13-120/LC	2600	1"600RFx2"150RF	D	813491-1-A10	0G8442.5R2CL

SERVICE:

SERVICE: Gas Stamp Symbol: UV NB

CAPACITY: 106.8 M3/MIN Metric Only: Yes (Per CC:2116)

<u>Set Pressure</u>	<u>Back Pressure</u>	<u>Diff</u>	<u>Cold Diff</u>	<u>Temp. Corr.</u>	<u>Temperature</u>
9930 KPAG	0 KPAG	9930 KPAG	9930 KPAG	0 KPAG	104 F (40 C)

MATERIAL/HEAT NUMBER ASSIGNMENT:

Body T2363 Nozzle 425301 Valve Inspected for Hydro Tested Parts WRTCL

Bonnet T2455 Disc L1L1

PERFORMANCE TEST DATA:

TEST FLUID Air Water Air Over Water Saturated Steam

Final Test Pressure 9930 PSIG Upper B.D.R. Setting: _____ Notches

Lower B.D.R. Setting: 10 Notches

Shop Test Gauges Used: 1.511K 2.511K

BACK PRESSURE TEST:

Not Applicable, (Open Bonnet / Cap Design)

30 PSIG Air

SEAT TIGHTNESS TEST: API-527

TEST FLUID Air Water Air Over Water Saturated Steam

Req'd At 90% 95%

Leak Test Pressure 8937 PSIG 8937 KPAG

No Visible Leaks

Leak Rate 4 B.P.M.

Final Inspection / Tech Tested C. R. G. S.

Date Tested 10/13/04

FOR WITNESS TESTING ONLY

Tested By: _____ Date: _____

Customer Witness: _____ Farris Witness: _____



MULTI TRANSMITTER CALIBRATION REPORT

COMPANY: Natpro			DATE: SEPT/23/2015		
LSD: Calgary					
INSTRUMENT INFORMATION			ORIFICE METER RUN		
Tag No.: PZT-08071A			Make:		
Manufacturer: Rosemount			Serial No.:		
Model No: 3051			Orifice Size:		
Service: s/n 0591787			Up Stream Pipe Diameters:		
			Down Stream Pipe Diameters:		
			Plate Clean: Warped: Edges Sharp:		
CALIBRATION DATA					
DIFFERENTIAL RANGE:			PRESSURE RANGE: 0-12000kPa		
TEST POINT	AS FOUND	AS LEFT	TEST POINT	AS FOUND	AS LEFT
			0	0	0
			3000	3000	3000
			6000	6000	6000
			9000	9000	9000
			12000	12000	12000
			TEMPERATURE:		
			0		
			25		
			50		
			75		
			100		
PRONGHORN CONTROLS LTD. TEST EQUIPMENT USED					
ASSET NO.	MAKE	MODEL NO.	CALIBRATION DUE DATE		
2262-738404	CRYSTAL	IS-33	JUNE/1/2016		
METHODS USED: HIGH PRESSURE PUMP					
CALIBRATED BY: MATT MACKINNON					



MULTI TRANSMITTER CALIBRATION REPORT

COMPANY: Natpro			DATE: SEPT/23/2015		
LSD: Calgary					
INSTRUMENT INFORMATION			ORIFICE METER RUN		
Tag No.: PZT-08071B			Make:		
Manufacturer: Rosemount			Serial No.:		
Model No: 3051			Orifice Size:		
Service: s/n 0591788			Up Stream Pipe Diameters:		
			Down Stream Pipe Diameters:		
			Plate Clean: Warped: Edges Sharp:		
CALIBRATION DATA					
DIFFERENTIAL RANGE:			PRESSURE RANGE: 0-5515kPa		
TEST POINT	AS FOUND	AS LEFT	TEST POINT	AS FOUND	AS LEFT
			0	0	0
			1378.75	1378.75	1378.75
			2757.5	2757.5	2757.5
			4136.25	4136.25	4136.25
			5515	5515	5515
			TEMPERATURE:		
			0		
			25		
			50		
			75		
			100		
PRONGHORN CONTROLS LTD. TEST EQUIPMENT USED					
ASSET NO.	MAKE	MODEL NO.	CALIBRATION DUE DATE		
2262-738404	CRYSTAL	IS-33	JUNE/1/2016		
METHODS USED: HIGH PRESSURE PUMP					
CALIBRATED BY: MATT MACKINNON					



MULTI TRANSMITTER CALIBRATION REPORT

COMPANY: Natpro			DATE: SEPT/23/2015		
LSD: Calgary					
INSTRUMENT INFORMATION			ORIFICE METER RUN		
Tag No.: PZT-08071C			Make:		
Manufacturer: Rosemount			Serial No.:		
Model No: 3051			Orifice Size:		
Service: s/n 0591789			Up Stream Pipe Diameters:		
			Down Stream Pipe Diameters:		
			Plate Clean: Warped: Edges Sharp:		
CALIBRATION DATA					
DIFFERENTIAL RANGE:			PRESSURE RANGE: 0-1500Pa		
TEST POINT	AS FOUND	AS LEFT	TEST POINT	AS FOUND	AS LEFT
			0	0	0
			375	375	375
			750	750	750
			1125	1125	1125
			1500	1500	1500
			TEMPERATURE:		
			0		
			25		
			50		
			75		
			100		
PRONGHORN CONTROLS LTD. TEST EQUIPMENT USED					
ASSET NO.	MAKE	MODEL NO.	CALIBRATION DUE DATE		
2262-738404	CRYSTAL	IS-33	JUNE/1/2016		
METHODS USED: HIGH PRESSURE PUMP					
CALIBRATED BY: MATT MACKINNON					



MULTI TRANSMITTER CALIBRATION REPORT

COMPANY: Natpro		DATE: SEPT/23/2015			
LSD: Calgary					
INSTRUMENT INFORMATION		ORIFICE METER RUN			
Tag No.:	TT-21601A	Make:			
Manufacturer:	Rosemount	Serial No.:			
Model No:	3144P	Orifice Size:			
Service:	s/n 0849598	Up Stream Pipe Diameters:			
		Down Stream Pipe Diameters:			
		Plate Clean:	Warped: Edges Sharp:		
CALIBRATION DATA					
DIFFERENTIAL RANGE:			PRESSURE RANGE:		
TEST POINT	AS FOUND	AS LEFT	TEST POINT	AS FOUND	AS LEFT
			TEMPERATURE: -50/50 Deg C		
			0	-50	-50
			25	-25	-25
			50	0	0
			75	25	25
			100	50	50
PRONGHORN CONTROLS LTD. TEST EQUIPMENT USED					
ASSET NO.	MAKE	MODEL NO.	CALIBRATION DUE DATE		
9557205	FLUKE	725	SEPT/10/2015		
METHODS USED: SOURCE					
CALIBRATED BY: MATT MACKINNON					



MULTI TRANSMITTER CALIBRATION REPORT

COMPANY: Natpro			DATE: SEPT/23/2015		
LSD: Calgary					
INSTRUMENT INFORMATION			ORIFICE METER RUN		
Tag No.: TT-08071A1			Make:		
Manufacturer: Rosemount			Serial No.:		
Model No: 3144P			Orifice Size:		
Service: s/n 0634701			Up Stream Pipe Diameters:		
			Down Stream Pipe Diameters:		
			Plate Clean: Warped: Edges Sharp:		
CALIBRATION DATA					
DIFFERENTIAL RANGE:			PRESSURE RANGE:		
TEST POINT	AS FOUND	AS LEFT	TEST POINT	AS FOUND	AS LEFT
			TEMPERATURE: -50/100 Deg C		
			0	-50	-50
			25	-12.5	-12.5
			50	25	25
			75	62.5	62.5
			100	100	100
PRONGHORN CONTROLS LTD. TEST EQUIPMENT USED					
ASSET NO.	MAKE	MODEL NO.	CALIBRATION DUE DATE		
9557205	FLUKE	725	SEPT/10/2015		
METHODS USED: SOURCE					
CALIBRATED BY: MATT MACKINNON					



MULTI TRANSMITTER CALIBRATION REPORT

COMPANY: Natpro			DATE: SEPT/23/2015		
LSD: Calgary					
INSTRUMENT INFORMATION			ORIFICE METER RUN		
Tag No.: TZT-08071B1			Make:		
Manufacturer: Rosemount			Serial No.:		
Model No: 3144P			Orifice Size:		
Service: s/n 0834702			Up Stream Pipe Diameters:		
			Down Stream Pipe Diameters:		
			Plate Clean: Warped: Edges Sharp:		
CALIBRATION DATA					
DIFFERENTIAL RANGE:			PRESSURE RANGE:		
TEST POINT	AS FOUND	AS LEFT	TEST POINT	AS FOUND	AS LEFT
			TEMPERATURE: -50/100 Deg C		
			0	-50	-50
			25	-12.5	-12.5
			50	25	25
			75	62.5	62.5
			100	100	100
PRONGHORN CONTROLS LTD. TEST EQUIPMENT USED					
ASSET NO.	MAKE	MODEL NO.	CALIBRATION DUE DATE		
9557205	FLUKE	725	SEPT/10/2015		
METHODS USED: SOURCE					
CALIBRATED BY: MATT MACKINNON					



MULTI TRANSMITTER CALIBRATION REPORT

COMPANY: Natpro			DATE: SEPT/23/2015		
LSD: Calgary					
INSTRUMENT INFORMATION			ORIFICE METER RUN		
Tag No.: TZT-08071A			Make:		
Manufacturer: Rosemount			Serial No.:		
Model No: 3144P			Orifice Size:		
Service: s/n 0834703			Up Stream Pipe Diameters:		
			Down Stream Pipe Diameters:		
			Plate Clean: Warped: Edges Sharp:		
CALIBRATION DATA					
DIFFERENTIAL RANGE:			PRESSURE RANGE:		
TEST POINT	AS FOUND	AS LEFT	TEST POINT	AS FOUND	AS LEFT
			TEMPERATURE: -50/100 Deg C		
			0	-50	-50
			25	-12.5	-12.5
			50	25	25
			75	62.5	62.5
			100	100	100
PRONGHORN CONTROLS LTD. TEST EQUIPMENT USED					
ASSET NO.	MAKE	MODEL NO.	CALIBRATION DUE DATE		
9557205	FLUKE	725	SEPT/10/2015		
METHODS USED: SOURCE					
CALIBRATED BY: MATT MACKINNON					



Calibrations – Traceable to NRC and NIST | Installation | Maintenance

Certificate of Calibration
Pressure Indicator

Company: Pronghorn Controls
Address: #601-9 Street SW
Drumheller, Alberta, T0J 0Y0

Date: June 1, 2015
Due: June 1, 2016
Tech: Austin Tarrant

Make: Crystal
Range: 36 – 3000 PSI

Model#: IS33 – 36/3000
Serial #: 2262-738404

Test Conditions: 20.0 – 21.0°C and 20.0 – 25.0% RH

Comments: Indicator is within $\pm 0.05\%$ of reading + 0.005% full scale as per manufacture's published accuracy. Indicator calibrated as per internal procedure RC-010.1.

The test accuracy ratio of this calibration is at least 4:1 unless otherwise indicated. This unit has been calibrated using equipment and standards traceable to the National Research Council of Canada (NRC), the National Institute of Standards and Technology (NIST), or derived from accepted values of natural physical constants. This calibration certificate applies only to the item described and shall not be reproduced, other than in full, without approval from Reding Instrument Services Ltd.

Calibration Standard(s) Used

Asset Used	Model Number	Serial Number	Asset Due Date
DH Instruments	PG7202	392	May 12, 2017
DH Instruments	RPM4	229	September 16, 2015
Fluke	5520A	8979001	October 17, 2015

Technician

June 1, 2015
Date

Crystal is33
 S/N:2262-738404

As Found Calibration Data

Applied Pressure Nominal (PSI)	Applied Pressure Actual (PSI)	Indicated Pressure (PSI)	Error (PSI)	Allowable Error (PSI)
L.P. Sensor				
5	5.00001	5.000	0.000	±0.0043
10	10.0002	9.999	-0.001	±0.0068
15	15.0001	15.000	0.000	±0.0093
20	20.0002	20.001	0.001	±0.0118
25	25.0000	25.003	0.003	±0.0143
30	30.0000	30.006	0.006	±0.0168
36	36.0001	36.007	0.007	±0.0198
H.P. Sensor				
500	500.0001	499.8	-0.2	±0.40
1000	1000.001	999.9	-0.1	±0.65
1500	1500.000	1500.0	0.0	±0.90
2000	2000.000	2000.2	0.2	±1.15
2500	2500.000	2500.2	0.2	±1.40
3000	3000.001	3000.2	0.2	±1.65

As Left Calibration Data

Applied Pressure Nominal (PSI)	Applied Pressure Actual (PSI)	Indicated Pressure (PSI)	Error (PSI)	Allowable Error (PSI)
L.P. Sensor				
5	5.00001	5.000	0.000	±0.0043
10	10.0002	9.999	-0.001	±0.0068
15	15.0001	15.000	0.000	±0.0093
20	20.0002	20.001	0.001	±0.0118
25	25.0000	25.003	0.003	±0.0143
30	30.0000	30.006	0.006	±0.0168
36	36.0001	36.007	0.007	±0.0198
H.P. Sensor				
500	500.0001	499.8	-0.2	±0.40
1000	1000.001	999.9	-0.1	±0.65
1500	1500.000	1500.0	0.0	±0.90
2000	2000.000	2000.2	0.2	±1.15
2500	2500.000	2500.2	0.2	±1.40
3000	3000.001	3000.2	0.2	±1.65

Applied Current (mA)		Indicated Current (mA)	Error (mA)	Allowable Error (mA)
4		4.000	0	±0.002
12		12.002	0.002	±0.006
20		20.004	0.004	±0.012

Math Mackinnon.

Certificate of Calibration Multifunction Process Calibrator

Make:	Fluke	Customer:	Pronghorn Controls
Model:	725	Address:	#601-9 Street S.W. Drumheller, Alberta, T0J 0Y0
Serial Number:	9557205		
Description:	Multi-function Calibrator	Calibration Date:	September 9, 2015
Location:	Calgary, Alberta, Canada	Calibration Due:	September 9, 2016
Procedure :	Fluke service manual	Technician:	Kaley Hough
Report Number:	PC-090915-02	As Returned:	In tolerance
As Received:	In tolerance		
Temperature:	20-22°C	Relative Humidity:	25-30%

Reding Instrument Services Ltd. certifies that the above listed instrument meets or exceeds all published specifications unless otherwise indicated. The test accuracy ratio of this calibration is at least 4:1 unless otherwise indicated. This instrument has been calibrated using equipment and standards traceable to the National Research Council of Canada (NRC), the National Institute of Standards and Technology (NIST), or derived from accepted values of natural physical constants. This calibration certificate applies only to the item described and shall not be reproduced, other than in full, without approval from Reding Instrument Services Ltd.

Calibration Standards

Make	Model	Serial Number	Recall Date
Fluke	5520A	8979001	October 17, 2015
Agilent	3458A	MY45043539	October 17, 2015

Kaley Hough
Technician

September 9 2015
Date

Fluke 725

Multifunction Process Calibrator

As Found/As Left

Instrument ID:9557205

Report #:PC-090915-02

TEST	L-LIMIT	READING	U-LIMIT	ERROR
UPPER DISPLAY VOLTAGE MEASUREMENT TESTS				
APPLIED (V)		OBSERVED (V)		
0	-0.002	0.001	0.002	0.001
15	14.995	14.999	15.005	-0.001
30	29.992	29.997	30.008	-0.003
LOWER DISPLAY mV/TC MEASUREMENT TESTS				
APPLIED (mV)		OBSERVED (mV)		
0	-0.02	0.00	0.02	0.00
45	44.97	45.00	45.03	0.00
90	89.96	90.00	90.04	0.00
LOWER DISPLAY VOLTAGE MEASUREMENT TESTS				
APPLIED (V)		OBSERVED (V)		
0	-0.002	0.000	0.002	0.000
10	9.996	9.999	10.004	-0.001
20	19.994	19.999	20.006	-0.001
UPPER DISPLAY mA MEASUREMENT TESTS				
APPLIED (mA)		OBSERVED (mA)		
4	3.997	4.000	4.003	0.000
12	11.995	12.000	12.005	0.000
24	23.993	24.000	24.007	0.000
LOWER DISPLAY mA MEASUREMENT TESTS				
APPLIED (mA)		OBSERVED (mA)		
4	3.997	4.000	4.003	0.000
12	11.995	12.000	12.005	0.000
24	23.993	24.002	24.007	0.002
LOWER DISPLAY FREQUENCY MEASUREMENT TEST				
APPLIED (kHz)		OBSERVED (kHz)		
10	9.98	10.00	10.02	0.00
LOWER DISPLAY FREQUENCY SOURCE TEST				
GENERATED (kHz)		OBSERVED (kHz)		
10	9.975	10.0001	10.025	0.0001

Fluke 725
Multifunction Process Calibrator

As Found/As Left

Instrument ID:9557205
 Report #:PC-090915-02

TEST	L-LIMIT	READING	U-LIMIT	ERROR	
LOWER DISPLAY 4-WIRE RESISTANCE MEASUREMENT TESTS					
APPLIED (Ohms)		OBSERVED (Ohms)			
15		14.90	15.02	15.10	0.02
350		349.90	350.01	350.10	0.01
500		499.5	500.0	500.5	0.00
1500		1499.5	1500.0	1500.5	0.00
3200		3199.0	3199.9	3201.0	-0.10
LOWER DISPLAY 3-WIRE RTD MEASUREMENT TEST					
APPLIED (Ohms)		OBSERVED (Ohms)			
350		349.80	349.96	350.20	-0.04
LOWER DISPLAY THERMOCOUPLE MEASUREMENT TEST (TYPE-J)					
APPLIED (°C)		OBSERVED (°C)			
0		-0.70	0.00	0.70	0.00
LOWER DISPLAY THERMOCOUPLE SOURCE TEST (TYPE-J)					
GENERATED (°C)		OBSERVED (°C)			
0		-0.70	-0.06	0.70	-0.06
LOWER DISPLAY mA SOURCE TESTS					
GENERATED (mA)		OBSERVED (mA)			
4		3.9972	3.9995	4.0028	-0.0005
12		11.9956	11.9989	12.0044	-0.0011
24		23.9932	23.9978	24.0068	-0.0022
LOWER DISPLAY mV SOURCE TESTS					
GENERATED (mV)		OBSERVED (mV)			
0		-0.020	0.000	0.020	0.000
45		44.970	44.994	45.030	-0.006
100		99.960	99.993	100.040	-0.007
LOWER DISPLAY VOLTAGE SOURCE TESTS					
GENERATED (V)		OBSERVED (V)			
0		-0.0020	0.0000	0.0020	0.0000
5		4.9970	4.9997	5.0030	-0.0003
10		9.9960	9.9998	10.0040	-0.0002

Fluke 725

Multifunction Process Calibrator

As Found/As Left

Instrument ID:9557205

Report #:PC-090915-02

TEST	L-LIMIT	READING	U-LIMIT	ERROR
LOWER DISPLAY OHMS SOURCE TESTS				
GENERATED (Ohms)	OBSERVED (Ohms)			
15	14.90	15.06	15.10	0.06
360	359.90	360.01	360.10	0.01
500	499.50	499.75	500.50	-0.25
1500	1499.50	1500.39	1500.50	0.39
3200	3199.00	3200.52	3201.00	0.52

CERTIFICATE OF CALIBRATION

ISSUED BY SEAWARD ELECTRONIC

DATE OF ISSUE 25 November 20 CERTIFICATE NUMBER SEA01135/ MI / 3



Seaward Group
11, Bracken Hill
South West Ind. Estate
Peterlee
Co. Durham
SR8 2SW

Telephone: 0191 5878737(9) Fax: 0191 5184666
e-mail: service@calibrationhouse.com

CALIBRATED BY

M. WALTON

PAGE 1 of 3 PAGES

Requested By:	EXHEAT FARADAY HOUSE THETFORD IP25 6NG
Order Number:	
Manufacturer:	SEFELEC
Model:	SMG500+
Description:	ELECTRICAL SAFETY TESTER
Serial Number:	0801266/1109467
Asset Number:	
Seaward Reference:	000111
Temperature (°C):	18.5
Humidity (% RH):	63.4
Calibration Date:	25 April 2014
Calibration Category::	A: WITHIN SPECIFICATION, NO ADJUSTMENT REQUIRED

The measurements reported in this certificate were carried out using equipment whose measured values are traceable to National Standards, where these exist.

All procedures employed and management controls are in conformance with BS EN ISO9001: 2008, certificate no.

Calibration was carried out on the above customers premises on the date shown.

Approved Signatory

CERTIFICATE OF CALIBRATION

Issued By HITEK Ltd

Certificate Number OUB0010

Date of Issue 02 February 2015



0404

Approved Signatory

Page 1 of 2 Pages



HITEK Ltd
Unit 6, Foundry Court
Foundry Lane
Horsham
West Sussex. RH13 5PY

Jeff King

Customer : Exheat Ltd
Threxton Road Industrial Estate, Watton
Thetford Norfolk IP25 6NG

Date Received : 02 February 2015

Instrument :	System ID :	H00018010	Job Number :	J2710-3
	Description :	Digital Multimeter	Ref. Number :	HX1103
	Manufacturer :	Cropico		
	Model Number :	DO05002		
	Serial Number :	26B-1135		
	Procedure Version :	1.00U/N		

Environmental Conditions

Temperature : 23°C +/- 3°C
Relative Humidity : 50% +/- 20%

Mains Voltage : 230V +/- 10V
Mains Frequency : 50Hz +/- 1Hz

Comments

Instrument was placed in lab and allowed to stabilise before calibration.
Consulted manufacturer manual for instrument specification.
*(1) = 25ppm + 100uR, *(2) = 19ppm + 100uR, *(3) = 15ppm + 1mR
*(4) = 16ppm, *(5) = 15ppm, *(6) = 16ppm

Calibration Information

The instrument was calibrated against laboratory standards whose values are traceable to recognised National Standards. The uncertainty limits quoted refer to the measured values only, with no account being taken of the instruments ability to maintain its calibration.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k=2$, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

Calibrated By : Chris Tymms

Date of Calibration : 02 February 2015

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to recognised national standards, and to the units of measurement realised at the National Physical Laboratory or other recognised national standards laboratories. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

CERTIFICATE OF CALIBRATION

Issued By Hitek Calibration Services

Certificate Number U6855

Date of Issue 29 October 2014



0404

Approved Signatory

Page 1 of 3 Pages



Hitek Calibration Services
Unit 6, Foundry Court
Foundry Lane
Horsham
West Sussex RH13 5PY

☒ Jeff King

Customer : Exheat Ltd
Thrextan Road Industrial Estate, Watton
Thetford Norfolk IP25 6NG

Date Received : 31 July 2014

Instrument -	System ID :	H00017947	Job Number :	J021161-1
	Description :	Multifunction Process Calibrator	Ref. Number :	HX0335
	Manufacturer :	Fluke	Owner :	On-Site
	Model Number :	725	Location :	Elec Test
	Serial Number :	8613174	Last Certificate Number :	U6772
	Procedure Version :	1.00U/N	Last Calibration Date :	02/09/2014

Environmental Conditions

Temperature :	23°C +/- 3°C	Mains Voltage :	230V +/- 10V
Relative Humidity :	50% +/- 20%	Mains Frequency :	50Hz +/- 1Hz

Comments

Instrument placed in laboratory and allowed to stabilise for at least 12 hours.
Tested to Manufacturers specification, Calibration Manual, Sep 1999 Rev.1,3/00.
Calibrated in accordance with ITS90 and BS EN60751.
Lead resistance subtracted from measurements.

Calibration Information

The instrument was calibrated against laboratory standards whose values are traceable to recognised National Standards. The uncertainty limits quoted refer to the measured values only, with no account being taken of the instruments ability to maintain its calibration.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k=2$, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

Calibrated By : Jeff King

Date of Calibration : 29 October 2014

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Flow Calibration with Adjustment

30320628-3413628

3003281804

Purchase order number

CA-3005264813-10 / Endress+Hauser Flowtec

Order N°/Manufacturer

83F15-ND05/0

Order code

PROMASS 83 F 1/2"

Transmitter/Sensor

JA04C816000

Serial N°

.

Tag N°

FCP-6.F

Calibration rig

47.76682 lb/min (\pm 100%)

Calibrated full scale

Service interface

Calibrated output

1.6956

Calibration factor

-1

Zero point

71.8 °F

Water temperature

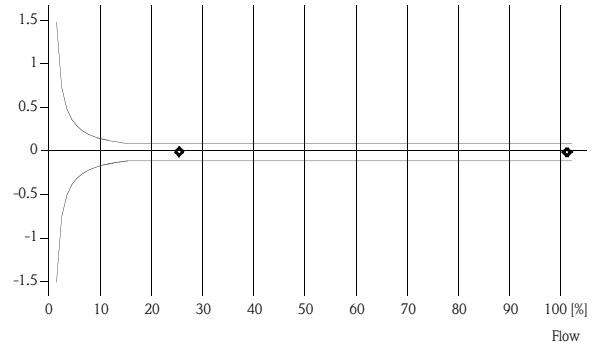
Flow [%]	Flow [lb/min]	Duration [s]	m target [lb]	m meas. [lb]	Δ o.r.* [%]	Outp.** [mA]
25.0	11.958	30.1	5.9889	5.9885	-0.01	8.01
25.1	11.969	30.1	5.9945	5.9952	0.01	8.01
100.9	48.187	60.2	48.338	48.338	0.00	20.14
101.3	48.370	60.2	48.514	48.514	0.00	20.20
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

*o.r.: of reading

**Calculated value (4 - 20 mA)

Measured error % o.r.

Tolerance limit: \pm 0.1% o.r.



For detailed data concerning output specifications of the unit under test, see Technical Information (TI), chapter Performance characteristics.

The calibration is traceable to the N.I.S.T. through standards certified at preset intervals.

Endress+Hauser Flowtec operates ISO/IEC 17025 accredited calibration facilities in Reinach (CH), Cernay (FR), Greenwood (USA), Aurangabad (IN) and Suzhou (CN).



10-17-2014

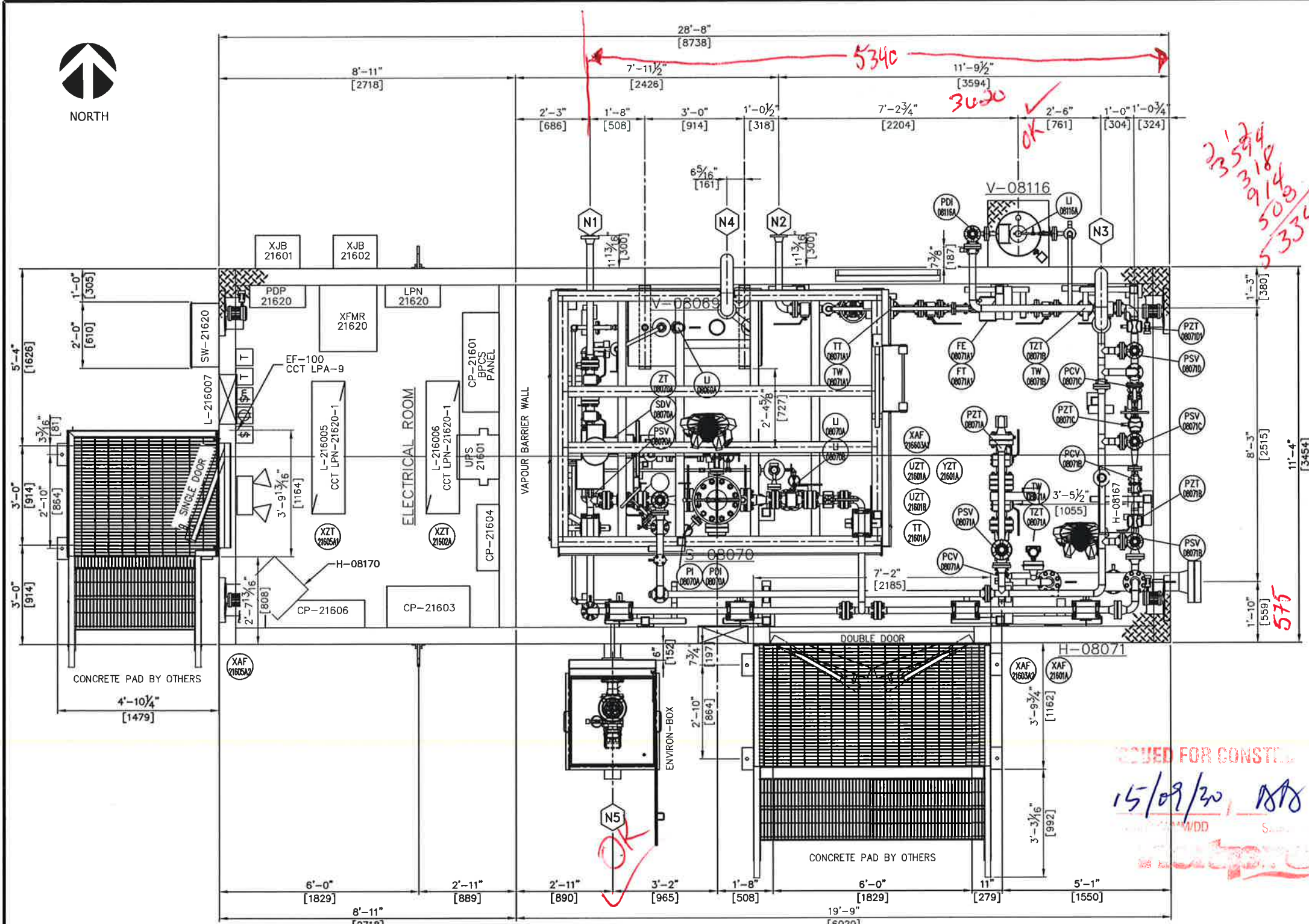
Date of calibration

Endress+Hauser Flowtec, Division USA
2330 Endress Place
Greenwood, IN 46143

W. Sprague

Operator

Certified acc. to
ISO 9001, Reg.-N° 030502.2
ISO 14001, Reg.-N° EMS561046



GENERAL NOTES:

- THIS DRAWING TO BE READ IN CONJUNCTION WITH THE PROCESS ENGINEERING FLOW SHEET, DRAWING 338716-100-Rev7.
- ALL PIPING ELEVATIONS ARE REFERENCE FROM TOP OF CHECKERED PLATE.
- FABRICATION TOLERANCE ±5mm FOR SKID EDGE CONNECTION LOCATION UNLESS NOTED OTHERWISE.
- ALL PIPING TO BE HELD TO DIMENSIONS & ELEVATIONS SHOWN FOR CUSTOMER TIE-INS.
- MAIN PIPING TO BE BUILT IN ACCORDANCE WITH THE LATEST EDITION OF B31.3.
- ALL PIPING PER B31.3 TO BE:
 - PIPING CLASS 'D900/LT, 1.0" C.A.
900 ANSI; 2" SCH 80
MATERIALS: PIPING - SA-333-6
FLANGES - SA-350-LF2 CL. 1
FITTINGS - SA-420-WPL6
BOLTS - SA-320-L7
NUTS - SA-194-2H
GASKETS - 304SS SPIRAL WOUND, GRAPHITE FILLED, 304SS INNER RING, CS OR SS OUTER RING
 - PIPING CLASS 'C600/LT, 1.0" C.A.
600 ANSI; 2" SCH 80; 3" SCH 40
MATERIALS: PIPING - SA-333-6
FLANGES - SA-350-LF2 CL. 1
FITTINGS - SA-420-WPL6
BOLTS - SA-320-L7
NUTS - SA-194-2H
GASKETS - 304SS SPIRAL WOUND, GRAPHITE FILLED, 304SS INNER RING, CS OR SS OUTER RING
 - PIPING CLASS 'B300/LT, 1.0" C.A.
300 ANSI; 2" SCH 80
MATERIALS: PIPING - SA-333-6
FLANGES - SA-350-LF2 CL. 1
FITTINGS - SA-420-WPL6
BOLTS - SA-320-L7
NUTS - SA-194-2H
GASKETS - 304SS SPIRAL WOUND, GRAPHITE FILLED, 304SS INNER RING, CS OR SS OUTER RING
 - PIPING CLASS 'A150/LT, 1.0" C.A.
150 ANSI; 2" SCH 80
MATERIALS: PIPING - SA-333-6
FLANGES - SA-350-LF2 CL. 1
FITTINGS - SA-420-WPL6
BOLTS - SA-320-L7
NUTS - SA-194-2H
GASKETS - 304SS SPIRAL WOUND, GRAPHITE FILLED, 304SS INNER RING, CS OR SS OUTER RING
- CLASS 900 ANSI: SW PIPING & NIPPLES, CLASS 'D900/LT
3/4" - 1 1/2" PIPE: SCH. 80 SA-333-6
3/4" - 1 1/2" NIPPLE: SCH. 160, SA-333-6
3/4" - 1 1/2" SWAGE: SCH. 80, SA-420-WPL6
3/4" - 1 1/2" FITTING: 3000#, SA-350-LF2 CL. 1
- CLASS 600 ANSI: SW PIPING & NIPPLES, CLASS 'C600/LT
3/4" - 1 1/2" PIPE: SCH. 80 SA-333-6
3/4" - 1 1/2" NIPPLE: SCH. 160, SA-333-6
3/4" - 1 1/2" SWAGE: SCH. 80, SA-420-WPL6
3/4" - 1 1/2" FITTING: 3000#, SA-350-LF2 CL. 1
- CLASS 300 ANSI: SW PIPING & NIPPLES, CLASS 'B300/LT
3/4" - 1 1/2" PIPE: SCH. 80 SA-333-6
3/4" - 1 1/2" NIPPLE: SCH. 160, SA-333-6
3/4" - 1 1/2" SWAGE: SCH. 80, SA-420-WPL6
3/4" - 1 1/2" FITTING: 3000#, SA-350-LF2 CL. 1
- CLASS 150 ANSI: SW PIPING & NIPPLES, CLASS 'A150/LT
3/4" - 1 1/2" PIPE: SCH. 80 SA-333-6
3/4" - 1 1/2" NIPPLE: SCH. 160, SA-333-6
3/4" - 1 1/2" SWAGE: SCH. 80, SA-420-WPL6
3/4" - 1 1/2" FITTING: 3000#, SA-350-LF2 CL. 1
- BUILDING
- DIM: 28'-8" L X 11'-4" W X 13'-2" EAVE HEIGHT, GABLE TYPE WITH 4:12 SLOPE
MATERIAL - WALLS: 22GA PRE-PAINTED (TAN: 5MOC8315)
ROOF/DOOR/TRIMS: 22GA PRE-PAINTED (METRO BROWN: 5MOC8228)
INSULATION (FIBERGLASS BATT) - WALL: R22 (6" THICK)
ROOF: R22 (6" THICK)
INTERIOR LINER: 24GA WHITE ALUMINUM
VAPOR BARRIER: 6-mil POLYETHYLENE (CERTIFIED)
(1) - 3'-0" X 7'-0" DOOR HIGH, 20GA R12 INSULATED POLYURETHANE CORE C/W 18GA SINGLE DOOR FRAME, LOCKING PANIC HARDWARE, HYDRAULIC CLOSURE, 24"X24" IWG WINDOW, CHECK CHAIN, ALUMINUM THRESHOLD, CANOPY, AND WEATHER-STRIPPING (ELECTRICAL ROOM)
(1) - 6'-0" X 7'-0" DOOR HIGH, 20GA R12 INSULATED POLYURETHANE CORE C/W 18GA SINGLE DOOR FRAME, LOCKING PANIC HARDWARE, HYDRAULIC CLOSURE, 24"X24" IWG WINDOW, CHECK CHAIN, ALUMINUM THRESHOLD, CANOPY, AND WEATHER-STRIPPING (PROCESS ROOM)
(1) - 40" X 40" DOUBLE GLAZED SLIDING WINDOWS W/ HALF SCREEN & LOCK
(1) - 12" EXPLOSION PROOF SUPPLY FAN (120V/1 PH/60Hz) C/W BACK GUARD, SHUTTER AND 22GA STORM HOOD (ELECTRICAL ROOM)
(1) - 18" EXPLOSION PROOF SUPPLY FAN (120V/1 PH/60Hz) C/W BACK GUARD, SHUTTER AND 22GA STORM HOOD (PROCESS ROOM)
(1) - 12" X 12" MANUAL LOUVERS C/W INSECT SCREEN (ELECTRICAL ROOM)
(1) - 12" X 12" MANUAL LOUVERS C/W INSECT SCREEN (PROCESS ROOM)

GENERAL NOTES: (CONT'D) PLAN VIEW

- BUILDING (CONT'D)
(2) - 28'-8" FULL-LENGTH EAVES TROUGH C/W DOWNSPOUTS & ELBOW
(2) - 28'-8" FULL-LENGTH ANGE IRON ICE RAKES
(1) - PROFESSIONAL ENGINEERING STAMPED DRAWING
- CLEAN ALL STEEL SURFACES PRIOR TO PAINTING TO SSPC-SP10 SANDBLASTED NEAR TO WHITE METAL
STRUCTURAL STEEL, PIPING, AND FILTER COALESCER
ONE (1) - COAT OF ZINC PRIMER
ONE (1) - COAT OF EPOXY
ONE (1) - TOPCOAT OF POLYURETHANE (COLOR: WARM GREY)
TOTAL LAYERS (3); TOTAL MIN. OF NDF: 300µm
INSULATED HEATER SHELL & INSULATED INLET (N1) - TWO (2) - COATS EPOXY PHENOLIC
- ALL PIPING SHALL BE HYDROTESTED TO 1.5 TIMES THE DESIGN PRESSURE.
- ALL PIPE SUPPORT LOCATIONS TO BE DETERMINED BY SHOP.
- ALL UNION LOCATIONS TO BE DETERMINED BY SHOP IF ANY.
- UNIT IS REGISTERED FOR ALBERTA SERVICE.
- FLAME ARRESTOR TO BE SHIPPED LOOSE.
- SHIPPING DIMENSION: 13'-0" W X 30'-0" LG X 16'-0" HT
- SHIPPING WEIGHT: 24,200 LBS (10,977 KG)
OPERATING WEIGHT: TBD LBS
- SEE ELECTRICAL DOC. FOR DETAILED POWER LAYOUT AND INSTRUMENT GENERAL LAYOUT.

SCHEDULE OF OPENINGS			
CONN	SIZE	RATING	DESCRIPTION
N1	2"	600# RF	PACKAGE INLET
N2	2"	150# RF	PACKAGE OUTLET
N3	2"	-	VENT HEADER (VENT TO ATMOSPHERE)
N4	2"	-	TANK VENT (VENT TO ATMOSPHERE)
N5	3"	CAMLOCK	TANK DRAIN

QC COPY

761
304
324
15/09/20

REV	DESCRIPTION	APP	CHK	DATE
8	REVISED PER CUSTOMER REQUIREMENTS	NSP	AA	SEPT 1/15
7	REVISED TAGS & PROJECTIONS; PROVIDED HAND RAILS	GG	ET	DEC 18/14
6	REVISED PLATFORMS	NSP	ET	NOV 28/14
5	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	NOV 19/14
4	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	OCT 10/14
3	REVISED AS NOTED	GG	ET	SEP 30/14
2	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	SEP 03/14
1	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	AUG 22/14
0	ISSUED FOR PRELIMINARY REVIEW	GG	ET	JUN 27/14

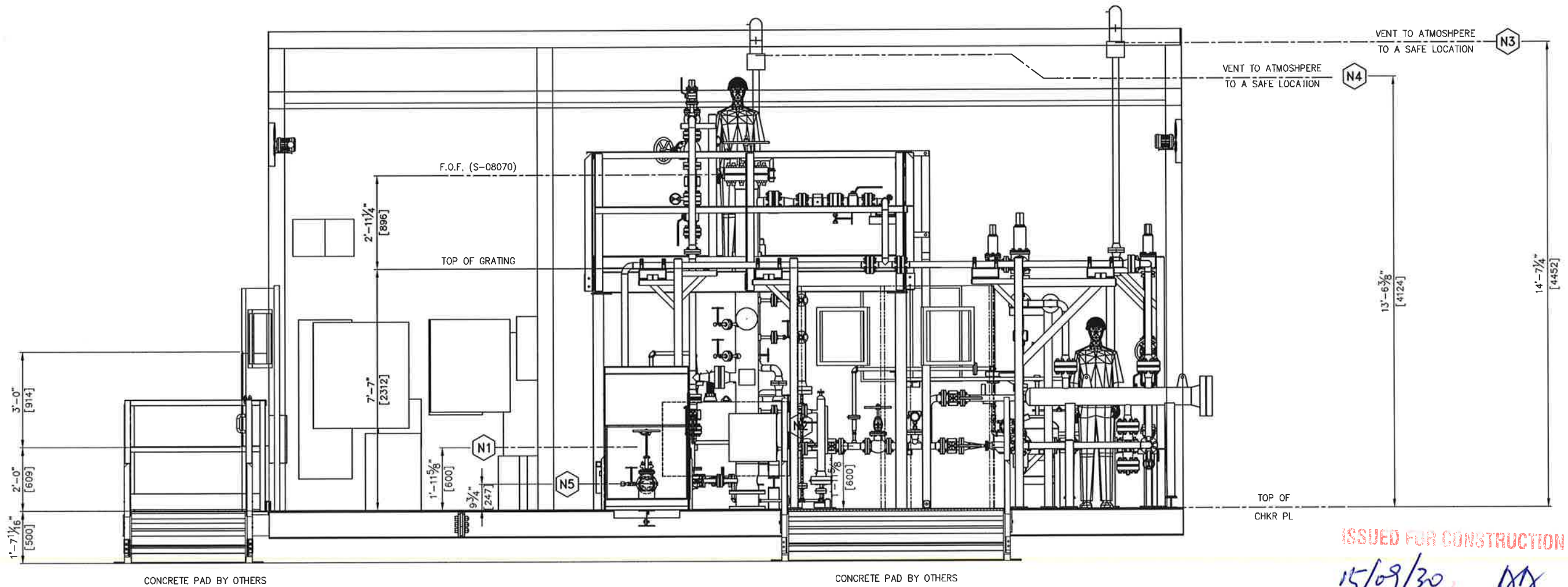
**CMT NG PRESSURE REDUCTION
SKID PACKAGE
GENERAL ARRANGEMENT**

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.

natpro

PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

DWN BY: GG	DATE: JUN 27/14	DWG #:	338716-200-Rev8
CHK BY: ET	DATE: JUN 27/14	PAGE:	1 OF 4
APP BY: COG	DATE: JUN 27/14	CAD:	N/A
		REV:	8



ELEVATION - FRONT VIEW

ISSUED FOR CONSTRUCTION
 15/09/30
 DATE:YY/MM/DD
 [Signature]
 SIGNATURE
matpro

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.

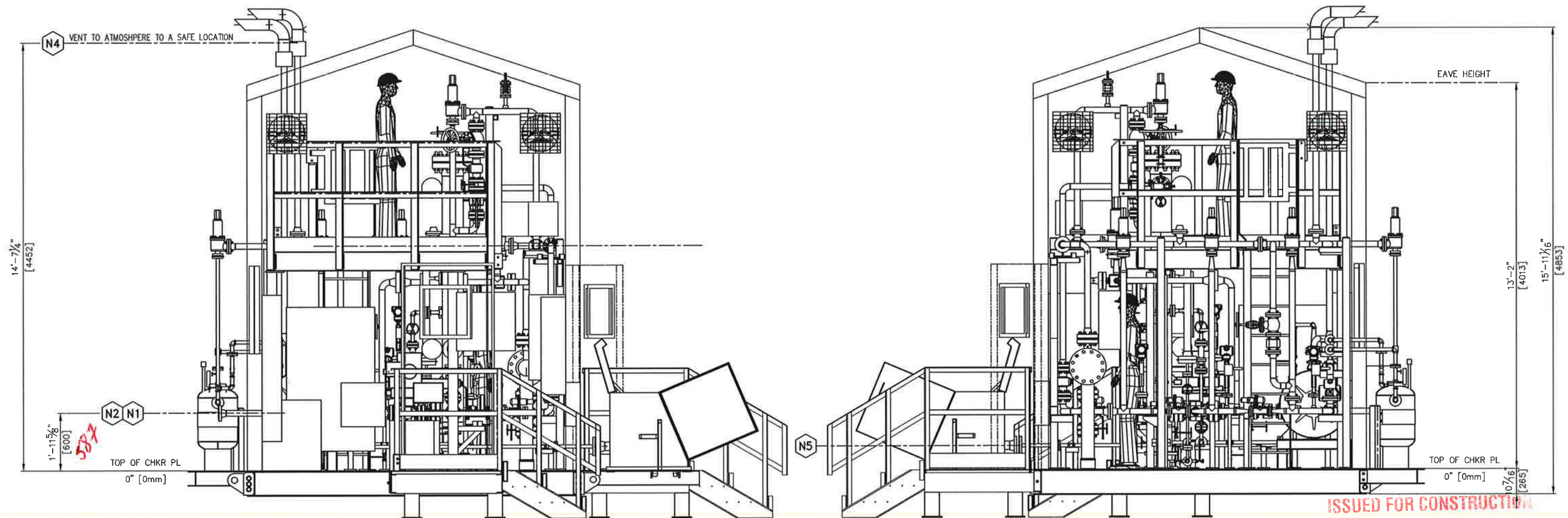
SCHEDULE OF OPENINGS			
CONN	SIZE	RATING	DESCRIPTION
N1	2"	600# RF	PACKAGE INLET
N2	2"	150# RF	PACKAGE OUTLET
N3	2"	-	VENT HEADER (VENT TO ATMOSPHERE)
N4	2"	-	TANK VENT (VENT TO ATMOSPHERE)
N5	3"	CAMLOCK	TANK DRAIN

QC COPY

REV	DESCRIPTION	DWN	CHK	APP	DATE
8	REVISED PER CUSTOMER REQUIREMENTS	NSP	AA	AA	SEPT 1/15
7	REVISED TAGS & PROJECTIONS; PROVIDED HAND RAILS	GG	ET	PM	DEC 18/14
6	REVISED PLATFORMS	NSP	ET	PM	NOV 28/14
5	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	-	NOV 19/14
4	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	OCT 10/14
3	REVISED AS NOTED	GG	ET	PM	SEP 30/14
2	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	SEP 03/14
1	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	AUG 22/14
0	ISSUED FOR PRELIMINARY REVIEW	GG	ET	PM	JUN 27/14

**CMT NG PRESSURE REDUCTION
 SKID PACKAGE
 GENERAL ARRANGEMENT**

PROJECT NAME: CARMON CREEK PROJECT			
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING			
LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2			
TAG: 0735A-08030			
SLS#	QUOTE	PO#	
338716	CGY2014-85	4512-109-130	
DWN BY	DATE	DWG #	
GG	JUN 27/14	338716-200-Rev8	
CHK BY	DATE		
ET	JUN 27/14		
APP BY	DATE	PAGE	CAD
COG	JUN 27/14	2 OF 4	N/A
			REV: 8



ELEVATION – LEFT SIDE VIEW

ELEVATION – RIGHT SIDE VIEW

ISSUED FOR CONSTRUCTION

15/09/30
DATE:YY/MM/DD
SIGNATURE: *MS*



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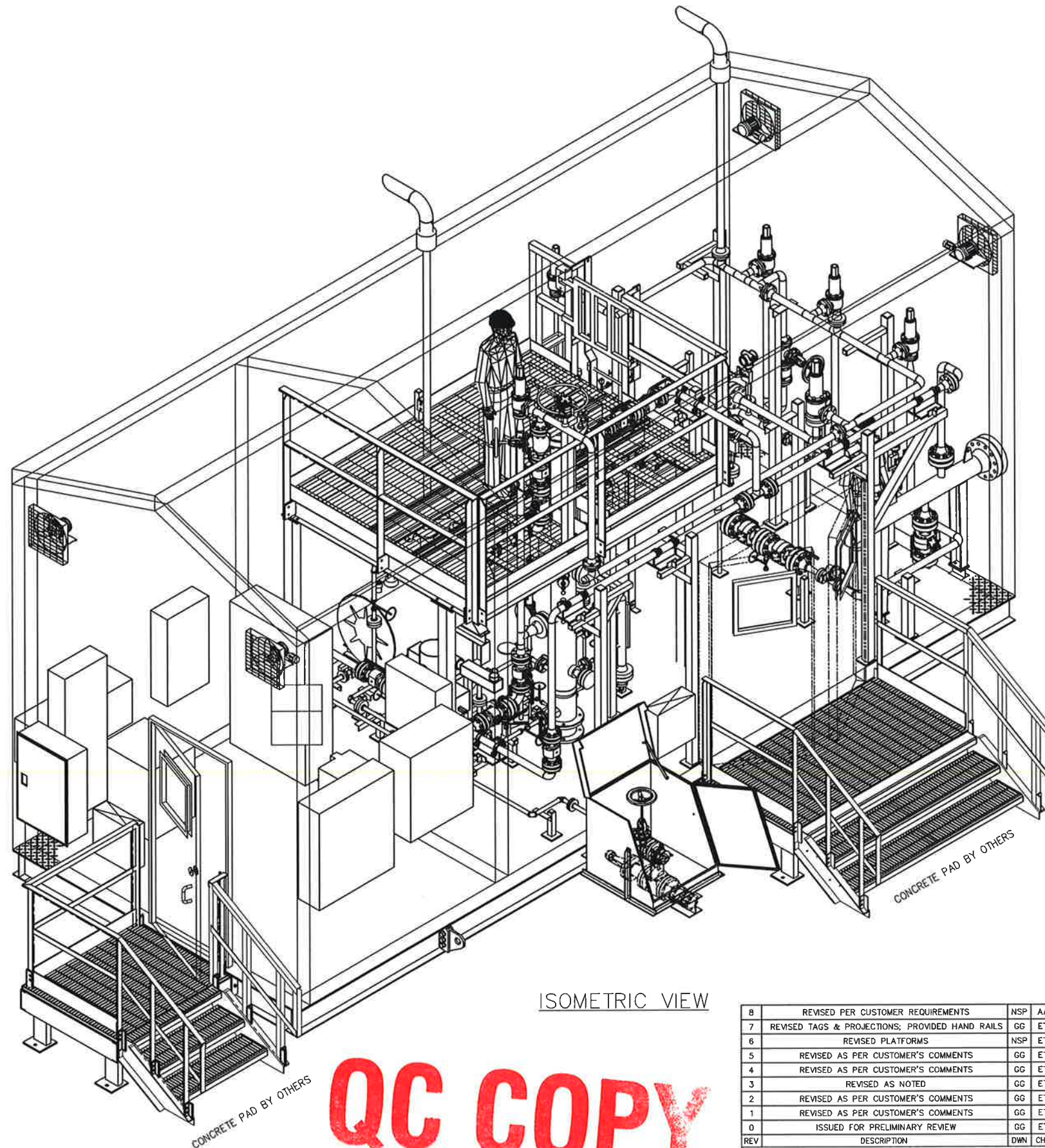
SCHEDULE OF OPENINGS			
CONN	SIZE	RATING	DESCRIPTION
N1	2"	600# RF	PACKAGE INLET
N2	2"	150# RF	PACKAGE OUTLET
N3	2"	-	VENT HEADER (VENT TO ATMOSPHERE)
N4	2"	-	TANK VENT (VENT TO ATMOSPHERE)
N5	3"	CAMLOCK	TANK DRAIN

QC COPY

REV	DESCRIPTION	DWN	CHK	APP	DATE
8	REVISED PER CUSTOMER REQUIREMENTS	NSP	AA	AA	SEPT 1/15
7	REVISED TAGS & PROJECTIONS; PROVIDED HAND RAILS	GG	ET	PM	DEC 18/14
6	REVISED PLATFORMS	NSP	ET	PM	NOV 28/14
5	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	-	NOV 19/14
4	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	OCT 10/14
3	REVISED AS NOTED	GG	ET	PM	SEP 30/14
2	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	SEP 03/14
1	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	AUG 22/14
0	ISSUED FOR PRELIMINARY REVIEW	GG	ET	PM	JUN 27/14

**CMT NG PRESSURE REDUCTION
SKID PACKAGE
GENERAL ARRANGEMENT**

PROJECT NAME: CARMON CREEK PROJECT			
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING			
LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2			
TAG: 0735A-08030			
SLS#: 338716	QUOTE: CGY2014-85	PO#: 4512-109-130	
DWN BY: GG	DATE: JUN 27/14	DWG #: 338716-200-Rev8	
CHK BY: ET	DATE: JUN 27/14		
APP BY: COG	DATE: JUN 27/14	PAGE: 3 OF 4	CAD: N/A REV: 8



ISSUED FOR CONSTRUCTION

15/09/30
DATE:YY/MM/DD

ET

natpro

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natpro

ISOMETRIC VIEW

QC COPY

REV	DESCRIPTION	DWN	CHK	APP	DATE
8	REVISED PER CUSTOMER REQUIREMENTS	NSP	AA	AA	SEPT 1/15
7	REVISED TAGS & PROJECTIONS; PROVIDED HAND RAILS	GG	ET	PM	DEC 18/14
6	REVISED PLATFORMS	NSP	ET	PM	NOV 28/14
5	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	NOV 19/14
4	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	OCT 10/14
3	REVISED AS NOTED	GG	ET	PM	SEP 30/14
2	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	SEP 03/14
1	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	AUG 22/14
0	ISSUED FOR PRELIMINARY REVIEW	GG	ET	PM	JUN 27/14

PROJECT NAME: CARMON CREEK PROJECT	
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING	
LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2	
TAG: 0735A-08030	
SLS#: 338716	QUOTE: CGY2014-85
PO#: 4512-109-130	
DWN BY: GG	DATE: JUN 27/14
CHK BY: ET	DATE: JUN 27/14
APP BY: COG	DATE: JUN 27/14
DWG #:	338716-200-Rev8
PAGE: 4 OF 4	CAD: N/A
REV: 8	

CMT NG PRESSURE REDUCTION
SKID PACKAGE
GENERAL ARRANGEMENT

FORM U-1A MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS
(Alternative Form for Single Chamber, Completely Shop or Field Fabricated Vessels Only)
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by FILTER SOLUTIONS INC. 649 Enfield Road, Burlington, Ontario, Canada L7T 2X9
(Name and address of Manufacturer)

2. Manufactured for JONELL CANADA INC. 1314 - 44th Ave. N.E. Calgary, AB, Canada T2E 6L6
(Name and address of Purchaser)

3. Location of installation Unknown
(Name and address)

4. Type Vertical filter 15946A / 15946B T5967.213 WO-6311-CRN REV.0 None 2014
(Horizontal or vertical, tank) (Manufacturer's serial number) (CRN) (Drawing number) (National Board number) (Year built)

5. ASME Code, Section VIII, Division 1 2013 Edition - None
[Edition and Addenda, if applicable (date)] (Code Case numbers) [Special service per UG-120(d)]

6. Shell SA 106C 0.500" 0.120" 7.625" 101"
(Material spec. number, grade) (Nominal thickness) (Corr. allow.) (Inner diameter) [Length (overall)]

Body Flanges on Shells										Bolting			
No.	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Location		Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material
1	1	7.625"	16.5"	600#	-	SA 105N	WELDED	TOP SHELL		(12) 1.125" 8UN STUD	SA 193 B7M	-	-
										(12) 1.125" 8UC NUT	SA 194 2HM	-	-

7. Seams Smls None 100 1125 DEG. F 1 Hr Type 1 Full 100 1
[Long. (welded, dbl., sngl., lap, butt)] [R.T. (spot or full)] (Eff., %) (H.T. temp.) (Time, hr) [Girth (welded, dbl., sngl., lap, butt)] [R.T. (spot or full)] (Eff., %) (No. of courses)]

8. Heads: (a) Material SA 105N (b) Material SA 234 WPC
(Spec. no., grade) (Spec. no., grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	Top	600"	0.12"	-	-	-	-	-	16.5"	-
(b)	Bottom	0.437"	0.12"	-	-	2:1	-	-	-	Concave

Body Flanges on Heads										Bolting			
	Location	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached		Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material
(a)													
(b)													

9. MAWP 1440 psi - at max. temp. 130 Deg. F -
(Internal) (External) (Internal) (External)

Min. design metal temp. -50 Deg. F at 1440 psi . Hydro., pneu., or comb. test pressure (Hydro) 1872 psig

Proof test None

10. Nozzles, inspection, and safety valve openings:

Purpose (Inlet, Outlet, Drain etc.)	No.	Diameter or Size	Type	Material		Nozzle Thickness		Reinforcement Material	Attachment Details		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
Inlet (N1)	1	3"	Cl. 600# flg	SA 106B	SA 105N	0.437"	0.12"	None	WLD	WLD	-
Outlet / LLC Upper (N2/N13)	2	3"	Cl. 600# flg	SA 106B	SA 105N	0.437"	0.12"	None	WLD	WLD	-
Vent / DPI (N3/N7/N8)	3	1/2"	CPLG.	SA 105N	-	6000#	0.12"	None	WLD	-	-
Drain / LO (N4/N5/N6)	3	1"	CPLG.	SA 105N	-	6000#	0.12"	None	WLD	-	-
LG/LT (N9/N10/N11/12)	4	3/4"	CPLG.	SA 105N	-	6000#	0.12"	None	WLD	-	-
LLC Lower (N14)	1	2"	CPLG.	SA 105N	-	6000#	0.12"	None	WLD	-	-

11. Supports: Skirt Yes Lugs No Legs No Other No Attached Welded to bottom head
(Yes or no) (Number) (Number) (Describe) (Where and how)

12. Remarks: Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report: (Name of part, item number, Manufacturer's name and identifying stamp)
Built to drawing "W015946 FAB REV.0"
Impact test exempt per UCS-66(b) & UCS-68(c) applies

FORM U-1A (Back)

CERTIFICATE OF SHOP/FIELD COMPLIANCE

We certify that the statements made in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. "U" Certificate of Authorization Number 35,087 expires May 3rd, 2017.

Date Aug 25/14 Co. name Filter Solutions Inc. Signed [Signature]
(Manufacturer) (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

Vessel constructed by Filter Solutions Inc. at Burlington, Ontario.
I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by TSSA of Ontario

have inspected the component described in this Manufacturer's Data Report on August 25, 2014, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date Aug 25, 2014 Signed [Signature] Commissions NB 12474A
(Authorized Inspector) [National Board (incl. endorsements)]

National Board Number: 161
Mfr. Representative: W. Kelly Date: 12-03-2015
Authorized Inspector: [Signature] Date: 12/3/2015

FORM U-1 MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by Exheat Ltd., Threxton Road Industrial Estate, Watton, Thetford, Norfolk, IP25 6NG, England, United Kingdom
(Name and address of Manufacturer)
2. Manufactured for National Process Equipment 5049 74 Avenue SE Calgary, AB T2C 3H2
(Name and address of Purchaser)
3. Location of installation Carmon Creek Project, Carmon Creek Complex Sec. Hwy 986 KM 54 N.E. Peace River AB T8S 1V1
(Name and address)
4. Type Horizontal Pressure Vessel with EIH Elements 146520
(Horizontal, vertical, or sphere) (Tank, separator, jkt. vessel, heat exch., etc.) (Manufacturer's serial number)
- W8598.2 041168.01.01A / VQ0510 Rev. 2 161 2015
(CRN) (Drawing number) (National Board number) (Year built)
5. ASME Code, Section VIII, Div. 1 Edition 2013 - -
[Edition and Addenda, if applicable (date)] (Code Case number) [Special service per UG-120(d)]

Items 6-11 incl. to be completed for single wall vessels, jackets of jacketed vessels, shell of heat exchangers, or chamber of multichamber vessels.

6. Shell: (a) Number of course(s) 1 (b) Overall length 1491mm

Course(s)			Material	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B & C)			Heat Treatment	
No.	Diameter	Length	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time
1	168mm O/D	1491mm	ASME SA333-6	10.97mm	1.5mm	None	N/A	N/A	A	Full	1.0	None	N/A
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-

Body Flanges on Shells

No.	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Location	Bolting			
									Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material
1	RFWN	146mm	381mm	55.6mm	10.97mm	ASME SA350-LF2	Weld	END	12 x M28	SA320-L7	70mm, 32mm, 5mm	Carbon Steel
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-

7. Heads: (a) SA420 WPL6 (Pipe Cap) (b) N/A
(Material spec. number, grade or type) (H.T. — time and temp.) (Material spec. number, grade or type) (H.T. — time and temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemis. Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)	END	10.97mm	1.5mm	134.4mm	25.9mm	2:1	N/A	N/A	N/A	No	Yes	A	Full	1.0
(b)	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Body Flanges on Heads

	Location	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Bolting				
									Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material	
(a)	-	-	-	-	-	-	-	-	-	-	-	-	-
(b)	-	-	-	-	-	-	-	-	-	-	-	-	-

8. Type of jacket - Jacket closure -
(Describe as ogee and weld, bar, etc.)
If bar, give dimensions - If bolted, describe or sketch.
9. MAWP 9930 kPa 101 kPa at max. temp. +93°C +93°C Min. design metal temp. -45°C at 9930 kPa
(Internal) (External) (Internal) (External)
10. Impact test Yes - shell, cap end, flanges, pipes & EIH element support plate at test temperature of -45°C or below
(Indicate yes or no and the component(s) impact tested)
11. Hydro., pneu., or comb. test pressure 12909 kPa Proof test -

Items 12 and 13 to be completed for tube sections.

12. Tubesheet SA-350 LF2 Class 1 381.0mm 61.9mm 1.5mm Bolted
[Stationary (material spec. no.)] [Diameter (subject to press.)] (Nominal thickness) (Corr. allow.) [Attachment (welded or bolted)]
13. Tubes SB-515 (UNS N08800) 12.5mm 0.7mm 7 U
(Material spec. no., grade or type) (O.D.) (Nominal thickness) (Number) [Type (straight or U)]

National Board Number: 161
Mfr. Representative: [Signature] Date: 12-03-2015
Authorized Inspector: [Signature] Date: 12-3-2015

FORM U-1 (Cont'd)

Items 14-18 incl. to be completed for inner chambers of jacketed vessels or channels of heat exchangers.

14. Shell: (a) No. of course(s) _____ (b) Overall length _____

Course(s)			Material	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B & C)			Heat Treatment	
No.	Diameter	Length	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-

Body Flanges on Shells													
No.	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Location	Bolting				
									Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material	
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-

15. Heads: (a) _____ (Material spec. number, grade, or type) (H.T. — time and temp.) (b) _____ (Material spec. number, grade, or type) (H.T. — time and temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemis. Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(b)	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Body Flanges on Heads													
	Location	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Bolting				
									Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material	
(a)	-	-	-	-	-	-	-	-	-	-	-	-	-
(b)	-	-	-	-	-	-	-	-	-	-	-	-	-

16. MAWP _____ at max. temp. _____ Min. design metal temp. _____ at _____
(Internal) (External) (Internal) (External)

17. Impact test _____ at test temperature of _____
[Indicate yes or no and the component(s) impact tested]

18. Hydro., pneu., or comb. test pressure _____ Proof test _____

19. Nozzles, inspection, and safety valve openings:

Purpose (Inlet, Outlet, Drain, etc.)	No.	Diameter or Size	Type	Material		Nozzle Thickness		Reinforcement Material	Attachment Details		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
Inlet	1	2" NB	RFWN	SA333-6	SA350-LF2 Cl.1	11.07mm	1.5mm	SA516-70	UW16.1c	Butt Weld	N/A
Outlet	1	2" NB	RFWN	SA333-6	SA350-LF2 Cl.1	11.07mm	1.5mm	SA516-70	UW16.1c	Butt Weld	N/A
Drain	1	2" NB	RFWN	SA333-6	SA350-LF2 Cl.1	11.07mm	1.5mm	SA516-70	UW16.1c	Butt Weld	N/A

20. Supports: Skirt No Lugs 0 Legs 0 Others 2 x Saddles Attached Welded to Underside of Shell
(Yes or no) (Number) (Number) (Describe) (Where and how)

21. Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report (list the name of part, item number, Manufacturer's name, and identifying number):

Vessco Engineering Ltd Partial U-2A Data Report, UJ0404-1.

22. Remarks

Sensor Bosses & Plugs: SA-479 316/316L, Sensor Pockets: ASME SA-213 TP316/316L.
Section 11 - Hydrotest completed with Heater in Vessel.
Tubesheet is an Electric Immersion Heater Element Support Plate.
Impact Testing exempt for stainless steel materials as per UHA-51 (d) (1) (a)

No PWHT required as per UCS-56.
Tubes are Electric Immersion Heater Elements.
Construction in Conformance with Mandatory Appendix 41
Safety device by others UG-125.

National Board Number: 161
 Mfr. Representative: [Signature] Date: 12-03-2015
 Authorized Inspector: [Signature] Date: 12/3/2015

FORM U-1 (Cont'd)

CERTIFICATE OF SHOP COMPLIANCE

We certify that the statements in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1.

U Certificate of Authorization Number 39042 Expires Nov 10, 2015

Date 12/03/2015 Name Exheat Ltd Signed [Signature]
(Manufacturer) (Representative)

CERTIFICATE OF SHOP INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by ROYAL SUN ALLIANCE INSURANCE of MANCHESTER UK have inspected the pressure vessel described in this Manufacturer's Data Report on 10TH MARCH 2015, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date 12/3/2015 Signed [Signature] Commissions NS #14397 AND OH #1152
(Authorized Inspector) (National Board (incl. endorsements))

CERTIFICATE OF FIELD ASSEMBLY COMPLIANCE

We certify that the statements in this report are correct and that the field assembly construction of all parts of this vessel conforms with the requirements of ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. U Certificate of Authorization Number _____ Expires _____.

Date _____ Name _____ Signed _____
(Assembler) (Representative)

CERTIFICATE OF FIELD ASSEMBLY INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by _____ of _____, have compared the statements in this Manufacturer's Data Report with the described pressure vessel and state that parts referred to as data items _____, not included in the certificate of shop inspection, have been inspected by me and to the best of my knowledge and belief, the Manufacturer has constructed and assembled this pressure vessel in accordance with the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. The described vessel was inspected and subjected to a hydrostatic test of _____. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date _____ Signed _____ Commissions _____
(Authorized Inspector) (National Board (incl. endorsements))

FORM U-2A MANUFACTURER'S PARTIAL DATA REPORT (ALTERNATIVE FORM)
A Part of a Pressure Vessel Fabricated by One Manufacturer for Another Manufacturer
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by Vessco Engineering Limited, Kingsway Buildings, Bridgend Industrial Estate, Bridgend. CF31 3YH

(Name and address of Manufacturer)

2. Manufactured for Exheat Ltd, Threxton Road Industrial Estate, Watton, IP25 6NG

(Name and address of Purchaser)

3. Location of installation Alberta, Canada

(Name and address)

4. Type Vessel Shell UJ0404-1 TBA

[Description of vessel part (shell, two-piece head, tube bundle)]

(Manufacturer's serial number)

(CRN)

none
(National Board number)

VQ0510 Rev. 2
(Drawing number)

Vessco Engineering Limited
(Drawing prepared by)

2014
(Year built)

5. ASME Code, Section VIII, Div. 1 2013 none none

[Edition and Addenda, if applicable (date)]

(Code Case number)

[Special service per UG-120(d)]

6. Shell: (a) Number of course(s) 1 (b) Overall length 1491mm

No.	Course(s)		Material Spec./Grade or Type	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B & C)			Heat Treatment	
	Diameter	Length		Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time
	168mm O/D	1491mm	ASME SA333-6	10.97mm	1.5mm	none	n/a	n/a	A	Full	1.0	None	n/a

Body Flanges on Shells

No.	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Location	Bolting			
									Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material
1	RFWN	146mm	381mm	55.6mm	10.97mm	ASME SA350-LF2	Weld	End	12xM28	SA320 L7	by others	by others

7. Heads: (a) Pipe cap SA420 WPL6 (b) Blind Flange by others

(Material spec. number, grade or type) (H.T. — time and temp.)

(Material spec. number, grade or type) (H.T. — time and temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemis. Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)	End	10.97mm	1.5mm	134.4mm	25.9mm	2:1	n/a	n/a	n/a	No	Yes	A	Full	1.0
(b)														

Body Flanges on Heads

	Location	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Bolting				
									Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material	
(a)													
(b)													

8. MAWP 9930KPag FV at max. temp. 93 deg. C 93 deg. C Min. design metal temp. -45 deg. C at 9930KPag

(Internal)

(External)

(Internal)

(External)

9. Impact test Yes: shell, cap end, flanges & pipes at test temperature of -45 deg. C or below

[Indicate yes or no and the component(s) impact tested]

10. Hydro., pneu., or comb. test pressure Hydro - 12909KPag - 1 hour Proof test _____

11. Nozzles, inspection, and safety valve openings:

Purpose (Inlet, Outlet, Drain, etc.)	No.	Diameter or Size	Type	Material		Nozzle Thickness		Reinforcement Material	Attachment Details		Location (Insp. Open)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
Inlet/Outlet	2	2"	RFWN	SA333-6	SA350	11.07mm	1.5mm	SA516-70	UW16.1c	Butt Weld	N/A
Drain	1	2"	RFWN	SA333-6	SA350	11.07mm	1.5mm	SA516-70	UW16.1c	Butt Weld	N/A

12. Identification of part(s)

Name of Part	Quantity	Line No.	Mfr's. Identification No.	Mfr's. Drawing No.	CRN	National Board No.	Year Built
Vessel Shell	1	n/a	UJ0404-1	VQ0510 Rev. 2	TBA	none	2014

13. Supports: Skirt no Lugs 0 Legs 0 Other 2 x Saddles Attached Welded to Underside of Shell

(Yes or no)

(Number)

(Number)

(Describe)

(Where and how)

14. Remarks

no PWHT required as per UCS-56.
 Vessco Engineering take responsibility for design of the shell up to body flange (blank was used for hydrotest).

FORM U-2A (Back)

CERTIFICATE OF SHOP/FIELD COMPLIANCE

We certify that the statements made in this report are correct and that all details of material, construction, and workmanship of this pressure vessel part conform to the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1.

U Certificate of Authorization No. 40,179 Expires Dec. 08, 2016

Date 14/11/2014 Name Vessco Engineering Limited Signed Julian Vance-Davis
(Manufacturer) (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by ROYAL & SUNALLIANCE INSURANCE of MANCHESTER U.K.

have inspected the pressure vessel part described in this Manufacturer's Data Report on 14 NOVEMBER 2014 and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel part in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel part described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from connected with this inspection.

Date 14 NOV 14 Signed [Signature] Commissions NB# 10153 A B N NS
(Authorized Inspector) [National Board (incl. endorsements)]

FORM U-1 MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS Natl. Bd. No. 14,031
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by King Tool Company, 208 South Avenue A, Longview, Texas 75604
(Name and address of Manufacturer)

2. Manufactured for Tansley Associates, #3, 1470 28th. St, NE, Calgary, AL T2A 7W6 Canada
(Name and address of Purchaser)

3. Location of installation For Export
(Name and address)

4. Type Vertical Odorizer 15,101
(Horizontal, vertical, or sphere) (Tank, separator, jkt. vessel, heat exch., etc.) (Manufacturer's serial number)

L3956.52 KTC-14567-T 14,031 2014
(CRN) (Drawing number) (National Board number) (Year built)

5. ASME Code, Section VIII, Div. 1 2013
[Edition and Addenda, if applicable (date)] (Code Case number) (Special service per UG-120(d))

Items 6-11 incl. to be completed for single wall vessels, jackets of jacketed vessels, shell of heat exchangers, or chamber of multichamber vessels.

6. Shell: (a) Number of course(s) 1 (b) Overall length 1' 5-3/4"

Course(s)			Material	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B & C)			Heat Treatment	
No.	Diameter	Length	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time
1	16" OD	1' 5-3/4"	SA-106-B	.375	0	S			1	Full	1		

Body Flanges on Shells													
No.	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Location	Bolting				
									Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material	

7. Heads: (a) SA-516-70N (b) SA-516-70N
(Material spec. number, grade or type) (H.T. — time and temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)	Bottom	.375	0			2:1					X	S		
(b)	Top	.375	0			2:1					X	S		

Body Flanges on Heads													
	Location	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Bolting				
									Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material	
(a)													
(b)													

8. Type of jacket Jacket closure
(Describe as ogee and weld, bar, etc.)

If bar, give dimensions _____ If bolted, describe or sketch.

9. MAWP 300 at max. temp. 150 Min. design metal temp. 49 at 300
(Internal) (External) (Internal) (External)

10. Impact test No UCS-66(b) at test temperature of _____
(Indicate yes or no and the component(s) impact tested)

11. Hydro., pneu., or comb. test pressure 450 Proof test N/A

Items 12 and 13 to be completed for tube sections.

12. Tubesheet
[Stationary (material spec. no.)] [Diameter (subject to press.)] (Nominal thickness) (Corr. allow.) [Attachment (welded or bolted)]

[Floating (material spec. no.)] (Diameter) (Nominal thickness) (Corr. allow.) (Attachment)

13. Tubes
(Material spec. no., grade or type) (O.D.) (Nominal thickness) (Number) [Type (straight or U)]

Mfg. Rep. JK
 Date 8/28/14

Auth. Insp. Bg
 Date 8/28/14

FORM U-1 (Cont'd)

Items 14-18 incl. to be completed for inner chambers of jacketed vessels or channels of heat exchangers.

14. Shell: (a) No. of course(s) _____ (b) Overall length _____

Course(s)			Material	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B & C)			Heat Treatment	
No.	Diameter	Length	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time

Body Flanges on Shells													
No.	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Location	Bolting				
									Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material	

15. Heads: (a) _____ (Material spec. number, grade or type) (H.T. — time and temp.) (b) _____ (Material spec. number, grade or type) (H.T. — time and temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)														
(b)														

Body Flanges on Heads													
	Location	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Bolting				
									Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material	
(a)													
(b)													

16. MAWP _____ at max. temp. _____ Min. design metal temp. _____ at _____
(Internal) (External) (Internal) (External)

17. Impact test _____ at test temperature of _____
[Indicate yes or no and the component(s) impact tested]

18. Hydro., pneu., or comb. test pressure _____ Proof test _____

19. Nozzles, inspection, and safety valve openings:

Purpose (Inlet, Outlet, Drain, etc.)	No.	Diameter or Size	Type	Material		Nozzle Thickness		Reinforcement Material	Attachment Details		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
Inlet/Outlet	2	1"		SA-106-B		.18	0		UW-16.1(c)		
Fill & Drain	1	1"		SA-106-B		.18	0		UW-16.1(c)		
Handhole	1	6-5/8"		SA-516-70		1-1/4"	0		*		(b) Head
Others:	1	3/8"		SA-106-B		.13	0		UW-16.1(c)		
	3	3/4"		SA-105		6000	0		UW-16.1(y-1)		
	2	1/4"		SA-105		6000	0		UW-16.1(y-1)		

20. Supports: Skirt No Lugs 0 Legs 0 Others _____ Attached _____
(Yes or no) (Number) (Number) (Describe) (Where and how)

21. Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report (list the name of part, item number, Manufacturer's name, and identifying number):

22. Remarks _____
 Safety UG-125. *Handhole complete with 6 cap bolts. Overpressure protection provided by system design per UG-140(b).
 3-B 300# King Odorizer

FORM U-1 (Cont'd)

CERTIFICATE OF SHOP COMPLIANCE

We certify that the statements in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1.

U Certificate of Authorization Number 3196 Expires 28-Feb-16
 Date 8/28/14 Name King Tool Company Signed Jerry Combs
(Manufacturer) (Representative)

CERTIFICATE OF SHOP INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by The Hartford Steam Boiler Inspection and Insurance Company of Connecticut of Hartford, Connecticut

have inspected the pressure vessel described in this Manufacturer's Data Report on 8-28-14, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date 8/28/14 Signed [Signature] Commissions 2B9778A, TX1136
(Authorized Inspector) [National Board (incl. endorsements)]

CERTIFICATE OF FIELD ASSEMBLY COMPLIANCE

We certify that the statements in this report are correct and that the field assembly construction of all parts of this vessel conforms with the requirements of ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. U Certificate of Authorization Number _____ Expires _____

Date _____ Name _____ Signed _____
(Assembler) (Representative)

CERTIFICATE OF FIELD ASSEMBLY INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by _____

of _____, have compared the statements in this Manufacturer's Data Report with the described pressure vessel and state that parts referred to as data items _____, not included in the certificate of shop inspection, have been inspected by me and to the best of my knowledge and belief, the Manufacturer has constructed and assembled this pressure vessel in accordance with the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. The described vessel was inspected and subjected to a hydrostatic test of _____. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date _____ Signed _____ Commissions _____
(Authorized Inspector) [National Board (incl. endorsements)]

CERTIFICATE OF QUALITY

All Natpro products shall be in full and complete compliance with established design, performance and material specifications, standards and ratings. Such products are designed to be used as fully integrated units, complying with recognized industry and engineering codes, standards and specifications as they apply to insure the highest quality product possible.

National Process Equipment Job Identification :

Customer Name : Shell Canada Energy

Customer Purchase Order No. : 4512109130

Customer Requisition No. :

Customer Specification No. :

MANUFACTURER S/N	DESCRIPTION	CUSTOMER ITEM/ EQUIPMENT NO.
SLS 338716	Natural Gas Pressure Reduction Skid Package	20/0735A-08030 CMT

Signature:  _____
Quality Assurance Manager

Date: 7-16-15

FORM # QAF-032e	QUALITY CERTIFICATE	REV # 2	DATE 1/29/96	ORIGINATOR QA	REVIEW PRES	APPROVAL QA
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SCHEDULE A-2

**Confirmation of Commitment by Owner
and by Registered Professional of Record**

See Section 2.4.3 of the Alberta Building Code

To: The *authority having jurisdiction*

Date: March 25, 2015

Shell Canada Energy

Address

**Shell Canada Energy
400 – 4th Avenue SW
Calgary, Alberta
T2P 2H5**

Re: **Design and Field Review of Construction for the following project**

Name of project: **Shell Canada Carmon Creek
Building Tag: 0735A-08030
Camp Field Facilities & Infrastructure Phase 1 & 2
Natpro SLS338716, Straight-Up 15-5056**

Address: **Shell Canada Carmon Creek 40 km north-east of Peace River, Alberta**

Legal description: **Township 085, Range 18, West of 5th Meridian**

The *owner* has retained a *registered professional of record* for

- architecture,
- structural engineering,
- mechanical engineering,
- electrical engineering,
- geotechnical engineering

to coordinate the *design work* and *field reviews* required for this project.

The *registered professional of record* shall coordinate the *design work* and *field review* for that component of the project for which the *professional of record* is responsible in order that the design will comply with the Alberta Building Code (ABC).

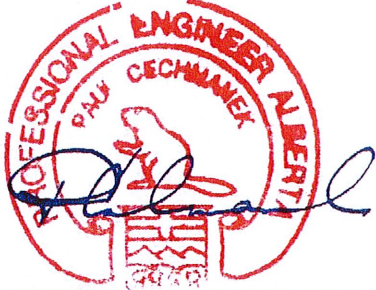
The *owner* and the *registered professional of record* have read and understand Part 1 of Division A and Part 2 of Division C, especially Subsection 2.4.3, of Division C, of the ABC.

The *owner* and the *registered professional of record* acknowledge their responsibility to notify the *authority having jurisdiction*, should the *registered professional* cease to be retained by the *owner*.

The *owner* understands that should the *registered professional of record* cease to be retained at any time during construction, work on the portion of the project for which the *registered professional* is responsible will cease until such time as a new *registered professional of record* is retained, and a new letter in the form set out in Schedule A-2 is filed with the *authority having jurisdiction*.

The *registered professional of record* is a *registered professional* as defined in the ABC.

Schedule A-2 - Continued

Registered Professional of Record	Owner
	
Signature	Signature
Date March 25,, 2015	Date
Note: affix seals over signatures	
I, Paul Cechmanek , have signed on behalf of	I, _____ , have signed on behalf of
Straight-Up Metal BuildingsLtd.	
Firm	Firm
Name	Name
7155-110 avenue S.E. Calgary, Alberta	Address
T2C 3B8	Postal Code
Postal Code	

Note:

1. This letter must be submitted before issuance of a *building* permit.
2. In this letter the words in italics are defined in the Alberta Building Code.
3. This letter must be signed by the *owner* and the *registered professional*. If signed by an agent, a letter of appointment must be attached. If the owner is a corporation, the letter must be signed by a signing officer of the corporation and the signing officer must set forth their position in the corporation.
4. The term "substantially comply" is used in *field review* because a *registered professional* does not supervise the actual construction.
5. The *constructor* is responsible for safety of the public and workers at the *project* site.

SCHEDULE B-1

**Letter of Commitment by the Registered
Professional of Record**

See Section 2.4.3 of the Alberta Building Code

To: The *authority having jurisdiction*

Date: March 25, 2015

Shell Canada Energy

Address

**Shell Canada Energy
400 – 4th Avenue SW
Calgary, Alberta
T2P 2H5**

Re: **Design and Field Review of Construction for the following project**

Name of project:

**Shell Canada Carmon Creek
Building Tag: 0735A-08030
Camp Field Facilities & Infrastructure Phase 1 & 2
Natpro SLS338716, Straight-Up 15-5056**

Address: **Shell at Carmon Creek 40 km north east of Peace River, Alberta**

Legal description: **Township 085, Range 18, West of 5th Meridian**

I hereby give assurance that the design of the

- architectural
- structural engineering
- mechanical engineering
- electrical engineering
- geotechnical engineering

components described on plans, specifications and other supporting documents, prepared reviewed by this *registered professional* in support of the application for a building permit, substantially comply with the Alberta Building Code (ABC).

I hereby undertake to be responsible for *field review* of the above referenced components during construction as indicated on the attached "Summary of Design and Field Review Requirements" (see Schedule B-2).

I also undertake to notify the *authority having jurisdiction* in writing if our contract for *field review* is terminated at any time during construction.

Schedule B-1 –Continued

Registered Professional of Record	
 <p>Signature</p>	
Date March 25, 2015	
Note: affix seals over signatures	
I, Paul Cechmanek , have signed on behalf of	
<p>Straight-up Metal BuildingsLtd.</p> <p>Firm</p>	
Name	
<p>7155-110 avenue S.E.</p> <p>Calgary, Alberta</p> <p>Address</p>	
<p>T2C 3B8</p> <p>Postal Code</p>	

- Note:
1. This letter must be submitted with the plans and specifications before issuance of a *building* permit.
 2. In this letter the words in italics have the same meaning as the Alberta Building Code.
 3. This letter must be signed by the registered professional.
 4. The *constructor* is responsible for safety of the public and workers at the *project* site.

SCHEDULE B-2

Summary of Design and Field Review Requirements


See Section 2.4.3 of the Alberta Building Code


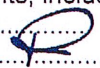
Submitted by: Straight-up.*(15-5056)
0735A-08030

Date: 25.3. 2015


(Initial applicable responsibilities and cross out and initial non-applicable items within the list of Code activities)


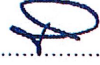

ARCHITECTURAL

.....initial to indicate overall responsibility

- 1.1 Development permit requirements and conditions
- 1.2 Requirements to prevent fire spread and collapse; *building height, building area, building classification street access*
- 1.3 Spacial separation requirements; *limiting distance, unprotected openings, construction characteristics*
- 1.4 Exterior walls and roofs; including exterior glazing dampproofing/water proofing of walls or ~~slabs below grade~~, wall cladding
- 1.5 Determining the need for fire detection, alarm notification and suppression; including emergency power and lighting *N/A*
- 1.6 Provisions for fire fighting *N/A*
- 1.7 Requirements pertaining to *interconnected floor spaces* and high buildings *N/A*
- 1.8 Safety within *floor areas*; including interim wall partitions and finishes, ~~access to exits~~, guards and handrails, ~~sound control~~, specific requirements related to function
- 1.9 Egress systems, *occupant loads*, stairs and exits
- 1.10 Barrier free requirements *N/A*
- 1.11 Vertical transportation *N/A*
- 1.12 Service facilities; horizontal and vertical *service spaces* *N/A*
- 1.13 Health requirements; including functional design i.e. washrooms, food preparation areas, swimming pools *N/A*
- 1.14 Structural capacity of architectural components; including anchorage and seismic restraint 
- 1.15 Site development and landscaping *N/A*
- 1.16 Review of all applicable shop drawings 

STRUCTURAL

.....initial to indicate overall responsibility

- 2.1 Structural capacity of structural components of *buildings*; including anchorage and seismic restraint 
- 2.2 Structural aspects of deep foundations *N/A*
- 2.3 Qualification of welded steel fabricators and erectors 
- 2.4. Review of all applicable shop drawings 

Schedule B-2 - Continued

[Handwritten initials]

MECHANICAL

.....initial to indicate overall responsibility

- 3.1 HVAC Systems; including fire stopping of service penetrations and placement of fire dampers *N/A*
- 3.2 Plumbing systems; including ~~potable water system~~, roof and storm drainage system, ~~sanitary drainage system~~ *N/A*
- 3.3 Fire Protection Systems; including automatic sprinkler and other fire suppression systems; stand pipes and hose system, evaluation of necessary water supply demand *N/A*
- 3.4 Swimming pool mechanical systems; including pool circulation and disinfection systems, ventilation in areas and chlorine rooms *N/A*
- 3.5 Medical gas piping systems *N/A*
- 3.6 Smoke control systems in high-rise and ~~care and detention occupancy~~ application *N/A*
- 3.7 Review of all applicable shop drawings *N/A*

ELECTRICAL

N/Ainitial to indicate overall responsibility

- 4.1 Electrical transformers vaults, switching devices and motors, including anchorage and seismic restraints
- 4.2 Electrical system and devices; including fire stopping of penetration through fire separation
- 4.3 Fire alarms; including voice communication system
- 4.4 Mechanical interface with controls and alarms
- 4.5 Emergency power and lighting systems
- 4.6 Fire protection of wiring for emergency systems
- 4.7 Review of all applicable shop drawings

GEOTECHNICAL

N/Ainitial to indicate overall responsibility

- 5.1 *Excavation*
- 5.2 Shoring and underpinning
- 5.3 Geotechnical aspects of *deep foundations*
- 5.4 Control of ground and subsurface water
- 5.5 Structural considerations of *soil*; including slope stability and seismic loading
- 5.6 Backfill and compaction of fill

Note:

1. Schedule B-2 must be attached to B-1.
2. In this letter the words in italics have the same meaning as the Alberta Building Code.
3. The *constructor* is responsible for safety to the public and workers at the *project* site.

15-5056 0735A-08030



Certificate of Design and Manufacturing Conformance with NBC, 2005

This Certificate is to affirm that all components of the steel building system described below, to be supplied by the Manufacturer, Straight-Up Metal Buildings Ltd., certified in accordance with CSA A660, have been or will be designed and fabricated in accordance with the following Standards to carry the loads and load combinations specified.

1. DESCRIPTION:

Manufacturer's Name and Address	Straight-Up Metal buildings Ltd. 7155 110th Ave SE, Calgary, T2C 3B8
Manufacturer's Certificate No. under CSA A660	Strai0
Customer Order Number	PUR633998. Straight-Up job 15-5056
Building Type and Size	3,455mm W x 8,738mm L x 4,013mm H GABLE BUILDING
Intended Use and Occupancy	Group F Division 3
Importance Category (NBC, Sentence 4.1.2.1.(3))	Normal
Site Location	085-16 W5M
Applicable Building Code	Alberta Building Code 2006
Builder's Name and Address	Straight-Up Metal buildings Ltd. 7155 110th Ave SE, Calgary, T2C 3B8
Owner's Name and Address	Shell Canada

2. DESIGN STANDARDS

National Building Code of Canada, 2005, Part 4: Structural Design

CAN/CSA-S16-01, Limit States Design of Steel Structures

CAN/CSA-S136-01, North American Specification for the Design of Cold-Formed Steel Structural Members

Other (specify) _____

Engineer's Initials*

MF

Dated 23-Mar-15

3. MANUFACTURING STANDARDS

(A) Fabrication has been or will be in accordance with CAN/CSA-S16 and CAN/CSA-S136, as applicable

(B) Welding has been or will be performed in accordance with CSA W59 and CAN/CSA-S136, as applicable

(C) The Manufacturer has been certified in accordance with CSA W47.1, for Division 1 or 2, and/or CSA W55.3, if applicable

(D) Welders have been qualified in accordance with CSA W47.1

MF

4. PURLIN STABILITY

N/A

Purlin braces are provided in accordance with CAN/CSA-S136, Clause D3 and Appendix B, Clause D3.2.3. In particular, for a standing seam roof supported on movable clips, braces providing lateral support to both top and bottom purlin flange have been or will be provided. The number of rows is determined by analysis but in no case is less than 1 for spans up to 7m inclusive or less than 2 for spans greater than 7m.

5. LOADS

(A) Snow and Rain Load

1-in-50 year ground snow load, S _s ,	2.2	(kPa)
1-in-50 year associated rain load, S _r ,	0.1	(kPa)
Wind exposure factor, C _w ,	1	
Importance Factor, I _s ,	1	
Roof snow load, S,	1.73	(kPa)
Drift load considered (NBC Sub-section 4.1.6.2.8) refer to drawing of specific building		
Specified rain load (NBC, Article 4.1.6.4)	86	(mm)

MF

**Initial each true statement. Mark N/A if statement does not apply.*



Certificate of Design and Manufacturing Conformance with NBC, 2005

5. LOADS con't...

(B) Full and Partial Snow Load

- (i) Applied on any one and any two adjacent spans of continuous purlins
(ii) Applied on any one and any two adjacent spans of modular rigid frames with continuous roof beams
(iii) Applied as described for the building geometry in NBC, Part 4, and in the User's Guide-NBC 2005 Structural Commentaries (Part 4), Commentary G: Snow Loads

Engineer's Initials*
N/A

(C) Wind Load

1-in-50 year reference velocity pressure 0.51 (kPa)
Importance Factor, Iw 1

MF

(D) Wind Load Application

- (i) Applied as per NBC, Part 4, Sub-section 4.1.7
(ii) Pressure coefficients as per User's Guide-NBC 2005 Structural Commentaries (Part 4), Commentary I: Wind Loads, Figures I3 through I12
(iii) Building internal pressure Category 1 per User's Guide-NBC 2005 Structural Commentaries (Part 4), Commentary I: Wind Loads

MF

(E) Crane Loads (where applicable)

Type N/A (top running)/(under-running)/(jib)
Capacity N/A (tonnes)
Wheel Base N/A (m)
Maximum Static, vertical wheel load N/A (kN)
Vertical impact factor N/A %
Lateral Factor N/A % Lateral Wheel Load N/A (kN)
Longitudinal Factor N/A % Maximum Longitudinal Load N/A (kN/side)

N/A

(F) Mezzanine Live Load

N/A (kPa)

N/A

(G) Seismic Load:

Applied as per NBC, Part 4, Sub-Section 4.1.8 S (0.2) 0.12 S (0.5) 0.06 S (1.0) 0.02 S (2.0) 0.01
Fa 1.3 Fv 1.4 Ie 1

MF

(H) Other Live Loads (specify)

1.0 kPa live load on roof

MF

(I) Dead Loads

Dead Load of building components is incorporated in the design
Collateral load (mechanical, electrical, ceiling, sprinklers, etc.) 0.06 (kPa)
Mezzanine N/A (kPa) Other (Specify) N/A ()

MF

(J) Load Combinations

Applied in accordance with NBC, Part 4, Section 4.1.
1.25D + 1.5S, 1.25D+1.4W

MF

6. GENERAL REVIEW DURING CONSTRUCTION

The Manufacturer, Straight-Up Metal Buildings Ltd., does not provide general review during construction for regulatory purposes.

*Initial each true statement. Mark N/A if statement does not apply.

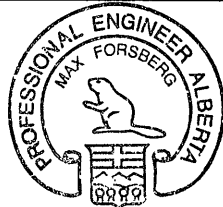
7. CERTIFICATION BY ENGINEER

I Max Forsberg a Professional Engineer registered or licensed to practice in the Province or Territory of Alberta, hereby certify that I have reviewed the design and manufacturing process for the steel building system described. I certify that the foregoing statements, initialed by me, are true.

NAME Max Forsberg
TITLE P.Eng
AFFILIATION Straight-Up Metal Buildings Ltd

SIGNATURE Max Forsberg
DATE 02 / 10 / 15
DD MM YY

Professional Seal



APEGA Permit to Practice P12663



the pressure equipment safety authority

Celebrating 20 years
1995 – 2015

9410 - 20 Ave N.W.
Edmonton, Alberta, Canada T6N 0A4
Tel: (780) 437-9100 / Fax: (780) 437-7787

October 22, 2015

Attention: Andrew Ai
NATIONAL PROCESS EQUIPMENT INC
5049 74 AVENUE SE
CALGARY, AB T2C 3H2

The design submission, tracking number 2015-07576, originally received on October 21, 2015 was surveyed and accepted for registration as follows:

Reg. No. : PP-0120-G-102-P

Accepted on: October 22, 2015

Reg Type: Modification

Drawing No. : 338716-LDT Rev 0 As Noted

Design registered in the name of : SHELL CANADA LIMITED

This piping design submission has been registered based on the conditions that:

- The Professional Engineer who stamped the AB-96 form in accordance with Section 16(2) of the AR 49/2006 Pressure Equipment Safety Regulation (hereafter referred to as "PESR"), (i) has reviewed this design, (ii) is satisfied that it is in compliance with applicable regulations and codes, and (iii) has accepted responsibility for the design;
- The design of each pressure piping system complies fully with the requirements of ASME B31.3 and that the piping contractor has a valid Certificate of Authorization Permit, issued in accordance with the PESR, for the scope of work;
- All valves, flanges, and other fittings have been registered in Alberta by their manufacturers and have pressure/temperature ratings equal to or higher than the system's maximum allowable working pressure;
- All pressure equipment shall be properly protected by pressure relief valves set at or below the lowest maximum allowable working pressure of any equipment protected by that relief valve, except as declared on the submitted AB-96 form and/or appropriate supporting documentation listed in the table below:

Type of Overpressure Protection	Document #	Rev.
Pressure Relief Valves (PRV), per Section 38(1)(a) of the PESR and Section 5.1 of AB-525	PSV LIST 338716-PSV	0

Where ABSA is not properly informed on the AB-96 form and application design documents that pressure equipment is protected by RDD, PD, OPPSD or OMOPP according to Section 38(1)(b) of AR49/2006, it is understood that RDD, PD, OPPSD or OMOPP will not be used with this design, and that all pressure equipment is properly protected by pressure relief valves set at or below the lowest maximum allowable working pressure of any equipment protected by that pressure relief valve.



the pressure equipment safety authority

Celebrating 20 years
1995 – 2015

9410 - 20 Ave N.W.
Edmonton, Alberta, Canada T6N 0A4
Tel: (780) 437-9100 / Fax: (780) 437-7787

October 22, 2015

The registration is conditional on your compliance with the following notes:

- *This pressure piping design has been accepted on the understanding that the on-skid piping in packages supplied by others must be registered before the operation of this piping system (per section 40 of the Province of Alberta Safety Codes Act and section 14 of the Pressure Equipment Safety Regulation)
This requirement shall be conveyed to the owner and these vendors to ensure that registration occurs and that the submission for such packages are identified to this specific plant to ensure compatibility of registration numbers.*
- *The tie-in or pneumatic test procedure are not part of this registration and must be registered by the contractor before a test is conducted.*
- *Acceptance is based on the understanding that all valves will be always open in front and behind of the PSV.*
- *Please note that the energy from hydraulic shock-Water hammer (momentum change) is not part of this registration.*
- *Acceptance is based on the understanding that all piping fittings have a valid ABSA registration and all PSV shall have sufficient capacity to avoid overpressure in case of an internal failure including fire case .*

Complete the enclosed AB-81 forms in triplicate, keep one copy and forward two copies to ABSA.

An invoice covering survey and registration fees will be forwarded from our Revenue Accounts.

Enclosed are stamped prints for your reference.

Sincerely,

DEDOVIC, BLAZO

NOTE: This form shall be completed (page 1 and 2) in **DUPLICATE** and submitted with specifications and prints of designs in accordance with Section 16 (1) of the Pressure Equipment Safety Regulation.

1. Ultimate Owner Shell Canada Limited
PO Box 100 Station M, Calgary, Alberta, T2P 2H5

(Name and Address)

2. Type of Plant CMT Natural Gas Pressure Reduction SKID Package

3. Location of Plant SW ¼, Sec. 16, Twp 85, Rge. 18, W 5
(Sec., TWP., Rge.)

4. Plant previously registered under PP - PP-0120-G-102-P

5. Construction: Tentative start and completion dates:

Commencement	<u>January</u>	<u>2015</u>	Completion	<u>May</u>	<u>2015</u>
	(month)	(year)		(month)	(year)

6(a) Engineered by Swift Engineering Inc. Ref. or Job No. _____
910, 736-8th Avenue S.W. Calgary, AB T2P 1H4
(Company Name and Address)

6(b) Permit to Practice Number P-8442

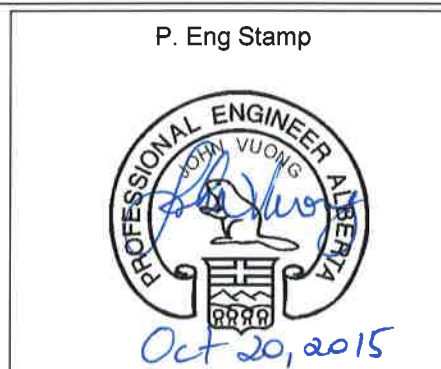
7. Prime Contractor National Process Equipment (DXPE) Ref. or Job No. SLS338716
5049 74 Avenue SE, Calgary, AB T2C 3H2
(Company Name and Address)

8. Pressure Piping to comply with the Code: B31.1 B31.3 B31.5 B31.9 Z662 2012
(Edition/Addenda)

9. List of documents with revision #'s (If additional space if required, use supplemental sheets) P&IDs, PSV and Line Lists, Specifications for pipe, valves & all fittings included in the scope of this piping design registration. If documents are listed on supplemental sheet, record the supplemental sheet numbers in this space.

P&ID 338716-100 Rev8
PSV LIST 338716-PSV Rev0
LINE DESIGNATION LIST TABLE 338716-LDT Rev 0
PIPING SPECIFICATIONS (A150/LT, B300/LT, C600/LT, D900/LT)

10. **Name and authenticated stamp/seal of Professional Engineer**
By applying my stamp/seal and signature to this document,
I, John Vuong, accept responsibility
(print name)
for the piping design in accordance with ASME/B31.3 /2012 and
(Code/Edition/Addenda)
the Safety Codes Act and Regulations.



FOR ABSA USE ONLY:

Reference Tracking No. _____

PP 0120 - 6 - 102 - E

11. Are all fittings suitable for the specific design service conditions? (Yes) Yes

Are all fittings registered with ABSA? (Yes) Yes (Pending) _____

12. Select the system overpressure protection type, as required in the PESR Section 38 and as defined in AB-525, and provide the corresponding document number(s) which lists equipment protected by this type.

Type	Document #	REV	Type	Document #	REV
PRV <input checked="" type="checkbox"/>	PSV LIST 338716-PSV	0	V-OPPSD <input type="checkbox"/>		
RDD or PD <input type="checkbox"/>			P-OMOPP <input type="checkbox"/>		
P-OPPSD <input type="checkbox"/>			V-OMOPP <input type="checkbox"/>		

13. Nondestructive Examination. Please specify type and extent of examination, for example, 100% or random radiography, magnetic particle, ultrasonic, etc.

Refer to attached LINE DESIGNATION LIST

14. Pressure Piping Test Procedure for other than Hydro test SUBMITTED (Yes) n/a (Pending) _____

15. Contractor's Quality Control Program Registration No. AQP-21321 [ALBERTA]

16. General Remarks _____

17. Submitted by

 , October 20, 2015
(Signature) (Date)

John Vuong , SWIFT ENGINEERING INC.
(Name) (Company Name)

FOR ABSA USE ONLY:

Registration Number PP-0120 - 6-102-1 Date OCT 22 2015

Reference Tracking No. _____ S.C.O's Signature _____

N/A



A large blue diagonal line is drawn across the page from the top right towards the bottom left. Two handwritten annotations in blue ink are present: the letters 'N/A' are enclosed in a hand-drawn oval, and a signature is enclosed in another hand-drawn oval to its right.

LINE DESIGNATION TABLE, DOC# 338716-LDT Rev0

Line System Description								Operating Conditions			Design Conditions Note 1.			Test & Inspection					
Line Number	Piping Size (Inch)	WT (SCH)	Piping Class	Corrosion Allowance (mm)	Materials	Insulation Material/ Thickness(mm)	From Source	To Destination	Fluid & State	(Min./Max) Flow (Sm3/h)	(Min./Max) Pres (kPag)	(Min./Max) Temp (°C)	Design Pressure (kPag)	(Min./Max) Temp (°C)	Piping Stress Analysis	Test Medium	Test Pressure @ Indoor Temp (kPag)	PWHT	NDE
2" FG-07984-80-C600/LT-CP/ETR/CMT	2	80	ASME 600# C600/LT	1	LOW TEMP.	Insulation and EHT by others	GAS INLET N1 (JACOBS P&ID CCK-0790-PX-2365-000-0001-002)	2" FG-07985-80-C600/LT/CMT	NATURAL GAS	150 / 1540	1200 / 8500	-5 / 40	9633 kPag @ 73 °C	-45 / 73	PASS	Water	15306	N/A	100% VISUAL 100% RT ON BW 10% MT ON SW
2" FG-07985-80-C600/LT/CMT	2 and 3	80 and 40	ASME 600# C600/LT	1	LOW TEMP.	n/a	2" FG-07984-80-C600/LT-CP/ETR/CMT	COALESCER FILTER S-08070	NATURAL GAS	150 / 1540	1200 / 8500	-5 / 40	9633 kPag @ 73 °C	-45 / 73	PASS	Water	15306	N/A	100% VISUAL 100% RT ON BW 10% MT ON SW
						n/a	COALESCER FILTER INLET LINE	HEATER H-08071	NATURAL GAS	150 / 1540	1200 / 8500	-5 / 40	9633 kPag @ 73 °C	-45 / 73	PASS	Water	15306	N/A	100% VISUAL 100% RT ON BW 10% MT ON SW
						n/a	COALESCER FILTER OUTLET LINE	HEATER H-08071	NATURAL GAS	150 / 1540	1200 / 8500	-5 / 40	9633 kPag @ 73 °C	-45 / 73	PASS	Water	15306	N/A	100% VISUAL 100% RT ON BW 10% MT ON SW
						n/a	2" FG-07987-80-D900/LT-HC/CM	PCV-08071A	NATURAL GAS	150 / 1540	1200 / 8500	-5 / 60.8	9633 kPag @ 73 °C	-45 / 73	PASS	Water	15306	N/A	100% VISUAL 100% RT ON BW 10% MT ON SW
	1 and 2	80	ASME 600# C600/LT	1	LOW TEMP.	n/a	COALESCER FILTER S-08070 INLET	PSV-08070A INLET	NATURAL GAS	150 / 1540	1200 / 8500	-5 / 40	9633 kPag @ 73 °C	-45 / 73	PASS	Water	15306	N/A	100% VISUAL 100% RT ON BW 10% MT ON SW
1" FG-07986-80-C600/LT/CMT	1 and under	80	ASME 600# C600/LT	1	LOW TEMP.	n/a	COALESCER FILTER S-08070	CONDENSATE STORAGE TANK V-08069	NATURAL GAS	150 / 1540	1200 / 8500	-5 / 40	9633 kPag @ 73 °C	-45 / 73	PASS	Water	15306	N/A	100% VISUAL 100% RT ON BW 10% MT ON SW
2" FG-07987-80-D900/LT-HC/CMT	2	80	ASME 900# D900/LT	1	LOW TEMP.	Mineral wool/ 37.5	HEATER H-08071	900#600#-SPEC BREAK AFTER DB&B VALVE	NATURAL GAS	150 / 1540	1200 / 8500	-5 / 60.8	13100 kPag @ 204 °C	-45 / 204	PASS	Water	22960	N/A	100% VISUAL 100% RT ON BW 10% MT ON SW
						n/a	HEATER H-08071	PSV-08071A INLET	NATURAL GAS	150 / 1540	1200 / 8500	-5 / 60.8	13100 kPag @ 204 °C	-45 / 204	PASS	Water	22960	N/A	100% VISUAL 100% RT ON BW 10% MT ON SW
2" FG-07988-80-B300/LT-HC/CMT	2	80	ASME 300# B300/LT	1	LOW TEMP.	Mineral wool/ 37.5	PCV-08071A OUTLET	PCV-08071B INLET	NATURAL GAS	150 / 1540	1200 / 4137	30.9 / 40	4378 kPag @ 204 °C	-45 / 204	PASS	Water	7653	N/A	100% VISUAL 100% RT ON BW 10% MT ON SW
						n/a	PCV-08071A OUTLET	PSV-08071B INLET	NATURAL GAS	150 / 1540	1200 / 4137	30.9 / 40	4378 kPag @ 204 °C	-45 / 204	PASS	Water	7653	N/A	100% VISUAL 100% RT ON BW 10% MT ON SW
2" FG-07989-80-A150/LT-HC/CMT	2	80	ASME 150# A150/LT	1	LOW TEMP.	Mineral wool/ 37.5	PCV-08071B OUTLET	PCV-08071C INLET	NATURAL GAS	150 / 1540	1100 / 1240	30 / 40	1530 kPag @ 149 °C	-45 / 149	PASS	Water	2847	N/A	100% VISUAL 15% RT ON BW 15% MT ON SW
						n/a	PCV-08071B OUTLET	PSV-08071C INLET	NATURAL GAS	150 / 1540	1100 / 1240	30 / 40	1530 kPag @ 149 °C	-45 / 149	PASS	Water	2847	N/A	100% VISUAL 15% RT ON BW 15% MT ON SW
2" FG-07990-80-A150/LT-HC/ETR/CMT	2	80	ASME 150# A150/LT	1	LOW TEMP.	Mineral wool/ 37.5	PCV-08071C OUTLET	GAS OUTLET N2 (JACOBS P&ID CCK-0790-PX-2365-000-0001-0002)	NATURAL GAS	150 / 1540	55 / 620	25 / 35	1530 kPag @ 149 °C	-45 / 149	PASS	Water	2847	N/A	100% VISUAL 15% RT ON BW 15% MT ON SW
						n/a	PCV-08071C OUTLET	PSV-08071D INLET	NATURAL GAS	150 / 1540	55 / 620	25 / 35	1530 kPag @ 149 °C	-45 / 149	PASS	Water	2847	N/A	100% VISUAL 15% RT ON BW 15% MT ON SW
	1 and under	80	ASME 150# A150/LT	1	LOW TEMP.	n/a	2" FG-07990-80-A150/LT-HC/ETR/CMT	ODORIZER INLET and OUTLET	NATURAL GAS	150 / 1540	55 / 620	-45 / 35	1530 kPag @ 149 °C	-45 / 149	PASS	Water	2847	N/A	100% VISUAL 15% RT ON BW 15% MT ON SW
						n/a	ODORIZER OUTLET	PSV-08116A INLET	NATURAL GAS	150 / 1540	55 / 620	-45 / 35	1530 kPag @ 149 °C	-45 / 149	PASS	Water	2847	N/A	100% VISUAL 15% RT ON BW 15% MT ON SW
2" FG-07991-80-A150/LT/CMT	2	80	ASME 150# A150/LT	1	LOW TEMP.	n/a	PSV 08070A/08071A/08071B/08071C/08071D /08116A OUTLET	ATMOSPHERE	NATURAL GAS	N/A	0	-45 / 35	1530 kPag @ 149 °C	-45 / 149	PASS	Water	2847	N/A	100% VISUAL 15% RT ON BW 15% MT ON SW
2" FG-07992-80-A150/LT/CMT	2	80	ASME 150# A150/LT	1	LOW TEMP.	n/a	TANK V-08069	ATMOSPHERE	NATURAL GAS	N/A	0	-45 / 35	1530 kPag @ 149 °C	-45 / 149	PASS	Water	2847	N/A	100% VISUAL 15% RT ON BW 15% MT ON SW
1" FG-07991-80-A150/LT/CMT	1	80	ASME 150# A150/LT	1	LOW TEMP.	n/a	TANK V-08069	ENVIRO BOX - N5	NATURAL GAS	N/A	0	-45 / 35	1530 kPag @ 149 °C	-45 / 149	PASS	Water	2847	N/A	100% VISUAL 15% RT ON BW 15% MT ON SW

Note:
1 Design condition refers to the Pipe class, A150/LT, B300/LT, C600/LT, D900/LT

SAFETY CODES ACT - PROVINCE OF ALBERTA
ACCEPTED
0120-8-102-P
338716-LDT Rev.0
OCT 22 2015
Signed *[Signature]*
BLAZO DEDOVIC
DESIGN SURVEYOR


OCT 20, 2015

PSV LIST, DOC# 338716-PSV REV.0
Natpro S.I.S. 338716

Tag No.	P&ID No.	Service	Fluid	Relief Conditions		Safety-Relief Valve				
				Case	Pressure Set Point	Make/Type	Orifice Size (ASME) Calculated/Selected	Inlet	Model	Outlet
					kPag		In2			
PSV-08070A	338716-100	COALESCER FILTER (TAG: S-08070)	NATURAL GAS	FIRE	9930	FARRIS/ CONVENTIONAL	0.012513/0.150	1" 600# RF	26DA13-120/LC	2" 150# RF
PSV-08071A	338716-100	NATURAL GAS ELECTRIC HEATER (TAG: H-08071)	NATURAL GAS	BLOCK CASE	9600	FARRIS/ CONVENTIONAL	0.001392/0.150	1.5" 900# RF	26DA14-120/LC	2" 300# RF
PSV-08071B	338716-100	DOWNSTREAM OF PCV 08071A	NATURAL GAS	VALVE FAILURE	4137	FARRIS/ CONVENTIONAL	0.10347/0.150	1" 300# RF	26DA12-120/LC	2" 150# RF
PSV-08071C	338716-100	DOWNSTREAM OF PCV 08071B	NATURAL GAS	VALVE FAILURE	1240	FARRIS/ CONVENTIONAL	0.037879/0.150	1" 150# RF	26DA10-120/LC	2" 150# RF
PSV-08071D	338716-100	DOWNSTREAM OF PCV 08071C	NATURAL GAS	VALVE FAILURE	620	FARRIS/ CONVENTIONAL	0.051314/0.150	1" 150# RF	26DA10-120/LC	2" 150# RF
PSV-08116A	338716-100	ODORIZER (TAG: V-08116)	MERCAPTAN	FIRE	1827	FARRIS/ CONVENTIONAL	0.025161/0.150	1" 150# RF	26DA10-120/LC	2" 150# RF

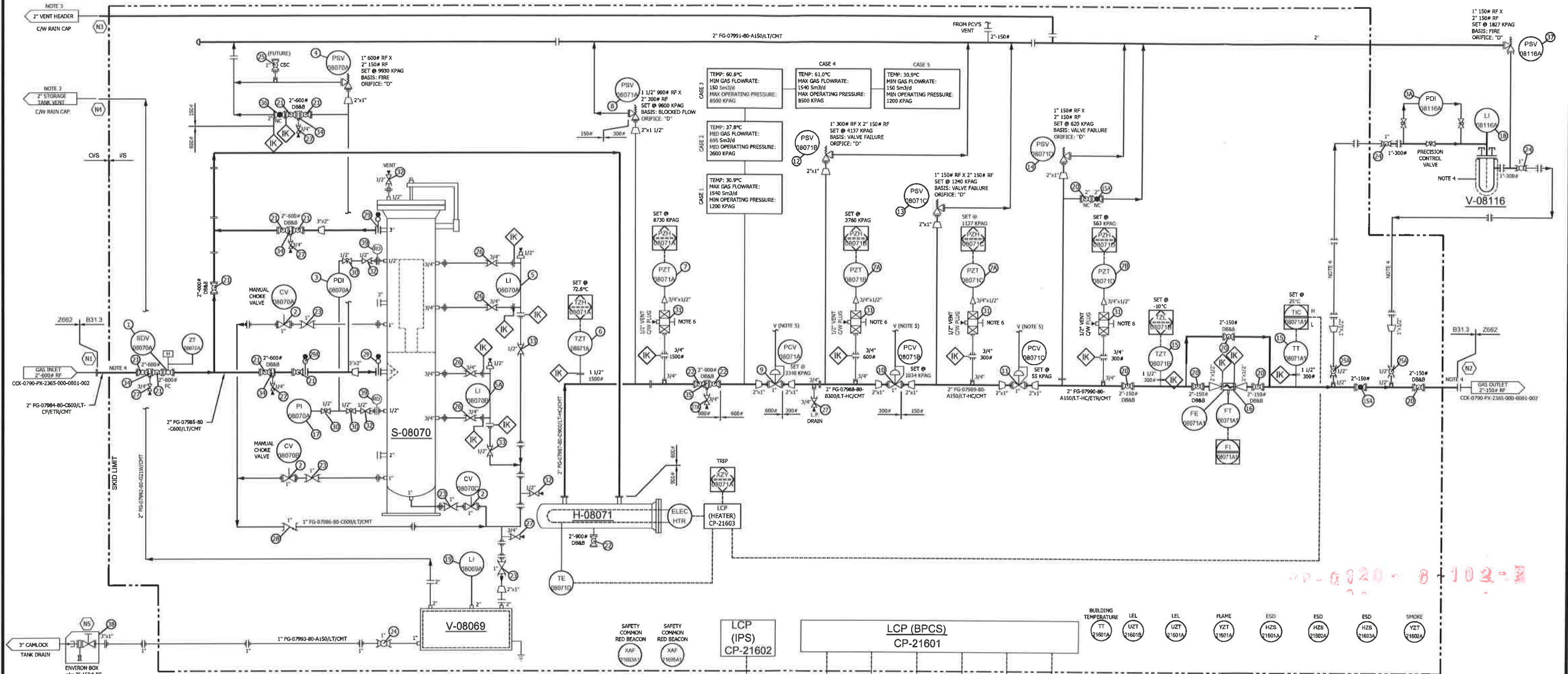


Oct 20, 2015

07 0120-0-102-2

S-08070 COALESCER FILTER MAKE: JONELL MODEL: JPMG-336-CE-R SIZE: 219mm x 2565mm S/S DP/DT: 9930 KPAG -45/54°C CRN: AB C.A.: 3.05	H-08071 NATURAL GAS ELECTRIC HEATER MAKE: EX HEAT RATED HEAT DUTY: 4.4 KW/600V/60HZ/3 PHASE VESSEL SIZE: 168mm OD x 1694mm LG DP/DT: 9930 KPAG -45/93°C CRN: AB CA: 1.6 INSULATION: PERSONNEL PROTECTION ONLY	V-08069 CONDENSATE STORAGE TANK MAKE: STEELCRAFT MODEL: 100 GAL DOUBLE WALL STEEL TANK SIZE: 711mm OD x 1219mm LG DP/DT: ATMOSPHERIC	V-08116 MERCAPTAN GAS ODORIZER MAKE: TANSLEY ASSOCIATES MODEL: 3-B SIZE: 406mm OD x 762mm LG DP/DT: 2068 KPAG -45/66°C C.A.: 0
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SKID LIMIT



Piping Designed to ASME B31.3



- GENERAL NOTES:**
- DELETED.
 - NATPRO SCOPE OF SUPPLY.
 - N3/N4 TO BE ROUTED TO SAFE LOCATION. VENT TO ATMOSPHERE.
 - ELECTRIC HEAT TRACING & INSULATION AT LEAST 1M INSIDE THE BUILDING SHOULD BE PROVIDED BY OTHERS.
 - TO 2" VENT HEADER.
 - SS SPOOLS TO BE SS316/L C/W 3/4" XS SCH NIPPLES.
 - IK INDICATING ISOLATION KIT
 - PIPING HEAT CONSERVATION AFTER ELECTRICAL HEATER BY NPE.

SCHEDULE OF OPENINGS			
CONN	SIZE	RATING	DESCRIPTION
N1	2"	600# RF	PACKAGE INLET
N2	2"	150# RF	PACKAGE OUTLET
N3	2"	-	VENT HEADER (VENT TO ATMOSPHERE)
N4	2"	-	TANK VENT (VENT TO ATMOSPHERE)
N5	3"	CAMLOCK	TANK DRAIN

8	REVISED AS PER CUSTOMER'S REQUIREMENT	NSP	AA	AA	SEPT 29/15
7	REVISED AS PER CUSTOMER'S REQUIREMENT	NSP	AA	AA	SEPT 1/15
6	REVISED TAGGING & ANSI RATING, ADDED GEN. NOTE 5	GG	ET	PM	DEC 18/14
5	REVISED AS PER CUSTOMER'S MARKUPS	GG	ET	PM	NOV 27/14
4	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	OCT 10/14
3	REVISED AS TITLE BLOCK/TAGGING & ADDED LINE NUMBERS	GG	ET	PM	OCT 02/14
2	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	SEP 17/14
1	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	SEP 08/14
0	ISSUED FOR APPROVAL	GG	ET	PM	JUL 04/14
REV	DESCRIPTION	DWN	CHK	APP	DATE

CMT NG PRESSURE REDUCTION SKID PACKAGE P & ID

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.

PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 P# 4512-109-130
 DWN BY: GG DATE: JUL 04/14 DWG #: 338716-100-Rev8
 CRK BY: ET DATE: JUL 04/14
 APP BY: COG DATE: JUL 04/14 PAGE: 1 OF 4 CAD: N/A REV: 8



urethane foam coatings inc

179 chapman close se
calgary, alberta, T2X 3T3
www.ufcsprayfoam.com

Job Report

Company: RollFab

Job#: 14-2415

PO#: [15-004178](#)

Completion Date: 08-Jan-15

Job Description: 2lb Sprayfoam (PF7217-0) applied to underside of plate only,
with Towerthon.

Thickness (inches): 2

Substrate Temp (Celcius): 17.8

Ambient Temp (Celcius): 10.2

% of Humidity: 29.2

Sprayed: Indoor

Darren Ward
Owner/Applicator
Ph: (403) 993-4997



DAILY WORK RECORD

CUFCA Contractor: The welding shop/ Insul-foam services
 Certified Installer Name: Terrance DeCoste Certification #: 305234
 Trainee:

Project Information Please Circle One
 Customer Name: Matpro Construction: New Occupied
 Project Name: Skid Ventilated 0.3 ACH: No Yes
 Project Address: Spray Area Isolated: No Yes
 Project Description: Spray 2" EPS skid Building Permit Posted: No Yes #

Material Information - Please Circle One
 Manufacturer: DEMILEC RFSI other Material Type:
 CCMC#: 13244-L(soya) 12380-R(0240/PF7300) Other 172170F

	"A"	"B"	Total Foam Sprayed in KGs
Expiry or Mfg Date:		<u>15/07/15</u>	<u>1/8 set</u>
Lot #:	<u>858</u>	<u>L449C</u>	

Equipment - Please List
 Equipment Manufacturer: Graco Model: H-33
 Tip Size: 5252 Hose Length: 200 m Pressure "A": 1100 PSI/Kpa
 Heater Temp Block: 103 C°/F° Hose Temp: 103 C°/F° Pressure "B": 1100 PSI/Kpa

Environmental Conditions

Time	Ambient Temp (C°)	Relative Humidity (%)	Wind Velocity (km/h)	Substrate Temp (C°/F°)
<u>12:00</u>	<u>18</u>	<u>48%</u>	<u>N/A</u>	<u>18</u>

Substrate Conditions - Please Circle One
 Type: Steel Preparation Required: poly around steel
 Conditions: Clean Dry Sound Free of Grease or Oil: Yes No

Test Results
 Density Test: Mass: 6.33 g Volume: 180 ml Density = $\frac{g}{ml} \times 1000 =$ 2.1 kg/m³

Manufacturer's Minimum Required Density: 1.9 Site Density Equal or Greater: Yes No
 Adhesion / Cohesion Test Results: Pass: Fail:
 Thickness required: 4' Thickness measured: 4' # of passes: 2
 Visual Inspection(circle one): Acceptable Not Acceptable

Primers / Coatings - Please Circle One
 Primer Required: Yes No Details:
 Exterior Coating: Yes No Interior Thermal Barrier: Yes No

Date: May 28/15 Certified Installer Signature: Terrance DeCoste

Note: To convert from kg/m³ to lb/ft³ divide by 16.02 kg/m³ / 16.02 = lb/ft³

Hydrostatic <input type="checkbox"/> Pneumatic <input type="checkbox"/>	Chart Recorder: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Sales Order #:	SLS 338716
Leak <input checked="" type="checkbox"/>		Client Reference:	
Chart Recorder Range:		Drawing No.:	338716-100
Test Gauge #:	235-010G / 235-008G	Date tested:	Sept 8 / 2015
Test Gauge Range:	0 ~ 400 PSI	Test Duration:	30 Min.
Test Pressure:	100 Psig		

ITEM IDENTIFICATION:

SDV - 8070A
 (Seat Test)

ISSUED FOR CONSTRUCTION


IMPORTANT: Refer to PID;
 Close the SDV-Item 1;
 Block the downstream of the SDV if need;
 Charge pressure 100 lbs to upstream of the SDV;
 Monitor the upstream pressure of the SDV.

15/09/01 
DATE:YY/MM/DD SIGNATURE



TESTED BY: Hailong	Signature: 
WITNESSED BY: SANDY COHAN	Signature: 
INSPECTOR: Alben Permeigalis	Signature: 



FORM # QAP-033C	LEAK TEST PROCEDURE	Initials Date: 	REV # CA 100P	DATE Sept 01/15	ORIGINATOR QA	REVIEW SERVICE/ PRODUCTION	APPROVAL
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15 Sep
15

Hydrostatic <input type="checkbox"/> Pneumatic <input type="checkbox"/>	Chart Recorder: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Sales Order #:	SLS 338716
Leak <input checked="" type="checkbox"/>		Client Reference:	
Chart Recorder Range:		Drawing No.:	338716-100, 200
Test Gauge #:	S23-0284 / 235-0014	Date tested:	Oct 15 / 2015
Test Gauge Range:	0 ~ 100 PSI	Test Duration:	30 Min.
Test Pressure:	25 Psig		

TOTAL UNITS:

ITEM IDENTIFICATION:	
- Used air as test medium as per Peter Makrawi & Shell engineer. GC	
Start @ 2:00 pm Finish 2:35 pm	
- long term storage medium & pressure to be determined at a later date. Project team to advise GC	
IMPORTANT: Once confirmed no leaking in the piping system, charge Nitrogen 5 psi into the piping system for preservation purpose before shipping.	
TESTED BY: <i>Hailong</i>	Signature: <i>[Signature]</i> Tester
WITNESSED BY: <i>[Signature] Peter Makrawi</i>	Signature: <i>[Signature]</i> NPE Representative
INSPECTOR: <i>Jamie Gabelton for Shen</i>	Signature: _____ Inspector
TAGGING / ROUTING INSTRUCTIONS:	

ISSUED FOR CONSTRUCTION

10/09/15
 DATE: YY/MM/DD SIGNATURE *[Signature]*



FORM #	LEAK TEST PROCEDURE	REV #	DATE	ORIGINATOR	REVIEW	APPROVAL
QAP-033C		3	Sep 22/14	QA	SERVICE/ PRODUCTION	SM

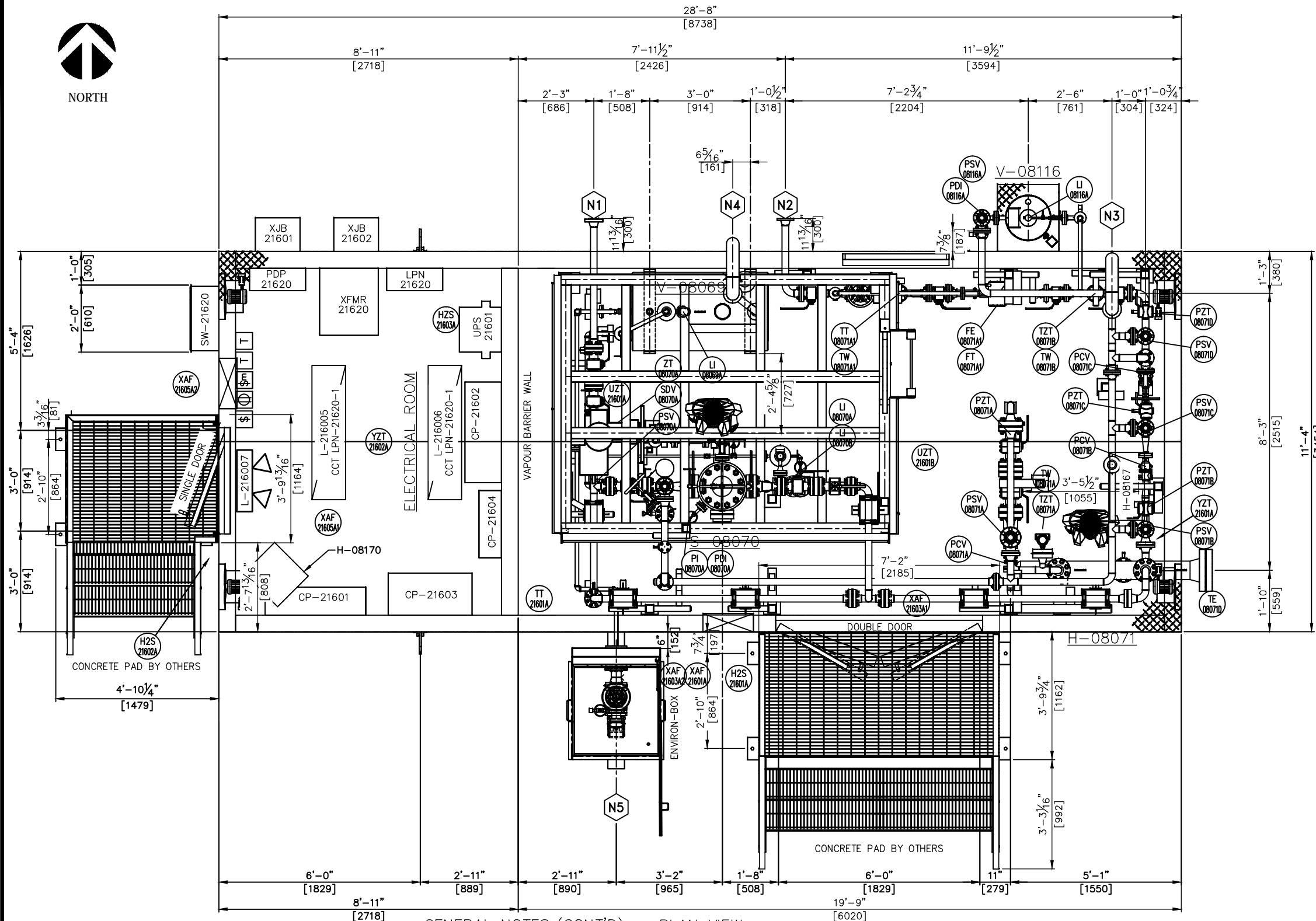
NON CONFORMANCE REPORTS

None reported

SECTION 4.0
FINAL DRAWINGS



NORTH



GENERAL NOTES:

- THIS DRAWING TO BE READ IN CONJUNCTION WITH THE PROCESS ENGINEERING FLOW SHEET, DRAWING 338716-100-Rev7.
- ALL PIPING ELEVATIONS ARE REFERENCE FROM TOP OF CHECKERED PLATE.
- FABRICATION TOLERANCE ±5mm FOR SKID EDGE CONNECTION LOCATION UNLESS NOTED OTHERWISE.
- ALL PIPING TO BE HELD TO DIMENSIONS & ELEVATIONS SHOWN FOR CUSTOMER TIE-INS.
- MAIN PIPING TO BE BUILT IN ACCORDANCE WITH THE LATEST EDITION OF B31.3.
- ALL PIPING PER B31.3 TO BE:
 - PIPING CLASS 'D900/LT', 1.0" C.A.
900 ANSI: 2" SCH 80
MATERIALS: PIPING - SA-333-6
FLANGES - SA-350-LF2 CL. 1
FITTINGS - SA-420-WPL6
BOLTS - SA-320-L7
NUTS - SA-194-2H
GASKETS - 304SS SPIRAL WOUND, GRAPHITE FILLED, 304SS INNER RING, CS OR SS OUTER RING
 - PIPING CLASS 'C600/LT', 1.0" C.A.
600 ANSI: 2" SCH 80; 3" SCH 40
MATERIALS: PIPING - SA-333-6
FLANGES - SA-350-LF2 CL. 1
FITTINGS - SA-420-WPL6
BOLTS - SA-320-L7
NUTS - SA-194-2H
GASKETS - 304SS SPIRAL WOUND, GRAPHITE FILLED, 304SS INNER RING, CS OR SS OUTER RING
 - PIPING CLASS 'B300/LT', 1.0" C.A.
300 ANSI: 2" SCH 80
MATERIALS: PIPING - SA-333-6
FLANGES - SA-350-LF2 CL. 1
FITTINGS - SA-420-WPL6
BOLTS - SA-320-L7
NUTS - SA-194-2H
GASKETS - 304SS SPIRAL WOUND, GRAPHITE FILLED, 304SS INNER RING, CS OR SS OUTER RING
 - PIPING CLASS 'A150/LT', 1.0" C.A.
150 ANSI: 2" SCH 80
MATERIALS: PIPING - SA-333-6
FLANGES - SA-350-LF2 CL. 1
FITTINGS - SA-420-WPL6
BOLTS - SA-320-L7
NUTS - SA-194-2H
GASKETS - 304SS SPIRAL WOUND, GRAPHITE FILLED, 304SS INNER RING, CS OR SS OUTER RING
- CLASS 900 ANSI: SW PIPING & NIPPLES, CLASS 'D900/LT'
3/4" - 1 1/2" PIPE: SCH. 80 SA-333-6
3/4" - 1 1/2" NIPPLE: SCH. 160, SA-333-6
3/4" - 1 1/2" SWAGE: SCH. 80, SA-420-WPL6
3/4" - 1 1/2" FITTING: 3000#, SA-350-LF2 CL. 1
- CLASS 600 ANSI: SW PIPING & NIPPLES, CLASS 'C600/LT'
3/4" - 1 1/2" PIPE: SCH. 80 SA-333-6
3/4" - 1 1/2" NIPPLE: SCH. 160, SA-333-6
3/4" - 1 1/2" SWAGE: SCH. 80, SA-420-WPL6
3/4" - 1 1/2" FITTING: 3000#, SA-350-LF2 CL. 1
- CLASS 300 ANSI: SW PIPING & NIPPLES, CLASS 'B300/LT'
3/4" - 1 1/2" PIPE: SCH. 80 SA-333-6
3/4" - 1 1/2" NIPPLE: SCH. 160, SA-333-6
3/4" - 1 1/2" SWAGE: SCH. 80, SA-420-WPL6
3/4" - 1 1/2" FITTING: 3000#, SA-350-LF2 CL. 1
- CLASS 150 ANSI: SW PIPING & NIPPLES, CLASS 'A150/LT'
3/4" - 1 1/2" PIPE: SCH. 80 SA-333-6
3/4" - 1 1/2" NIPPLE: SCH. 160, SA-333-6
3/4" - 1 1/2" SWAGE: SCH. 80, SA-420-WPL6
3/4" - 1 1/2" FITTING: 3000#, SA-350-LF2 CL. 1
- BUILDING
- DIM.: 28'-8" L X 11'-4" W X 13'-2" EAVE HEIGHT, GABLE TYPE WITH 4:12 SLOPE
MATERIAL - WALLS: 22GA PRE-PAINTED (TAN: 5MQC8315)
ROOF/DOOR/TRIMS: 22GA PRE-PAINTED (METRO BROWN: 5MQC8228)
INSULATION (FIBERGLASS BATT) - WALL: R22 (6" THICK)
ROOF: R22 (6" THICK)
INTERIOR LINER: 24GA WHITE ALUMINUM
VAPOR BARRIER: 6-mil POLYETHYLENE (CERTIFIED)
(1) - 3'-0" X 7'-0" DOOR HIGH, 20GA R12 INSULATED POLYURETHANE CORE C/W 16GA SINGLE DOOR FRAME, LOCKING PANIC HARDWARE, HYDRAULIC CLOSURE, 24"X24" IWG WINDOW, CHECK CHAIN, ALUMINUM THRESHOLD, CANOPY, AND WEATHER-STRIPPING (ELECTRICAL ROOM)
(1) - 6'-0" X 7'-0" DOOR HIGH, 20GA R12 INSULATED POLYURETHANE CORE C/W 18GA SINGLE DOOR FRAME, LOCKING PANIC HARDWARE, HYDRAULIC CLOSURE, 24"X24" IWG WINDOW, CHECK CHAIN, ALUMINUM THRESHOLD, CANOPY, AND WEATHER-STRIPPING (PROCESS ROOM)
(1) - 40" X 40" DOUBLE GLAZED SLIDING WINDOWS W/ HALF SCREEN & LOCK
(1) - 12" EXPLOSION PROOF SUPPLY FAN (120V/1 PH/60Hz) C/W BACK GUARD, SHUTTER AND 22GA STORM HOOD (ELECTRICAL ROOM)
(1) - 16" EXPLOSION PROOF SUPPLY FAN (120V/1 PH/60Hz) C/W BACK GUARD, SHUTTER AND 22GA STORM HOOD (PROCESS ROOM)
(1) - 12" X 12" MANUAL LOUVERS C/W INSECT SCREEN (ELECTRICAL ROOM)
(1) - 12" X 12" MANUAL LOUVERS C/W INSECT SCREEN (PROCESS ROOM)

GENERAL NOTES: (CONT'D) PLAN VIEW

- BUILDING (CONT'D)
(2) - 28'-8" FULL-LENGTH EAVES TROUGH C/W DOWNSPOUTS & ELBOW
(2) - 28'-8" FULL-LENGTH ANGE IRON ICE RAKES
(1) - PROFESSIONAL ENGINEERING STAMPED DRAWING
- CLEAN ALL STEEL SURFACES PRIOR TO PAINTING TO SSPC-SP10 SANDBLASTED NEAR TO WHITE METAL.
STRUCTURAL STEEL, PIPING, AND FILTER COALESCER
ONE (1) - COAT OF ZINC PRIMER
ONE (1) - COAT OF EPOXY
ONE (1) - TOPCOAT OF POLYURETHANE (COLOR: WARM GREY)
TOTAL LAYERS (3); TOTAL MIN. OF NDFPT: 300UM
INSULATED HEATER SHELL & INSULATED INLET (N1) - TWO (2) - COATS EPOXY PHENOLIC
- ALL PIPING SHALL BE HYDROTESTED TO 1.5 TIMES THE DESIGN PRESSURE.
- ALL PIPE SUPPORT LOCATIONS TO BE DETERMINED BY SHOP.
- ALL UNION LOCATIONS TO BE DETERMINED BY SHOP IF ANY.
- UNIT IS REGISTERED FOR ALBERTA SERVICE.
- FLAME ARRESTOR TO BE SHIPPED LOOSE.
- SHIPPING DIMENSION: 13'-0" W X 30'-0" LG X 16'-0" HT
- SHIPPING WEIGHT: 24,200 LBS (10,977 KG)
OPERATING WEIGHT: TBD LBS
- SEE ELECTRICAL DOC. 214068-7400/7401 FOR DETAILED POWER LAYOUT AND INSTRUMENT GENERAL LAYOUT.

SCHEDULE OF OPENINGS

CONN	SIZE	RATING	DESCRIPTION
N1	2"	600# RF	PACKAGE INLET
N2	2"	150# RF	PACKAGE OUTLET
N3	2"	-	VENT HEADER (VENT TO ATMOSPHERE)
N4	2"	-	TANK VENT (VENT TO ATMOSPHERE)
N5	3"	CAMLOCK	TANK DRAIN

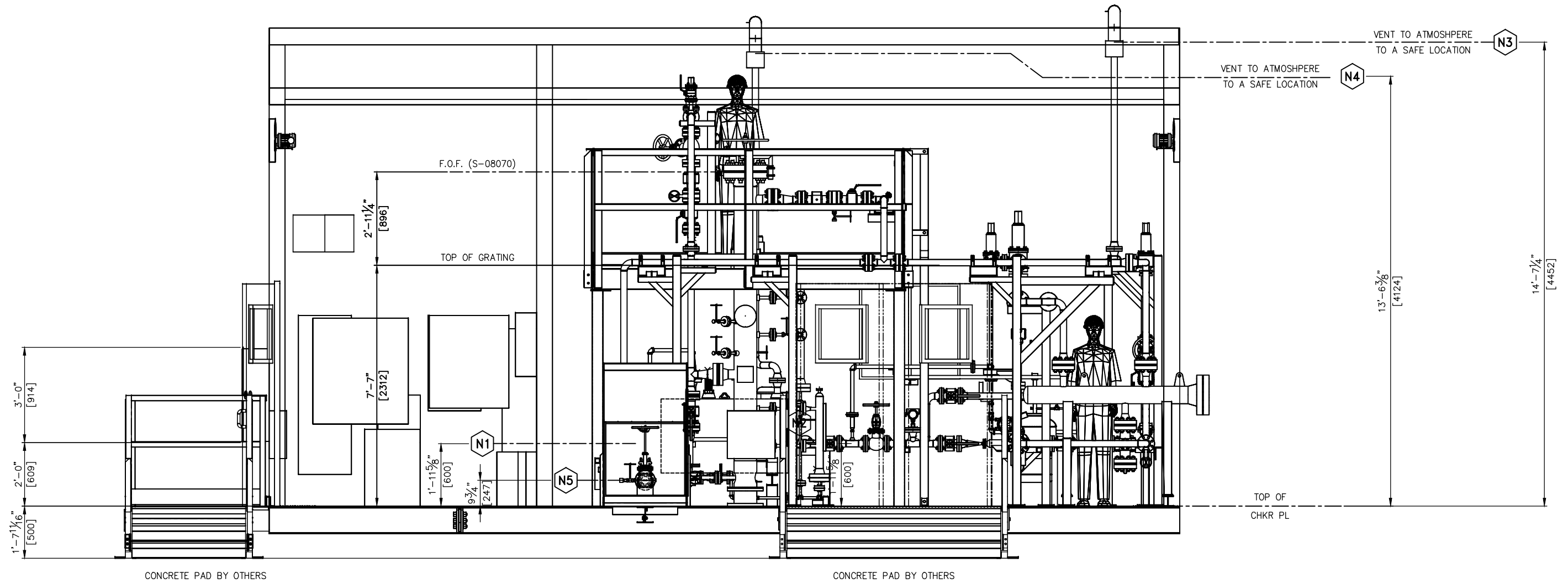
REV	DESCRIPTION	DWN	CHK	APP	DATE
9	REVISED PER CUSTOMER REQUIREMENTS	NSP	AA	AA	OCT 21/15
8	REVISED PER CUSTOMER REQUIREMENTS	NSP	AA	AA	SEPT 1/15
7	REVISED TAGS & PROJECTIONS; PROVIDED HAND RAILS	GG	ET	PM	DEC 18/14
6	REVISED PLATFORMS	NSP	ET	PM	NOV 28/14
5	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	NOV 19/14
4	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	OCT 10/14
3	REVISED AS NOTED	GG	ET	PM	SEP 30/14
2	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	SEP 03/14
1	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	AUG 22/14
0	ISSUED FOR PRELIMINARY REVIEW	GG	ET	PM	JUN 27/14

CMT NG PRESSURE REDUCTION SKID PACKAGE GENERAL ARRANGEMENT

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.

PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

DWN BY: GG	DATE: JUN 27/14	DWG #:	338716-200-Rev9
CHK BY: ET	DATE: JUN 27/14	PAGE:	1 OF 4
APP BY: COG	DATE: JUN 27/14	CAD:	N/A
		REV:	9



ELEVATION – FRONT VIEW

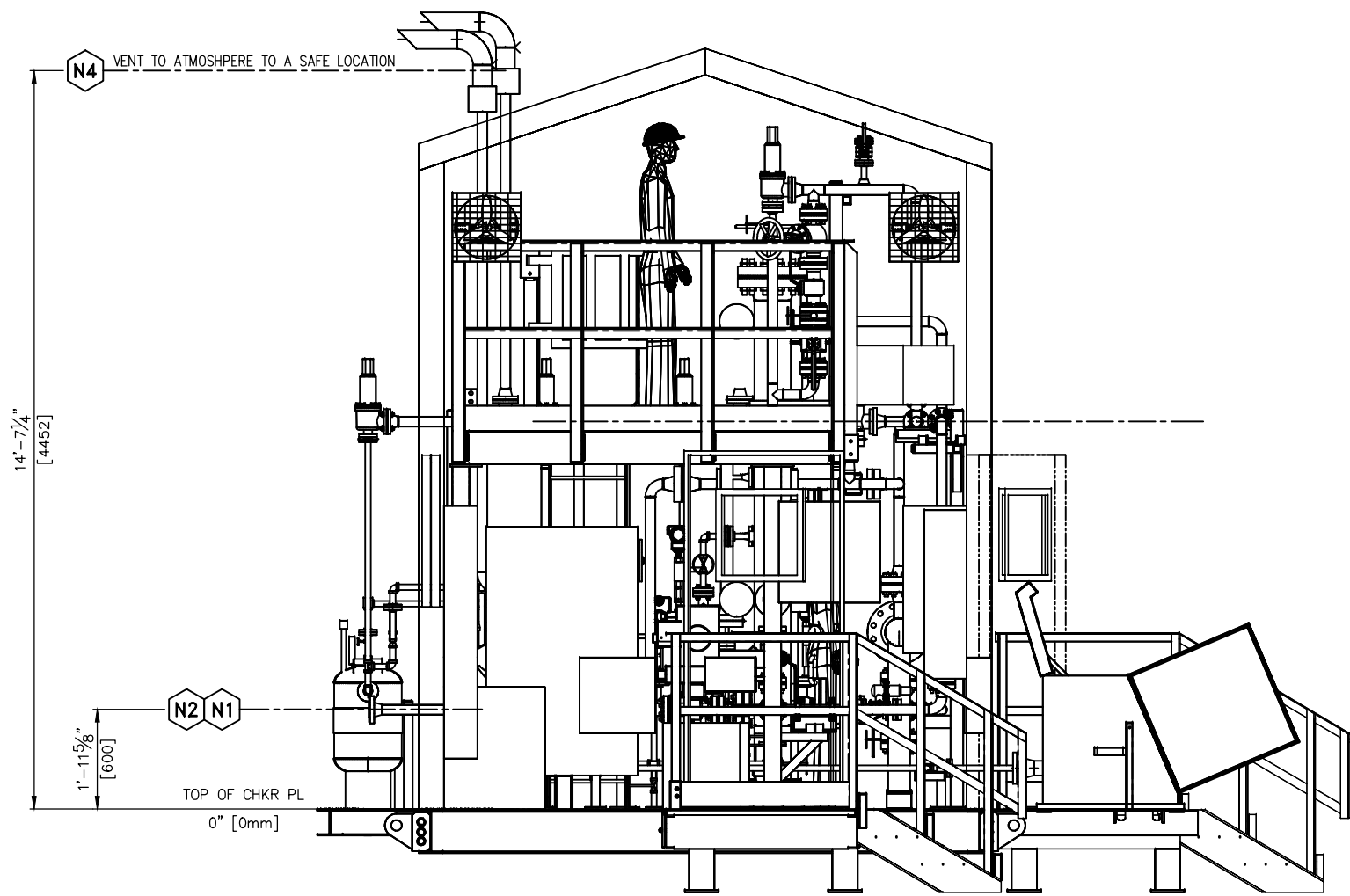
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SCHEDULE OF OPENINGS			
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N1	2"	600# RF	PACKAGE INLET
N2	2"	150# RF	PACKAGE OUTLET
N3	2"	-	VENT HEADER (VENT TO ATMOSPHERE)
N4	2"	-	TANK VENT (VENT TO ATMOSPHERE)
N5	3"	CAMLOCK	TANK DRAIN

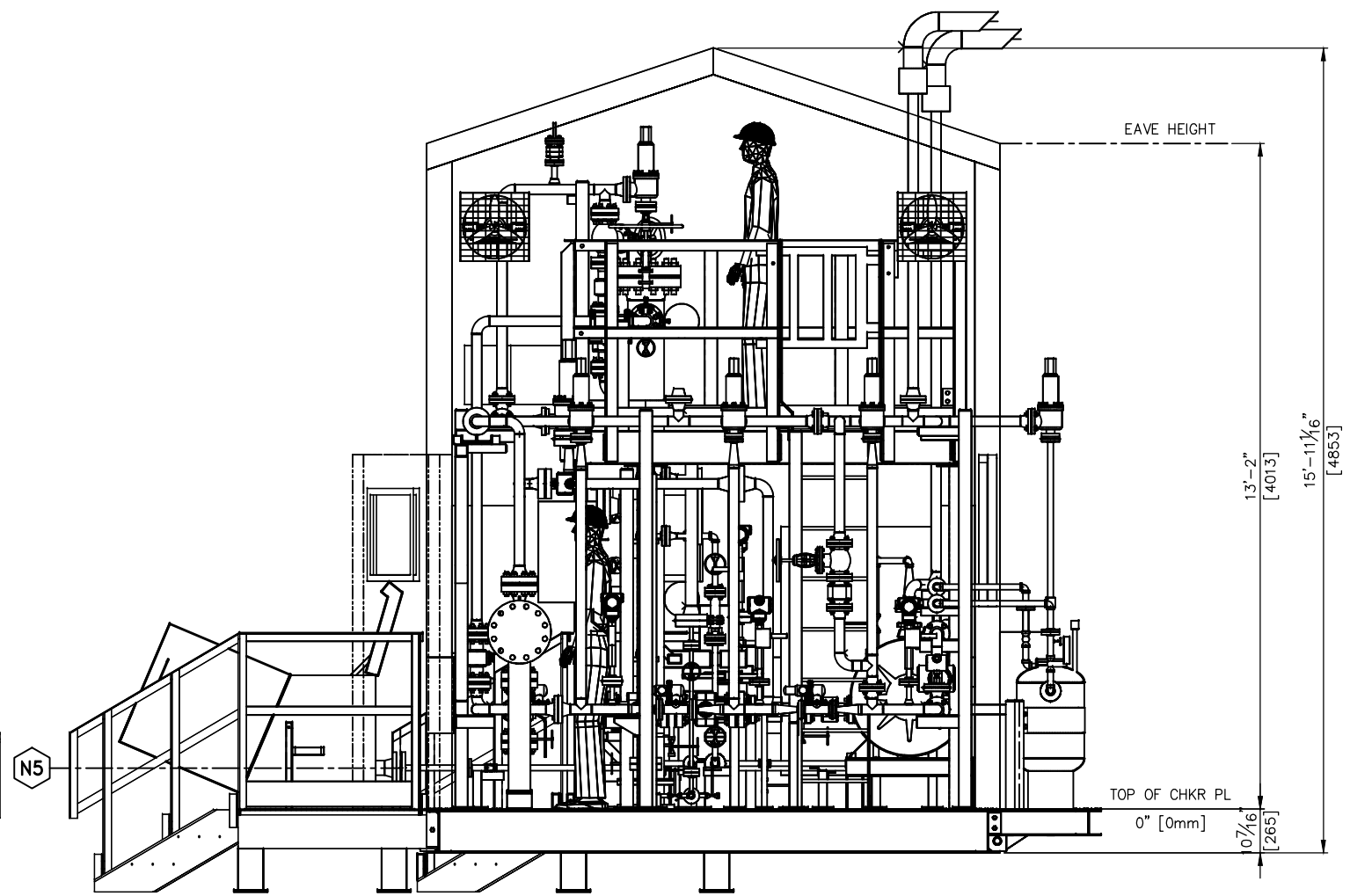
8	REVISED PER CUSTOMER REQUIREMENTS	NSP	AA	AA	SEPT 1/15
7	REVISED TAGS & PROJECTIONS; PROVIDED HAND RAILS	GG	ET	PM	DEC 18/14
6	REVISED PLATFORMS	NSP	ET	PM	NOV 28/14
5	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	-	NOV 19/14
4	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	OCT 10/14
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0	ISSUED FOR PRELIMINARY REVIEW	GG	ET	PM	JUN 27/14
REV	DESCRIPTION	DWN	CHK	APP	DATE

PROJECT NAME: CARMON CREEK PROJECT					
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING					
LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2					
TAG: 0735A-08030					
SLS#: 338716		QUOTE: CGY2014-85		PO#: 4512-109-130	
DWN BY: GG	DATE: JUN 27/14	DWG #: 338716-200-Rev8			
CHK BY: ET	DATE: JUN 27/14				
APP BY: COG	DATE: JUN 27/14	PAGE: 2 OF 4	CAD: N/A	REV: 8	

**CMT NG PRESSURE REDUCTION
SKID PACKAGE
GENERAL ARRANGEMENT**



ELEVATION – LEFT SIDE VIEW



ELEVATION – RIGHT SIDE VIEW

SCHEDULE OF OPENINGS

CONN	SIZE	RATING	DESCRIPTION
N1	2"	600# RF	PACKAGE INLET
N2	2"	150# RF	PACKAGE OUTLET
N3	2"	-	VENT HEADER (VENT TO ATMOSPHERE)
N4	2"	-	TANK VENT (VENT TO ATMOSPHERE)
N5	3"	CAMLOCK	TANK DRAIN

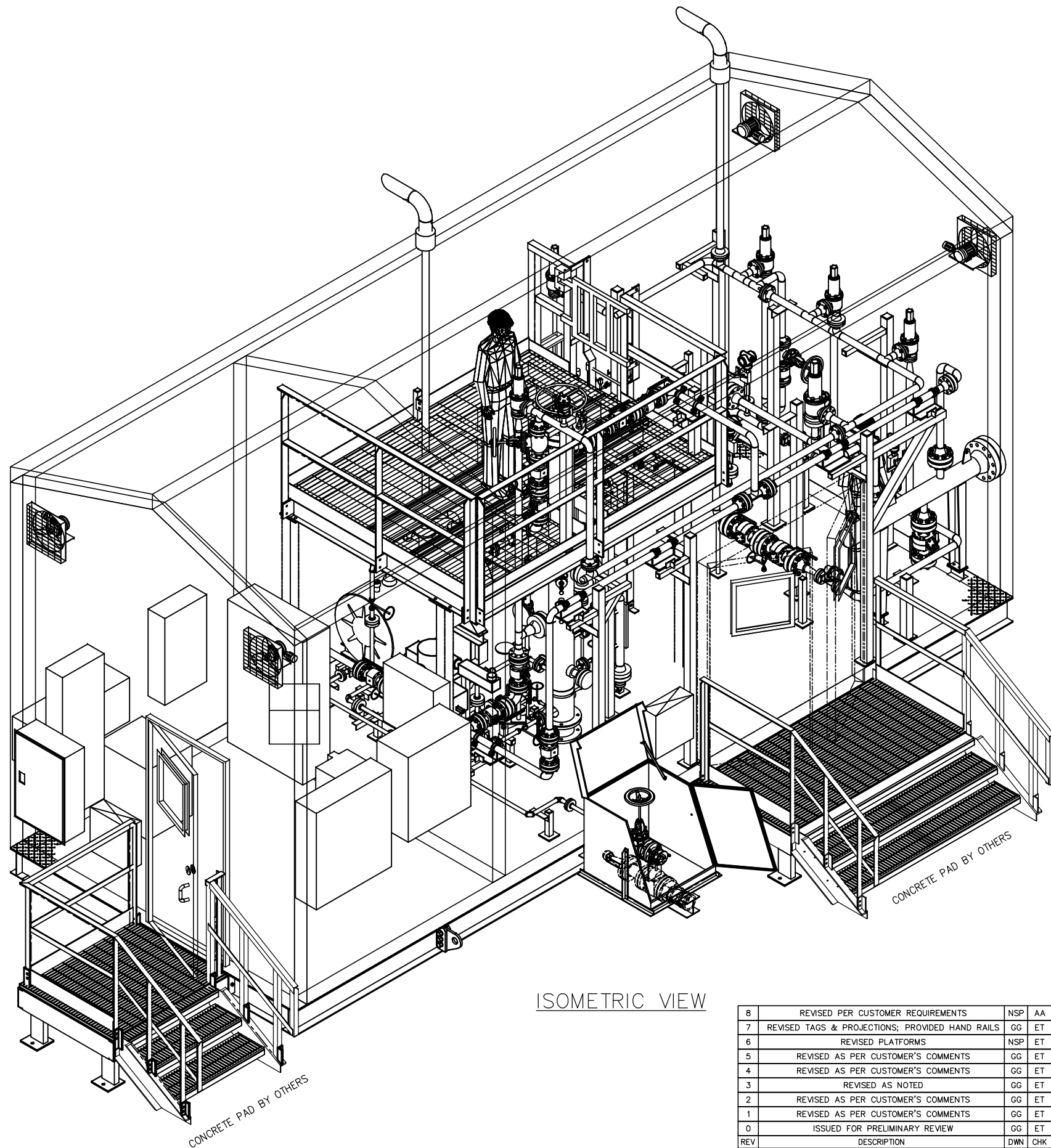
8	REVISED PER CUSTOMER REQUIREMENTS	NSP	AA	AA	SEPT 1/15
7	REVISED TAGS & PROJECTIONS; PROVIDED HAND RAILS	GG	ET	PM	DEC 18/14
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5	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	-	NOV 19/14
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1	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	AUG 22/14
0	ISSUED FOR PRELIMINARY REVIEW	GG	ET	PM	JUN 27/14
REV	DESCRIPTION	DWN	CHK	APP	DATE

**CMT NG PRESSURE REDUCTION
SKID PACKAGE
GENERAL ARRANGEMENT**

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PROJECT NAME: CARMON CREEK PROJECT			
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING			
LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2			
TAG: 0735A-08030			
SLS#: 338716	QUOTE: CGY2014-85	PO#: 4512-109-130	
DWN BY: GG	DATE: JUN 27/14	DWC # : 338716-200-Rev8	
CHK BY: ET	DATE: JUN 27/14		
APP BY: COG	DATE: JUN 27/14	PAGE: 3 OF 4	CAD: N/A REV: 8



ISOMETRIC VIEW

CONCRETE PAD BY OTHERS

CONCRETE PAD BY OTHERS

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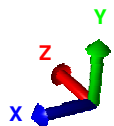
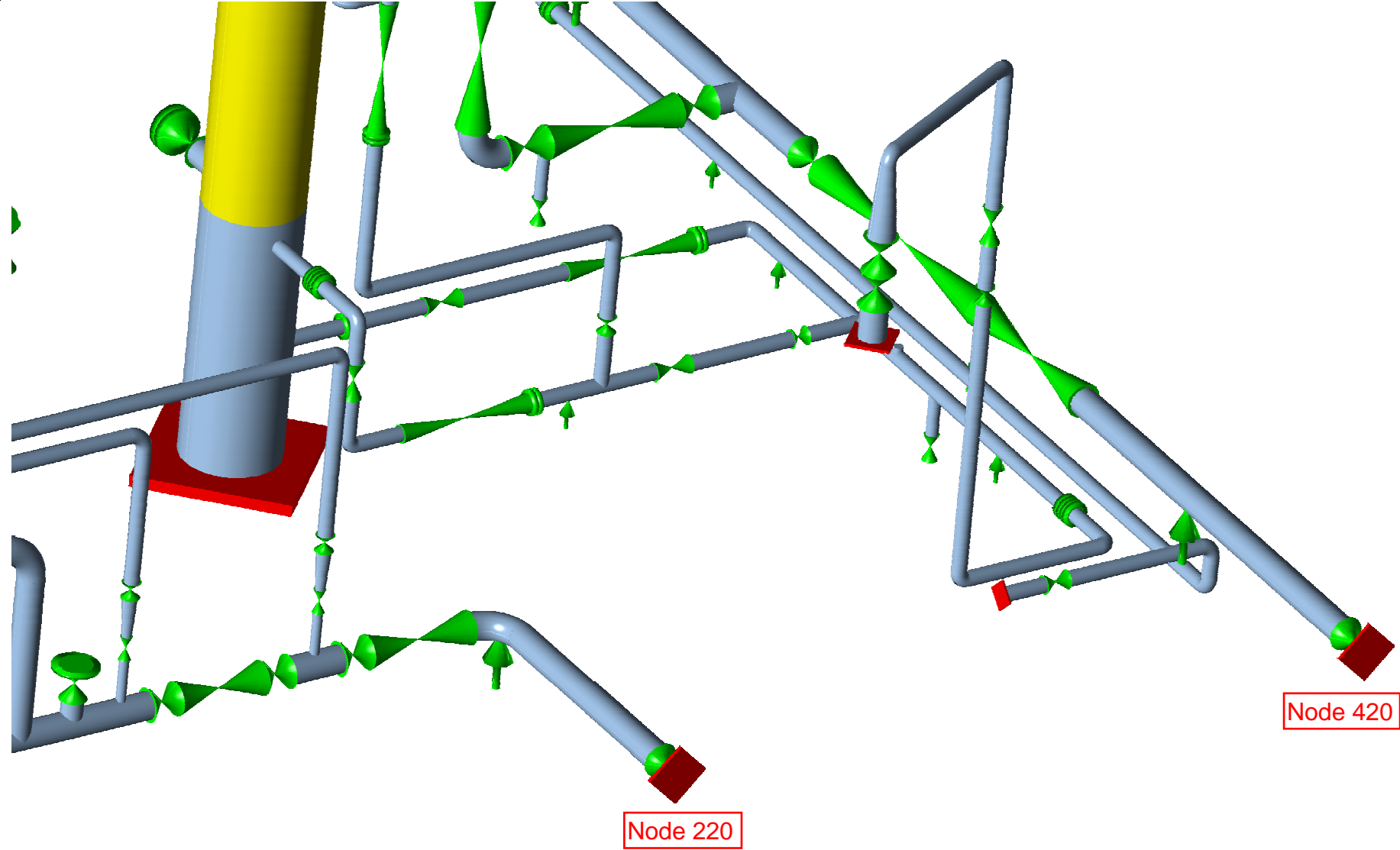


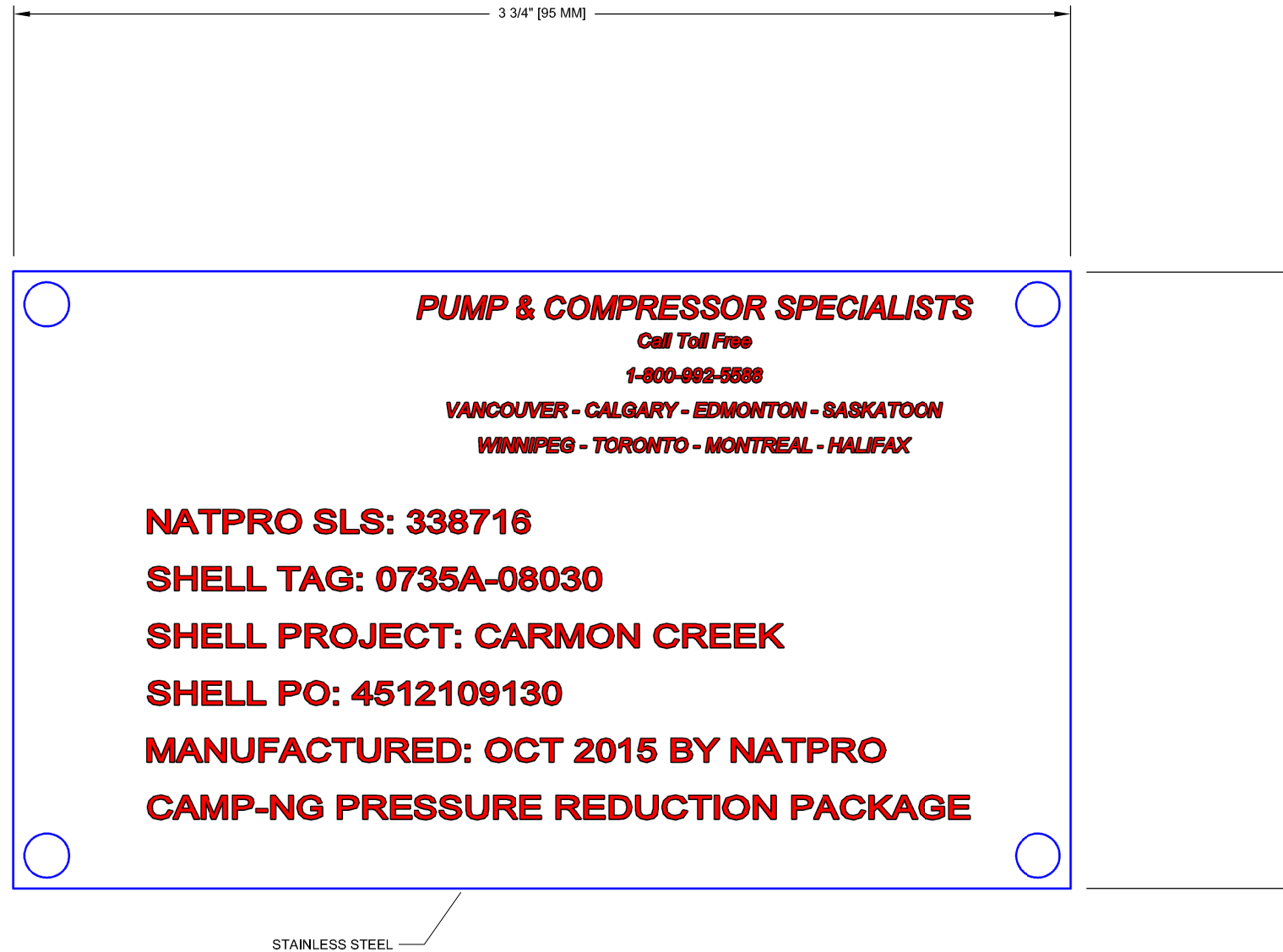
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REV	DESCRIPTION	DWN	CHK	APP	DATE

PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

**CMT NG PRESSURE REDUCTION
 SKID PACKAGE
 GENERAL ARRANGEMENT**

DWN BY: GG	DATE: JUN 27/14	DWG #:	338716-200-Rev8
CHK BY: ET	DATE: JUN 27/14		
APP BY: COG	DATE: JUN 27/14	PAGE: 4 OF 4	
		CAD: N/A	REV: 8





GENERAL NOTES


1. ALL DIMENSIONS ARE IN INCHES [mm] UNLESS NOTED OTHERWISE.
2. FABRICATION TOLERANCE +/- 1/8" [3mm] UNLESS NOTED OTHERWISE.

National Process Equipment	
PUMPS & COMPRESSORS	
<small>Vancouver - Calgary - Edmonton - Saskatoon - Winnipeg - Toronto - Montreal - Halifax</small>	
PROJECT NAME: CARMON CREEK	
CUSTOMER: SHELL CANADA	
LOCATION: CARMON CREEK, ALBERTA	
TAG: 0735A-08030	
SLS#: 338716	QUOTE: PO#: 4512109130
DWN BY: AA	DATE: DWG #: 338716-NP01
CHK BY: AA	DATE:
APP BY: AA	DATE: JUNE 01/15
PAGE: 1 OF 1	SCALE: NTS
REV: 0	

0	AS BUILT	AA	AA	AA	Sept 01 /15
REV	DESCRIPTION	DWN	CHK	APP	DATE
NAME PLATE DETAIL					

DOCUMENT FRONT SHEET

PURCHASERS NAME	National Process Equipment
PURCHASE ORDER NO	PUR630251
EXHEAT REFERENCE	041168
SDR DOCUMENT NO	041168.VESSFAB
CLIENT DOCUMENT NO	
DOCUMENT TITLE	Vessel Fabrication Drawing

Doc Num	Revision	Issue	Date	Initials	Supplier's Approval Signature	Approval By
B20	3	1	03/10/2014	RDav		17/10/2014

To be filled by the reviewer of this document prior to its return

Tick Box	Code	Status	Description
<input type="checkbox"/>	E1	Approved	Approval given, no comments, final issue.
<input type="checkbox"/>	E2	Approved to Proceed	Approval given for work to proceed with document to be submitted as Final Issue providing comments are incorporated
<input type="checkbox"/>	E3	Not Approved	Document rejected and must be re-submitted with incorporation of comments. Work may NOT proceed
<input type="checkbox"/>	E4	Information Only	No comments made or approval given, for information purposes only.
<input type="checkbox"/>	E5	As-Built	Approval given for work to proceed provided comments incorporated in As-Built revision.

PAGES (Including this one)

2

COMMENTS

Please be aware that EXHeat will not be held responsible for late approval of documents and will not be held liable for any liquidated damages as a consequence.

Late approval of documents by the client may impact on the contractual delivery date.

EXHEAT LTD

Threxton Road Industrial Estate, Watton, IP25 6NG

Tel: +44 (0)1953 886200, Fax: +44 (0) 1953 886222, Email: accounts@exheat.com, Web: www.exheat.com

DESIGN DATA

EQUIPMENT	6" 900# SHELL LINE HEATER VESSEL
DESIGN CODE / CODE STAMPING	ASME VIII DIV 1 EDITION 2013 / 'U' STAMPED
COMPANY DATA SHEET	CCK-0735-MS-2105-000-0001-000
3RD PARTY INSPECTION	ROYAL SUN ALLIANCE
NATIONAL BOARD REGISTRATION	N/A
ABSA REGISTRATION	VESSEL TO BE REGISTERED IN ALBERTA, CANADA
DESIGN PRESSURE	9930 KPa.g
DESIGN TEMPERATURE	-45°C TO 93°C
MDMT	-45°C @ 9930 KPa.g
MAWP @ DESIGN TEMPERATURE	9930 KPa.g @ 93°C
MAEWP	FV @ 93°C
HYDROTEST PRESSURE / DURATION	12909 KPa.g / 1 HOUR
JOINT EFFICIENCY	1.0
CORROSION ALLOWANCE	1.5 mm
PWHT	NONE
SPECIAL SERVICE	NONE
IMPACT TESTING	YES, FOR ALL PRESSURE CONTAINING MATERIALS EXCEPT PADS
RADIOGRAPHY	FULL
UT	ALL NOZZLE TO SHELL WELDS
MPI	ALL ATTACHMENT WELDS
FLANGE SPECIFICATION	ASME B16.5
INSULATION (BY OTHERS)	TBC
WIND LOADING	AS PER ABC 2006
SEISMIC DESIGN	AS PER ABC 2006

MATERIALS

ALL EN10204 3.1 CERTIFIED	
VESSEL SHELL	SA333-6
VESSEL HEAD	SA420 WPL6
FLANGES	SA350-LF2
NOZZLE NECKS PIPE	SA333-6
SADDLE SUPPORTS	SA516 GR 70
LIFTING LUGS	SA516 GR 70
EARTHING LUGS	SA516 GR 70
NAMEPLATE	STAINLESS STEEL
NAMEPLATE BRACKET	SA516 GR 70
BOLTS/NUTS (BY EXHEAT)	SA320 L7/SA194 GRADE 4-HDG
GASKETS (BY EXHEAT)	ST. ST. SPIRAL WOUND

WEIGHTS

WEIGHT EMPTY (NO BUNDLE)	235 KG
HEATER BUNDLE WEIGHT	98 KG
OPERATIONAL WEIGHT	355 KG
HYDROTEST WEIGHT	370 KG
CAPACITY (VOLUME)	0.03 m ³

FINISH

SURFACE PREPARATION
 LOOSE RUST/DEBRIS TO BE REMOVED AND INTERNAL AND EXTERNAL SURFACES TO BE CLEANED AND DRIED AFTER TESTING

PAINTING: BY EXHEAT

NOTES

- 1) ALL DIMENSIONS ARE IN MILLIMETRES UNO.
- 2) ALL FLANGE BOLT HOLES ARE TO STRADDLE MAIN VESSEL CENTRE LINES.
- 3) ALL NOZZLE STANDOUTS MEASURED FROM VESSEL CENTRE LINES UNO.
- 4) RFWN FLANGES TO ASME B16.5 WITH 3.2 TO 6.3 Ra um JOINT FACE FINISH.
- 5) ALL NOZZLES TO BE FITTED WITH SUITABLE BLANKS FOR PROTECTION DURING TRANSIT.
- 6) REFER TO DOCUMENT VQ0511 FOR VESSEL MECHANICAL CALCULATIONS.
- 7) REFER TO DOCUMENT VQ0512 FOR VESSEL QUALITY PLAN.
- 8) VESSEL TO ACCEPT HEATER BUNDLE OF DIA 141mm FULL LENGTH
- 9) ALL SHARP EDGES/CORNERS TO BE REMOVED (EXCEPT BOLT HOLES)

REV	DRAWN	CHECKED	APPROVED	DATE	MODIFICATIONS
0	MVD	DB	JVD	04/09/14	FIRST ISSUE
1	MVD	DB	JVD	30/09/14	REVISED AS PER CLIENT'S COMMENTS
2	MVD	DB	JVD	02/10/14	REVISED AS PER CLIENT'S COMMENTS



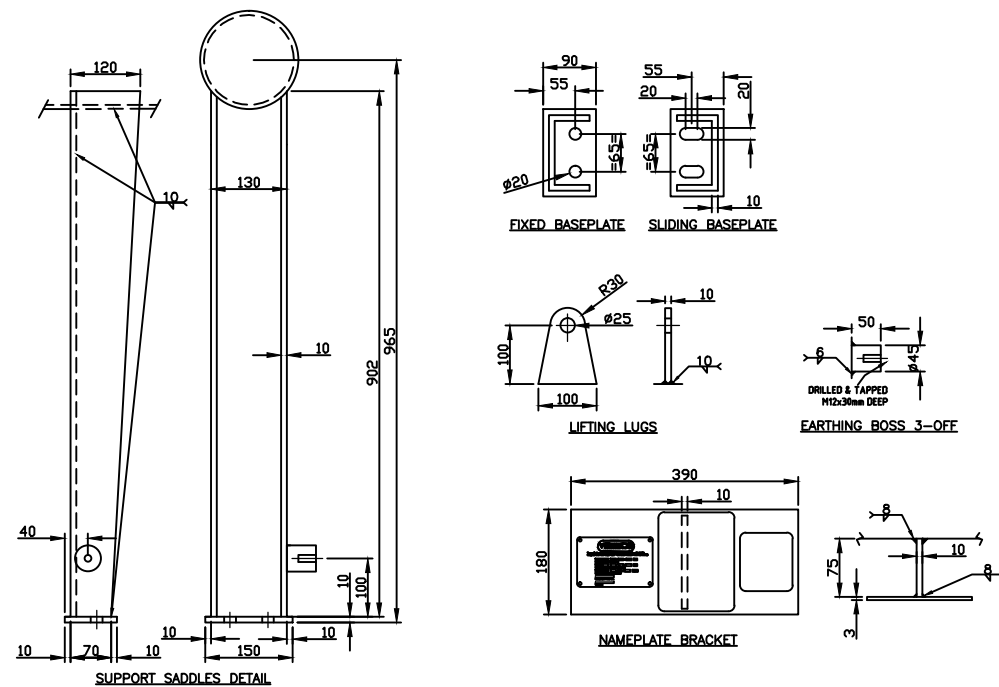
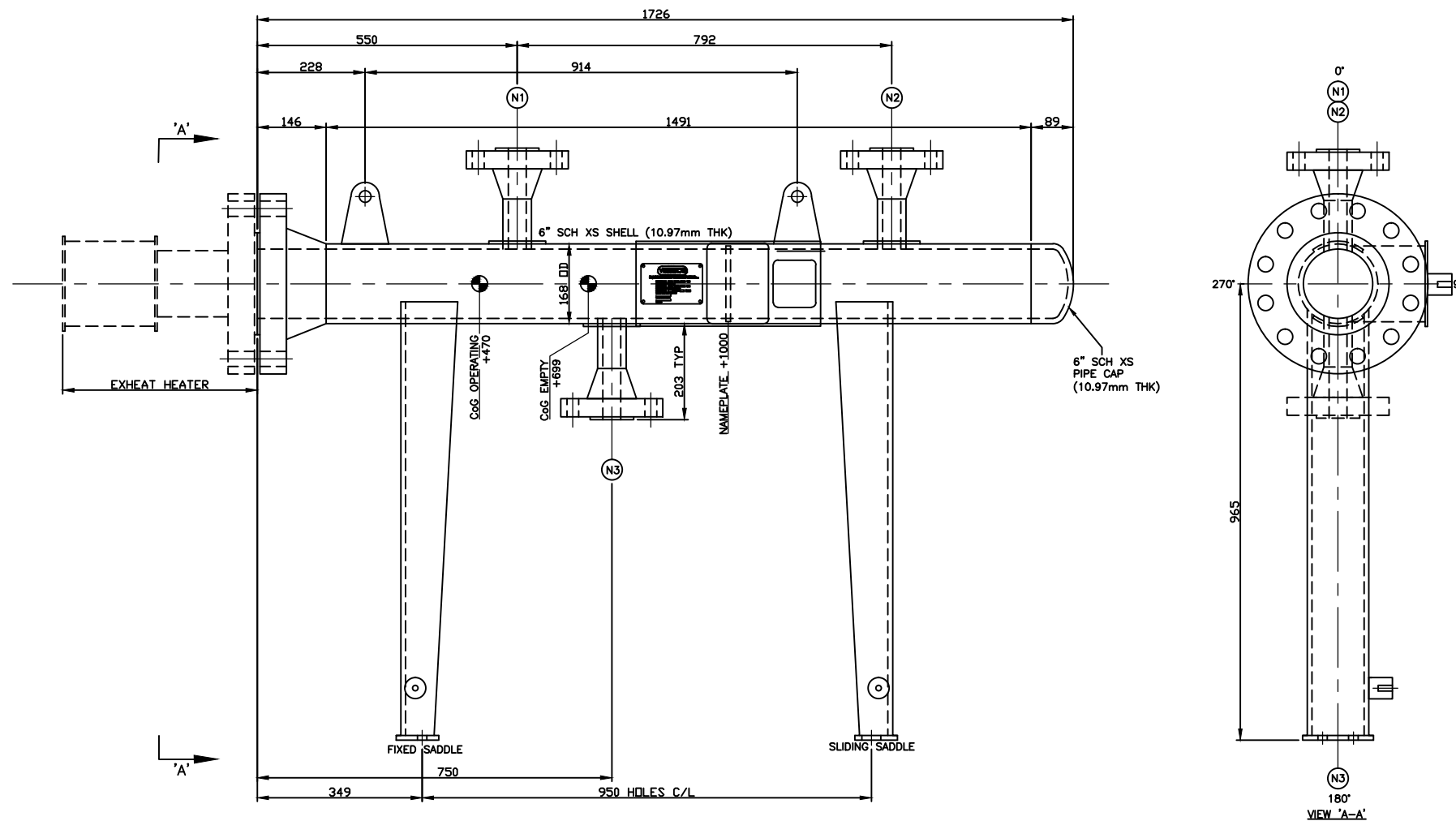
Vessco Engineering Ltd., 11 Kingsway Buildings, Bridgend Ind. Est.
 Bridgend CP31 3YH South Wales Tel: 01656 750262 www.vessco.co.uk

CLIENT **EXHEAT**

JOB No. UJ0404-1

TITLE
**GENERAL ARRANGEMENT OF
 6" 900# SHELL LINE HEATER VESSEL
 ITEM TAG No. H-08071**

SCALE DO NOT SCALE DRG. No. **VQ0510** REV. **2**



Certified by

Vessco Engineering Ltd., 11 Kingsway Buildings, Bridgend Ind. Est.
 Bridgend CP31 3YH South Wales Tel: 01656 750262 www.vessco.co.uk

U PART W

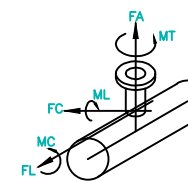
Pressure: 9930 KPa.g AT 93 °C
 Max. Allowable Working Pressure

Pressure: 103.4 KPa.g AT 93 °C
 Max. Allowable External Working Pressure

Temperature: -45 °C AT 9930 KPa.g
 Minimum Design Metal Temperature

UJ0404-1
 Manufacturers Serial No.
 2014
 Year Built

VESSCO NAMEPLATE

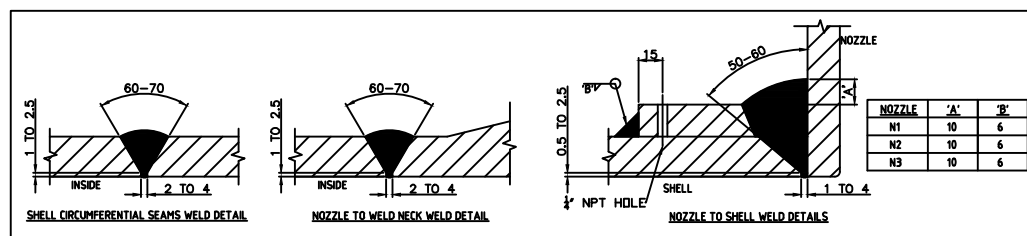


NOZZLE LOAD TABLE		FORCES (N)	MOMENTS (Nm)
N1/N2/N3		2480	480
REF	FA FC FL MT ML MC		
REF DEP	31.22.20.31-GEN ANNEX VIII		

FABRICATION TOLERANCES			
DATUM TO FLANGE	± 6.0		
VESSEL C TO FLANGE RF	± 6.0		
SADDLE CENTRES	± 3.0		
BASEPLATE TO VESSEL C	± 5		
REF DEP	31.22.20.31-GEN ANNEX VII		

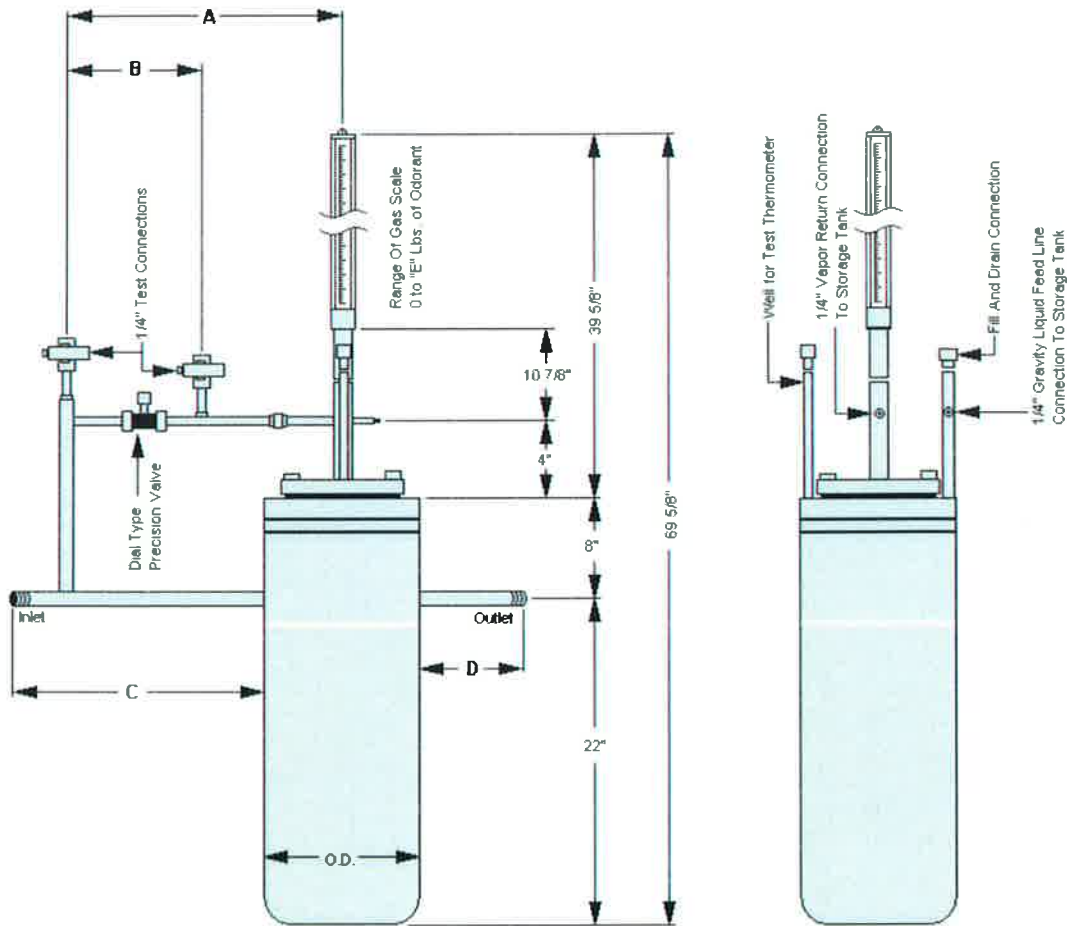
REF	NPS	FLANGE RATING / TYPE	SCHEDULE	SERVICE	OUTSTAND (SEE NOTE 3)	O/D COMPENSATION PADS	THK	REMARKS
BODY FLANGE	6"	CLASS 900 RFWN	SCH. XS	HEATER	N/A	N/A	-	
N1	2"	CLASS 900 RFWN	SCH. XXS	INLET	287	120	6	
N2	2"	CLASS 900 RFWN	SCH. XXS	OUTLET	287	120	6	
N3	2"	CLASS 900 RFWN	SCH. XXS	DRAIN	287	120	6	

NOZZLE SCHEDULE





4 Odorizer Dimensions



ODORIZER DIMENSIONS (See Diagram)	
MODEL	3-B
O.D.	16" (40.64 cm)
A	12-1/4" (31.12 cm)
B	6" (15.24 cm)
C	4-1/2" (11.43 cm)
D	3" (7.62 cm)
E	95
INLET & OUTLET SIZE	1" NPT

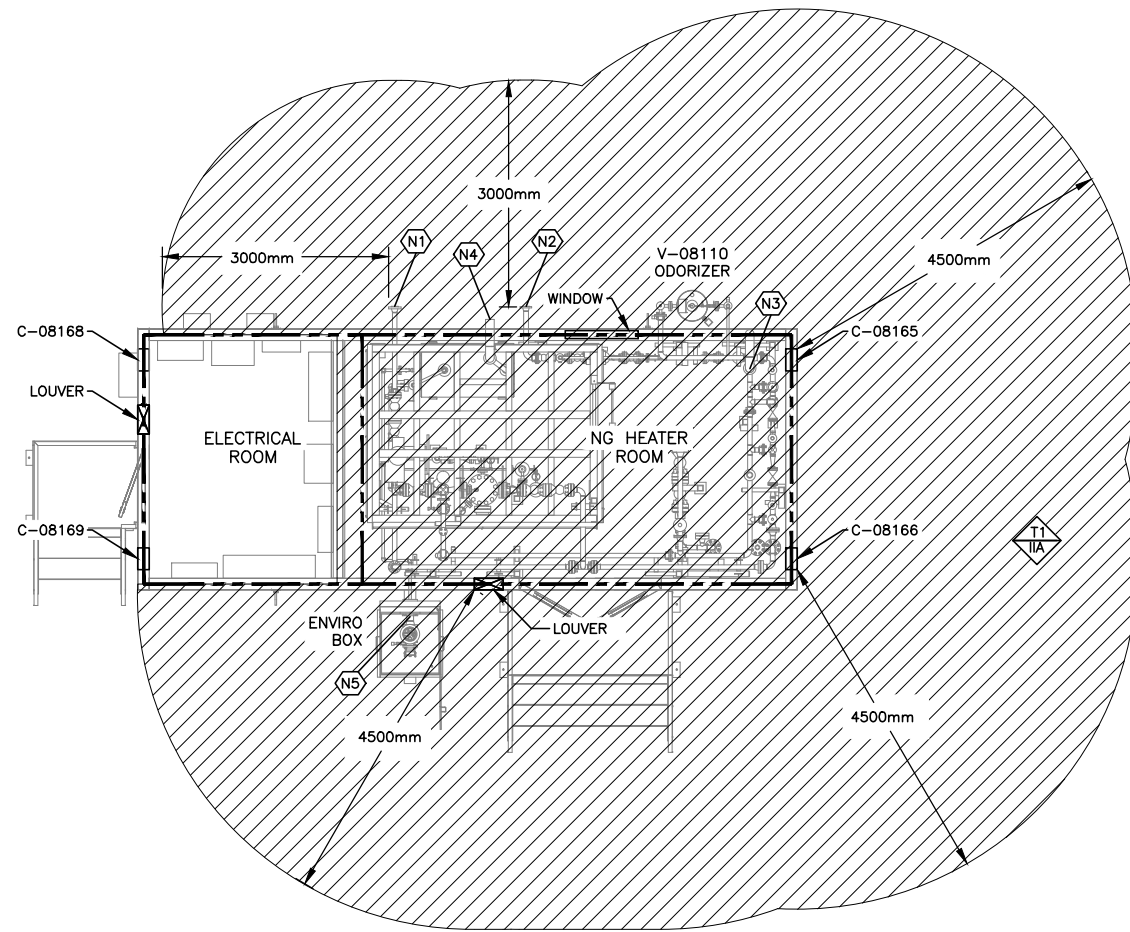
RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints

Various Load Cases

Node	Load Case	FX lb.	FY lb.	FZ lb.	MX ft.lb.	MY ft.lb.	MZ ft.lb.	DX in.	DY in.	DZ in.
220	Rigid ANC									
	1(HYD)	-10	56	-2	-48.4	-14.7	-132.7	0	0	0
	2(OPE)	6	32	-1	-29.6	-6.7	-118.9	0	0	0
	3(OPE)	-19	69	-2	-58.1	-14.7	-136.2	0	0	0
	4(SUS)	-9	55	-1	-47.1	-13	-129.5	0	0	0
	5(EXP)	15	-23	1	17.6	6.3	10.7	0	0	0
	6(EXP)	-10	14	-1	-10.9	-1.7	-6.7	0	0	0
	7(EXP)	25	-37	1	28.5	7.9	17.3	0	0	0
	MAX	25/L7	69/L3	-2/L3	-58.1/L3	-14.7/L1	-136.2/L3	0.0000/L	0.0000/L	-0.0000/L3
420	Rigid ANC									
	1(HYD)	7	84	25	-87	22.5	13.8	0	0	0
	2(OPE)	42	102	206	-102.3	101.7	19	0	0	0
	3(OPE)	-32	64	-184	-68.2	-68.9	6.1	0	0	0
	4(SUS)	7	84	24	-86	21.9	13.7	0	0	0
	5(EXP)	35	18	182	-16.3	79.8	5.3	0	0	0
	6(EXP)	-40	-20	-208	17.8	-90.8	-7.7	0	0	0
	7(EXP)	74	38	389	-34.1	170.6	12.9	0	0	0
	MAX	74/L7	102/L2	389/L7	-102.3/L3	170.6/L7	19.0/L2	0.0000/L	0.0000/L	0.0000/L7



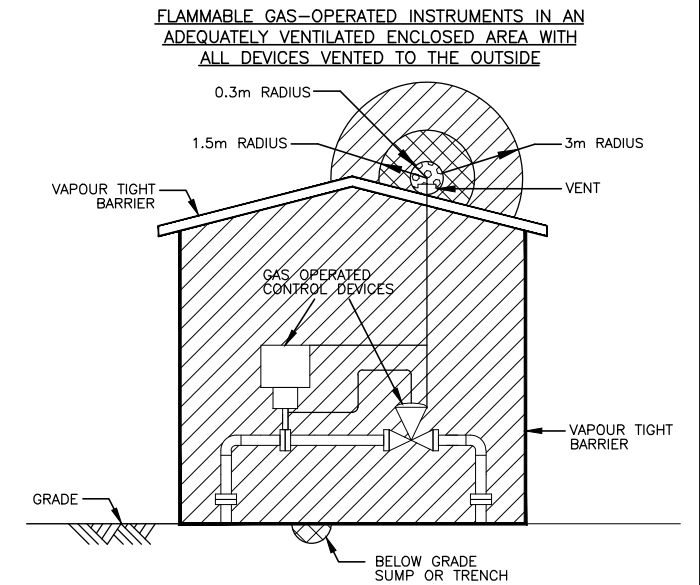
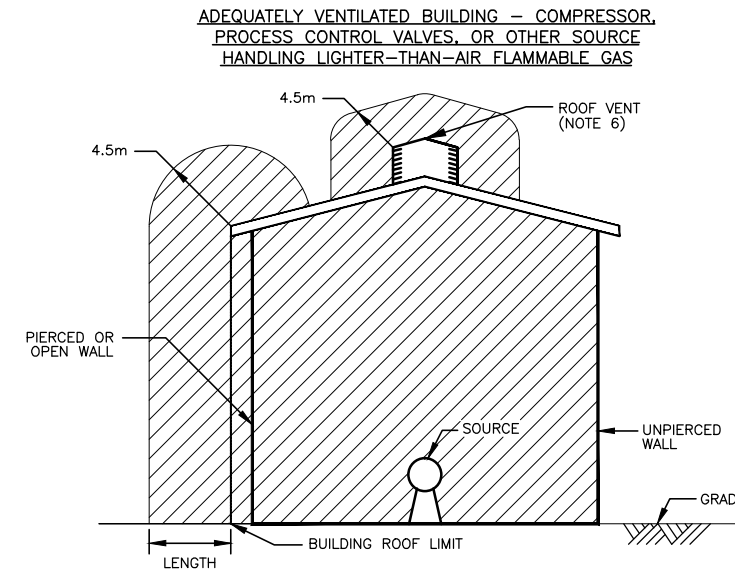
DWG NORTH



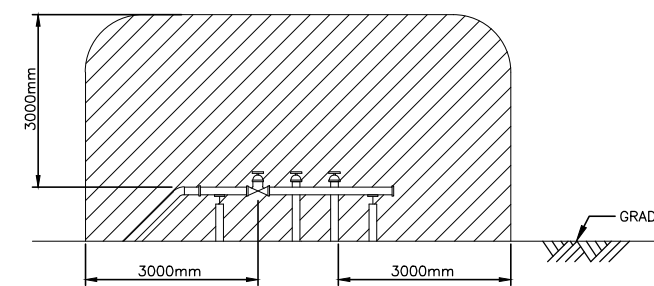
AREA CLASSIFICATION
SCALE: 1:100

SCHEDULE OF OPENINGS

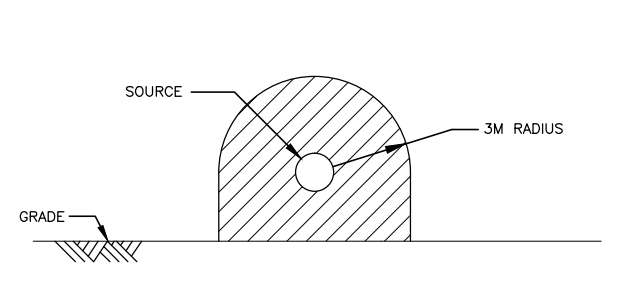
CONN	SIZE	RATING	DESCRIPTION
N1	2"	600# RF	PACKAGE INLET
N2	2"	150# RF	PACKAGE OUTLET
N3	2"	-	VENT HEADER (VENT TO ATMOSPHERE)
N4	2"	-	TANK VENT (VENT TO ATMOSPHERE)
N5	3"	CAMLOCK	TANK DRAIN



OUTDOORS - VALVES OR MANIFOLD
HANDLING LIGHTER-THAN-AIR FLAMMABLE HIGH PRESSURE GAS



OUTDOORS - PIPING WITH FLANGES
HANDLING LIGHTER-THAN-AIR FLAMMABLE HIGH PRESSURE GAS



LEGEND

- ZONE 0
- ZONE 1
- ZONE 2
- VAPOUR TIGHT BARRIER
- TEMPERATURE CLASS
- GAS GROUP

NOTES:

- AREA CLASSIFICATION DESIGN BASED ON API RP 505, CEC, AND FUGITIVE EMISSIONS REPORT.
- DUE TO THE PRESENCE OF NATURAL GAS ABOVE 1900kPA AT THE PACKAGE INLET FLANGE N1, THE EXTENT OF ZONE 2 SHALL BE 3m ON THE BASIS OF A 1m RADIUS USING AN ADJUSTMENT FACTOR OF 3.
- SECTION VIEWS ARE TYPICAL DETAILS FROM API RP 505.
- DOORS TO BE TIGHTLY SEALING UNITS, SELF CLOSING AND NORMALLY CLOSED. WINDOWS TO BE SEALED, NON OPENING.
- ALL WALL PENETRATIONS SHALL BE PROPERLY SEALED.
- THE INTERIOR OF THE VENT IS CLASSIFIED ZONE 2. CROSS HATCHING HAS BEEN OMITTED FOR DRAWING CLARITY.

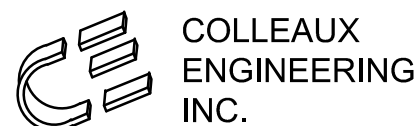
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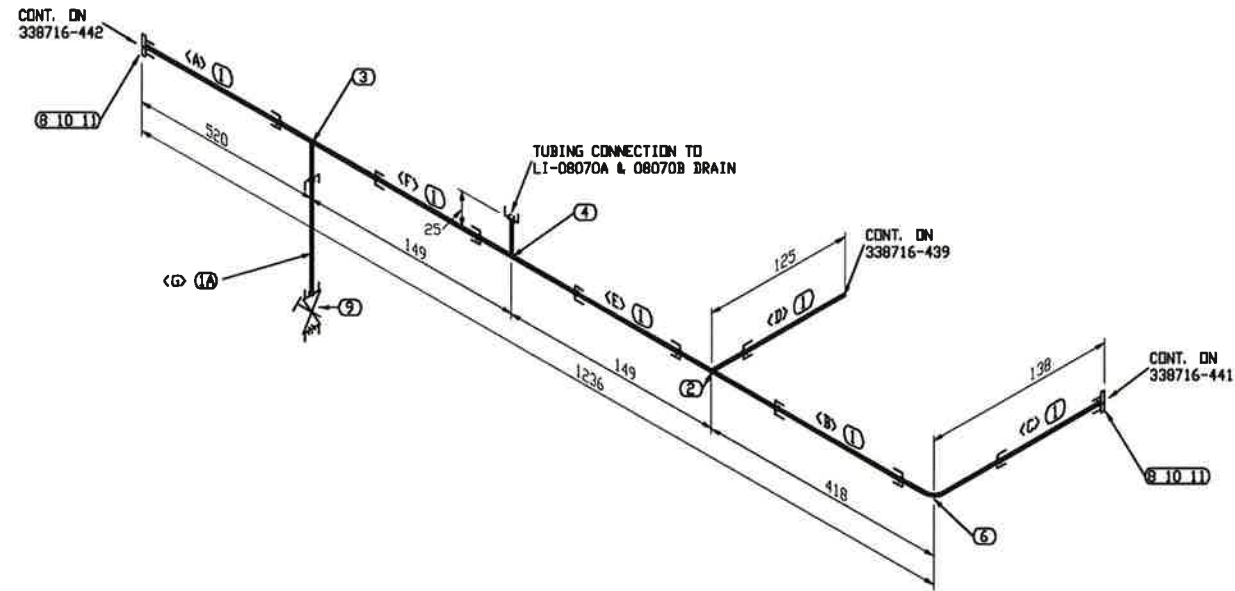


PROJECT NAME:	CARMON CREEK
CUSTOMER:	SHELL
LOCATION:	CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG:	0735A-08030
SLS#: 338716	QUOTE: CGY2014-85
PO#: 4512-109-130	
DWN BY: KS	DATE: AUG 14/14
CHK BY: JS	DATE: AUG 14/14
APP BY: -	DATE: -
DWG #:	214068-7002
PAGE: 1 OF 1	CAD: N/A
REV: 0	

REV	DESCRIPTION	DWN	CHK	APP	DATE
0	ISSUED FOR CONSTRUCTION	JB	JS	-	SEP 28/15
C	RE-ISSUED FOR APPROVAL	JP	JS	-	MAR 26/15
B	ISSUED FOR APPROVAL	RS	JS	-	JAN 30/15
A	ISSUED FOR INFORMATION	RS	JS	-	AUG 28/14

CMT NG PRESSURE REDUCTION SKID PACKAGE
AREA CLASSIFICATION





GENERAL NOTES

1. ALL DIMENSIONS ARE IN mm U.N.O.
2. FABRICATION TOLERANCE +/- 3mm U.N.O.
3. CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
4. ROOT GAP TO BE 1.6mm MAX.
5. NO FCAW ALLOWED BY SHELL.

⚠ 5. NO FCAW ALLOWED BY SHELL.

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
△ 1	1	PIPE, SMLS, SCH XS, ASTM A333-6	1243 MM	
△ 1A	3/4	PIPE, SMLS, SCH XS, ASTM A333-6	76 MM	
FITTINGS				
2	1X1	TEE, SW, 3000LB, ASTM A350-LF2-CL.1	1	
3	1X3/4	TEE RED, SW X SW X SW, 3000LB, ASTM A350-LF2-CL.1	1	
4	1X1/2	TEE RED, SW X SW X THRD, 3000LB, ASTM A350-LF2-CL.1	1	
△ 5	-	REMOVED	-	
6	1	90 ELL, SW, 3000LB, ASTM A350-LF2-CL.1	1	
△ 7	-	REMOVED	-	
FLANGES				
8	1	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL.1	2	
VALVES / IN-LINE ITEMS				
9	3/4	GATE VALVE, SW/NPT, REF. 338716-100 ITEM #27	1	

ERECTION MATERIALS

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
10	1	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	2	
BOLTS				
11	1X3 3/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	475	1
	370	1
<C>	92	1
<D>	102	1
<E>	102	1
<F>	102	1
<G>	76	3/4

ISSUED FOR CONSTRUCTION

15/04/15
DATE: YYY/M/DD
SIGNATURE
natpro

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PROJECT NAME: CARMON CREEK PROJECT

CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING

LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

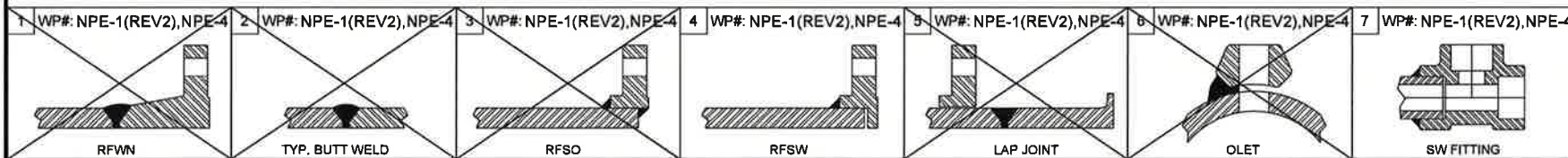
TAG: 0735A-08030

SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

OWN BY: GG DATE: JUL 04/14 DWG #: 338716-440-Rev1

CHK BY: ET DATE: JUL 04/14

APP BY: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A

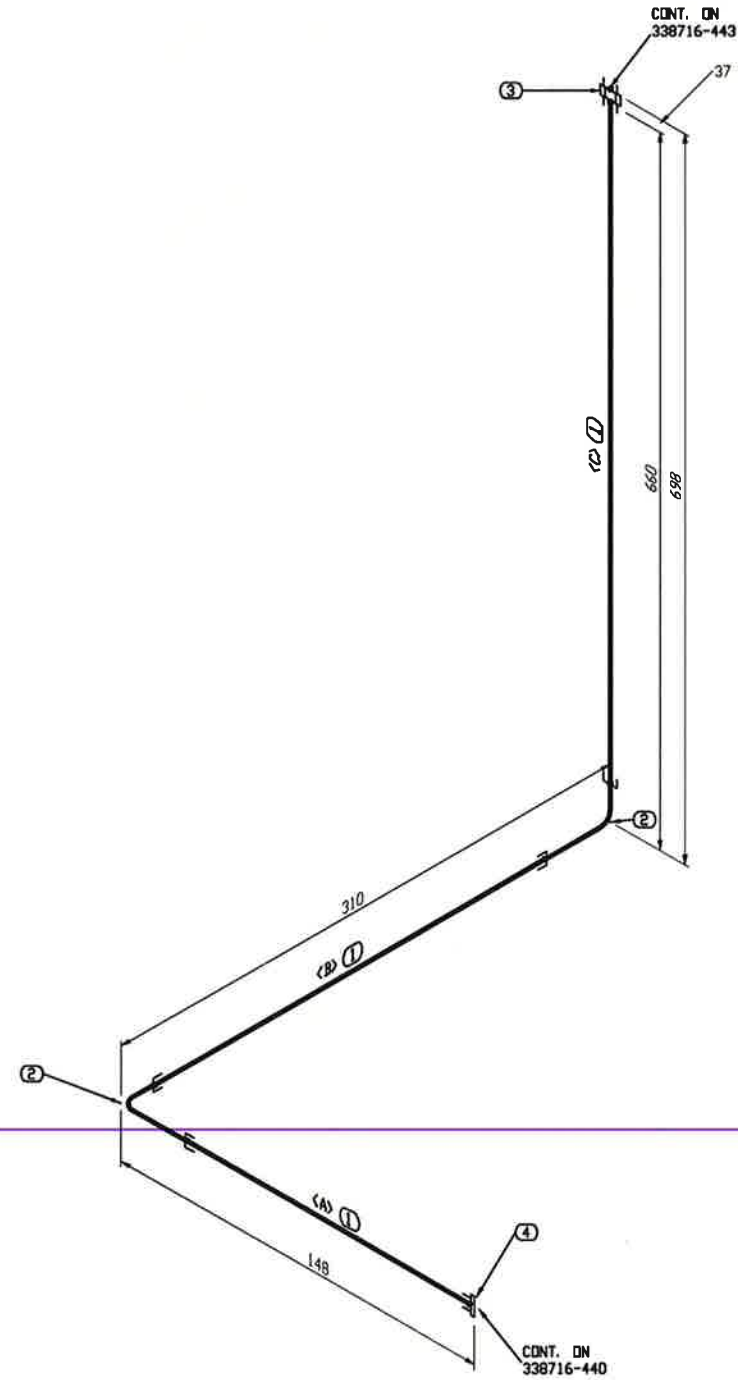


PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	ADDED 1<D>, <E>, <F> & 1A<G>, REMOVED #5&7; CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 28/15

DRAIN OUTLET SPOOL DETAIL



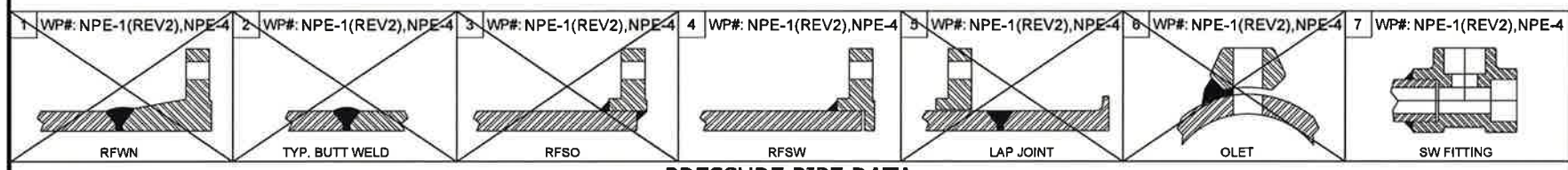
BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	1	PIPE, SMLS, SCH XS, ASTM A333-6	1000 MM	
FITTINGS				
2	1	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	2	
3	1	UNION, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
FLANGES				
4	1	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	1	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	102	1
	262	1
<C>	636	1

ISSUED FOR CONSTRUCTION
 15/04/15
 DAYEYYMM/DD
 natpro
 SIGNATURE



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI-RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

GENERAL NOTES

1. ALL DIMENSIONS ARE IN mm U.N.O.
2. FABRICATION TOLERANCE +/- 3mm U.N.O.
3. CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
4. ROOT GAP TO BE 1.6mm MAX.
5. NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT

CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING

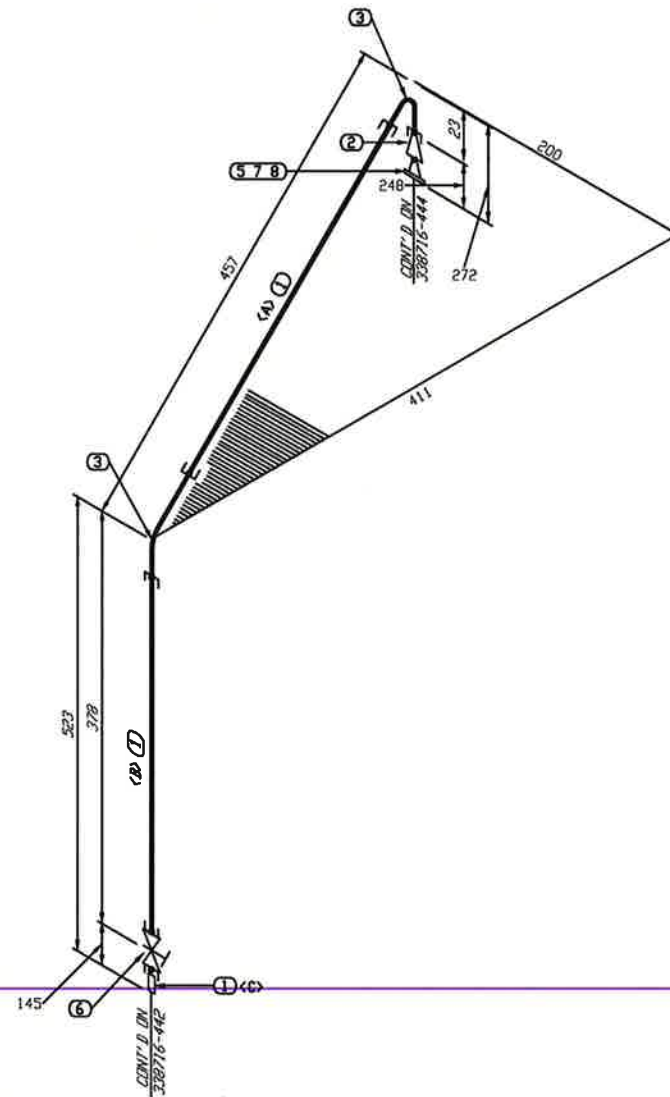
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

TAG: 0735A-08030

SL# 338716 QUOTE CGY2014-85 PO# 4512-109-130

DWG BY: LK	DATE: APR 06/15	DWG #: 338716-442-Rev0
CHK BY: AA	DATE: APR 09/15	
APP BY: AA	DATE: APR 09/15	PAGE: 1 OF 1 CAD: N/A

DESCRIPTION	DWN	CHK	APP	DATE
ISSUED FOR CONSTRUCTION				APR 09/15
DRAIN OUTLET TO V-08069 SPOOL DETAIL				



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
△ 1	1	PIPE, SMLS, SCH XS, ASTM A333-6	821 MM	
FITTINGS				
2	2X1	SWAGE CONC, SCH XS, ASTM A420-WPL-6 BLE	1	
3	1	PSE 90 ELL, SW, 3000LB, ASTM A350-LF2-CL.1	2	
△ 4	-	REMOVED	-	
FLANGES				
5	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL.1	1	
VALVES / IN-LINE ITEMS				
6	1	GATE VALVE, SW, REF. 338716-100 ITEM #23	1	

ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
7	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
8	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

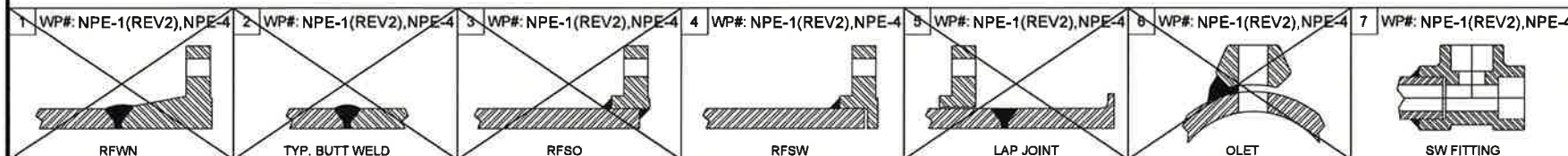
CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	409	1
	310	1
△ <C>	102	1

GENERAL NOTES

- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCAW ALLOWED BY SHELL.

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE:YY/MM/DD
 natpro



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CJ M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

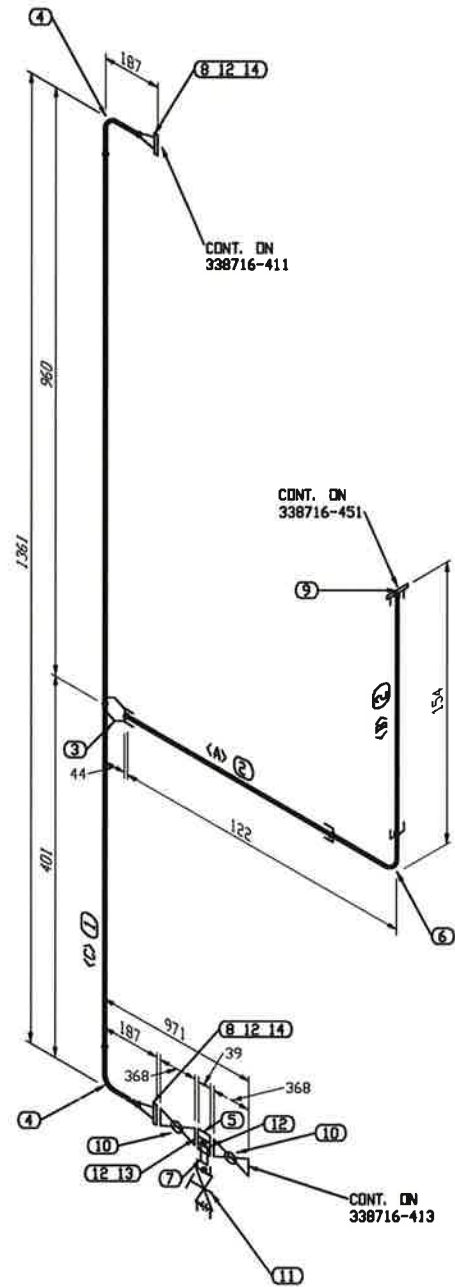
REV	DESCRIPTION	DWN	CHK	APP	DATE
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0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 28/15

**DRAIN OUTLET TO V-08069
SPOOL DETAIL**

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
 DWN: GG DATE: JUL 04/14 DWO#: 338716-443-Rev1
 CHK: ET DATE: JUL 04/14
 APP: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A



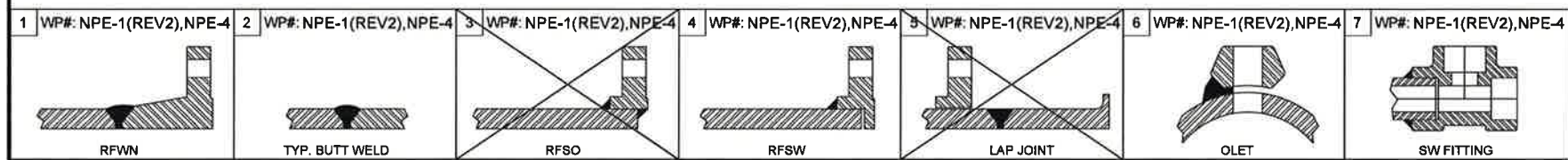
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1202 MM	
2	3/4	PIPE, SMLS, SCH XS, ASTM A333-6	203 MM	
FITTINGS				
3	2X3/4	OLET, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
4	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	2	
5	2	BLEED RING, REF. 338716-100 ITEM #35	1	
6	3/4	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
7	3/4	NIPPLE, SCH 160, ASTM A333-6 PBE (6' LG)	1	
FLANGES				
8	2	FLG RFWN, 1500LB, SCH XS, ASTM A350-LF2-CL. 1	2	
9	3/4	FLG RFSW, 1500LB, SCH XS, ASTM A350-LF2-CL. 1	1	
VALVES / IN-LINE ITEMS				
10	2	BALL VALVE, FLG, REF. 338716-100 ITEM #22	2	
11	3/4	GATE VALVE, SW/NPT, REF. 338716-100 ITEM #27A	1	

ERECTOR MATERIALS				
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
12	2	GASKET, 1500LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	4	
BOLTS				
13	2X7 1/2	7/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
14	2X5 3/4	7/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	16	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	101	3/4
	102	3/4
<C>	1202	2

NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

ISSUED FOR CONSTRUCTION
15/04/15
DATE:YY/MM/DD
SIGNATURE
natpro



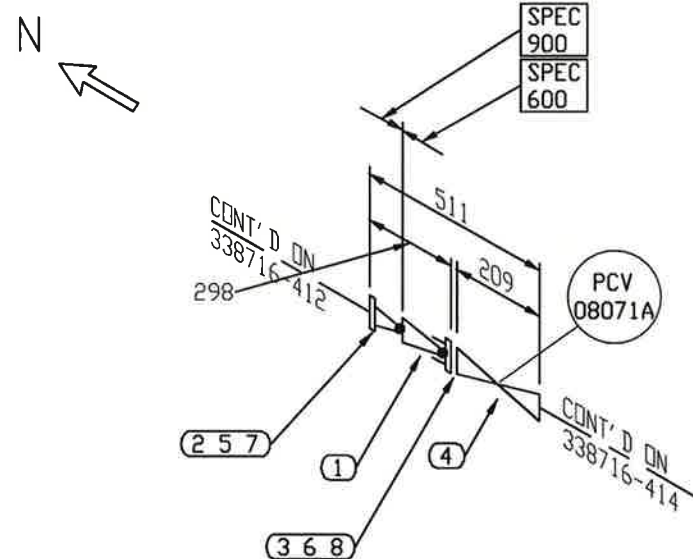
PRESSURE PIPE DATA		
SPECIFICATION: SHELL C20W CLASS 900	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 3330 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 2035 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
DATE: APR 06/15
DATE: APR 09/15
DATE: APR 09/15
PAGE: 1 OF 1
CAD: N/A

GAS OUTLET SPOOL DETAIL



BILL OF MATERIAL

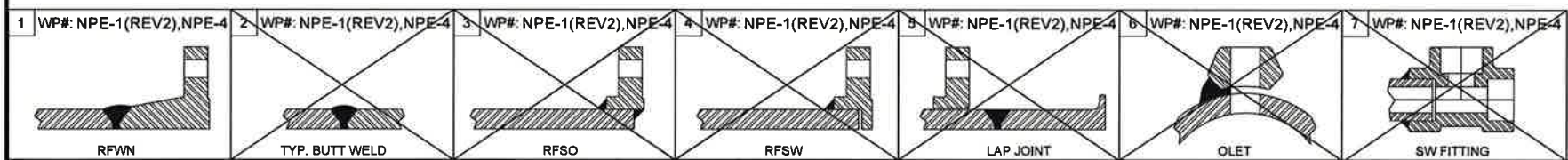
MARK	SIZE	DESCRIPTION	QTY	HT#
FITTINGS				
1	2X1	SWAGE CONC, SCH XS, ASTM A420-WPL-6 BLE PSE	1	
FLANGES				
2	2	FLG RFWN, 1500LB, SCH XS, ASTM A350-LF2-CL. 1	1	
3	1	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	1	
INSTRUMENTS				
4	1	CONTROL VALVE, FLG, REF. 338716-100 ITEM #9	1	

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
ERECTION MATERIALS				
GASKETS				
5	2	GASKET, 1500LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
6	1	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
7	2X5 3/4	7/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
8	1X3 3/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE:YY/MM/DD
 natpro
 SIGNATURE



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

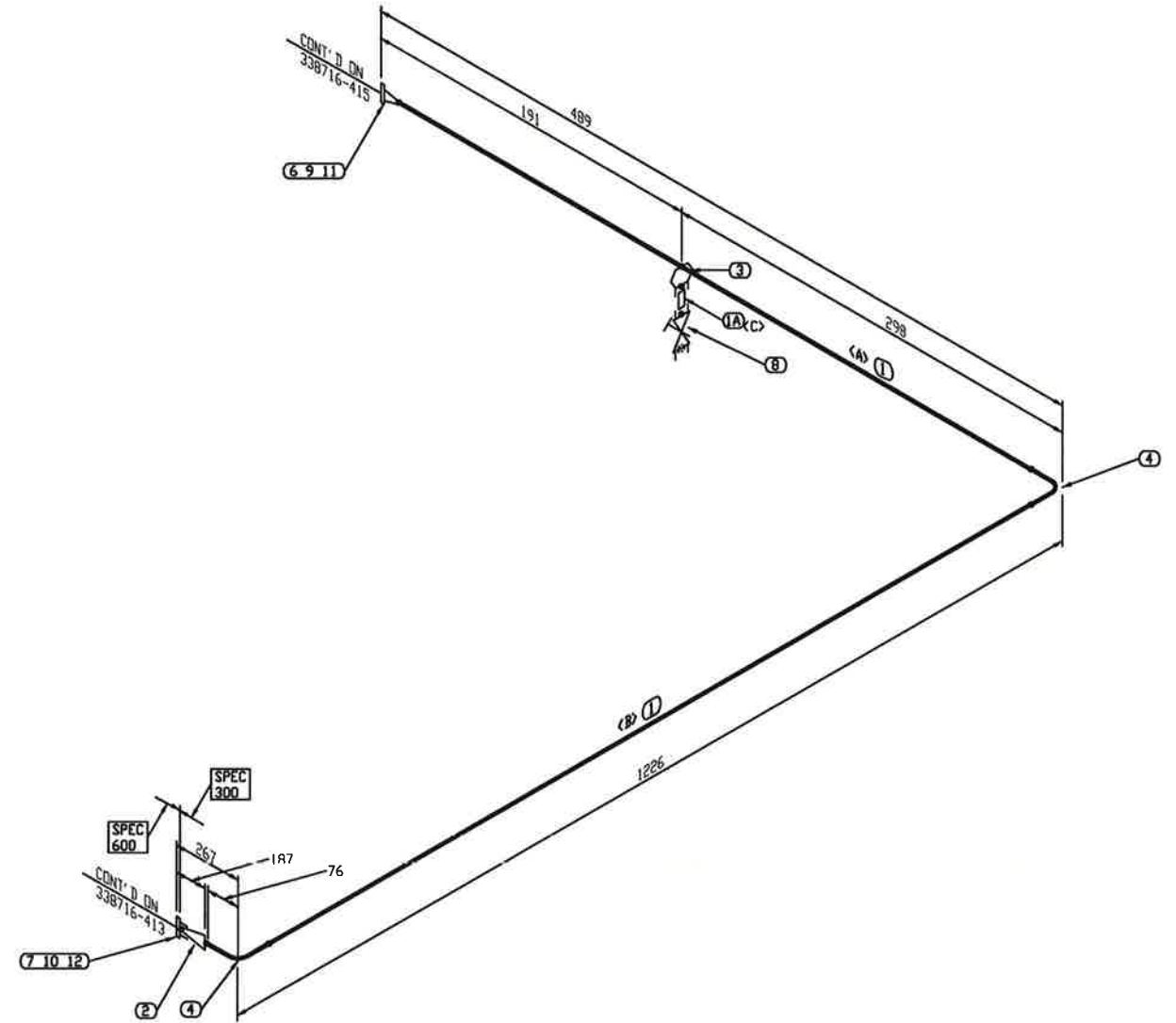
REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

GAS OUTLET SPOOL DETAIL

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
 DWN BY: GG DATE: JUL 04/14 DWO #: 338716-413-Rev1
 CHR BY: ET DATE: JUL 04/14
 APP BY: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1404 MM	
1A	3/4	PIPE, SMLS, SCH XS, ASTM A333-6	102 MM	
FITTINGS				
2	2X1	SWAGE CONC, SCH XS, ASTM A420-WPL-6 BLE PSE	1	
3	2X3/4	OLET, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
4	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	2	
5	-	REMOVED	-	
FLANGES				
6	2	FLG RFWN, 300LB, SCH XS, ASTM A350-LF2-CL. 1	1	
7	1	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	1	
VALVES / IN-LINE ITEMS				
8	3/4	GATE VALVE, SW/NPT, REF. 338716-100 ITEM #27	1	

ERECTION MATERIALS

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
9	2	GASKET, 300LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS DR SS OUTER RING	1	
10	1	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS DR SS OUTER RING	1	
BOLTS				
11	2X3 1/2	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
12	1X3 3/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	337	2
	1067	2
<C>	102	3/4

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCW ALLOWED BY SHELL.

ISSUED FOR CONSTRUCTION

15/04/15

180

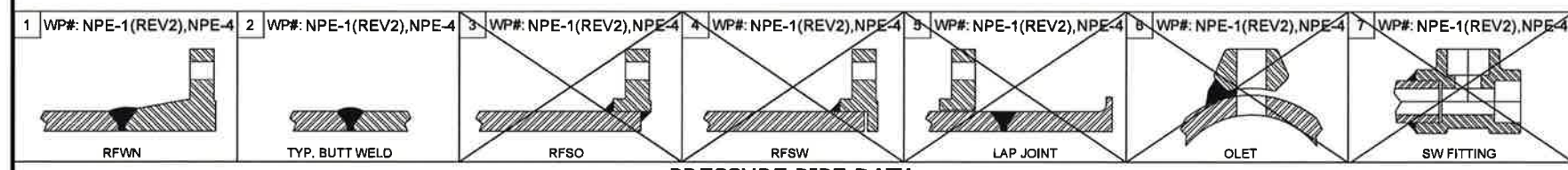
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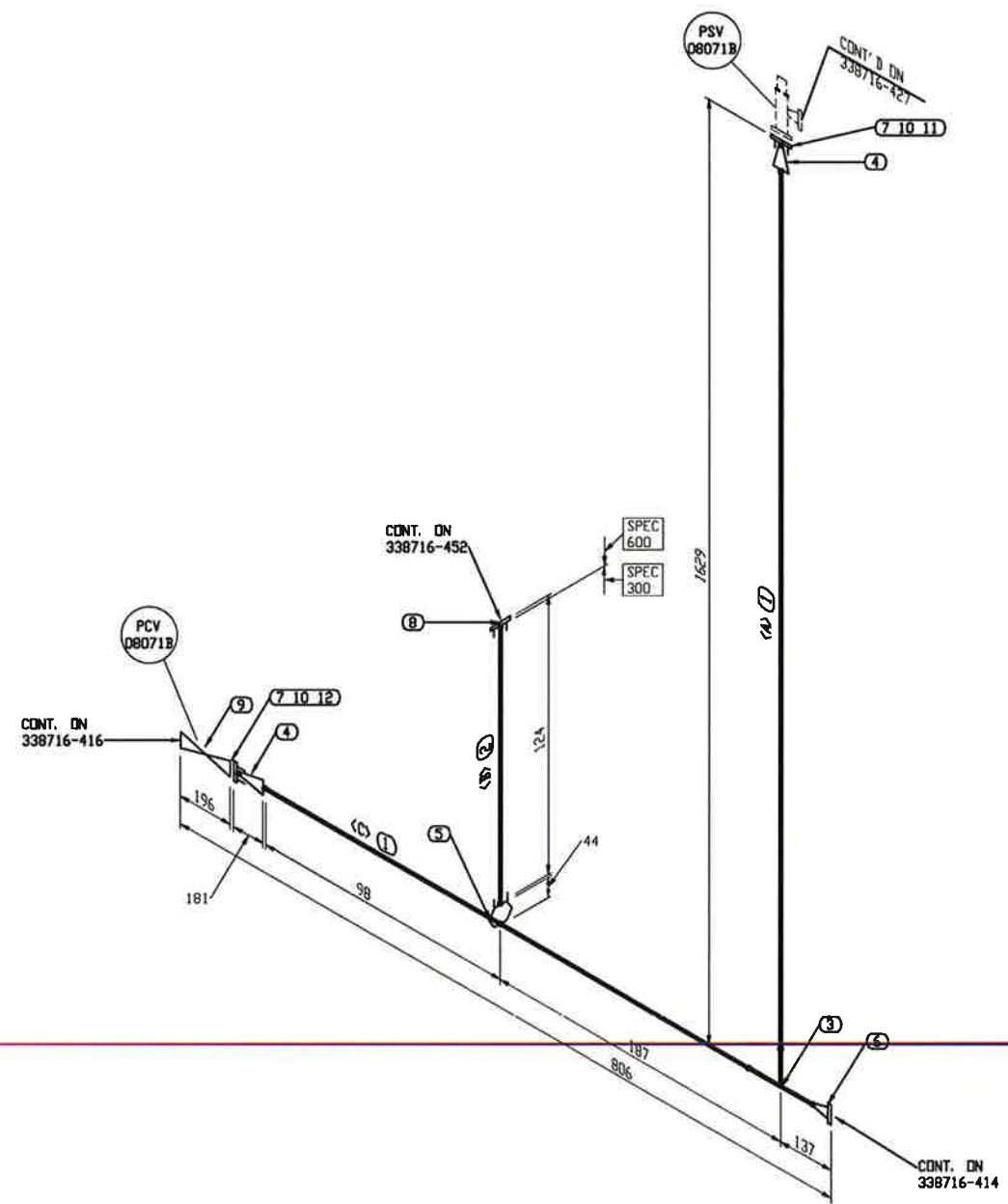


PROJECT NAME: CARMON CREEK PROJECT			
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING			
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2			
TAG: 0735A-08030			
SLS#: 338716	QUOTE: CGY2014-85	PO#: 4512-109-130	
OWN: GG	DATE: JUL 04/14	DWG #: 338716-414-Rev1	
CHK: ET	DATE: JUL 04/14		
APP: COG	DATE: JUL 04/14	PAGE: 1 OF 1	CAD: N/A



SPECIFICATION: SHELL E20W CLASS 300	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 1110 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 680 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

GAS OULET SPOOL DETAIL																								
<table border="1" style="width: 100%; text-align: center;"> <tr> <th>REV</th> <th>DESCRIPTION</th> <th>DWN</th> <th>CHK</th> <th>APP</th> <th>DATE</th> </tr> <tr> <td>1</td> <td>ADDED 1A, REMOVED #5, CHANGED NOTES</td> <td>LK</td> <td>AA</td> <td>AA</td> <td>APR 13/15</td> </tr> <tr> <td>0</td> <td>ISSUED FOR CONSTRUCTION</td> <td>GW</td> <td>ET</td> <td>PM</td> <td>MAR 05/15</td> </tr> <tr> <td>A</td> <td>ISSUED FOR APPROVAL</td> <td>GW</td> <td>ET</td> <td>PM</td> <td>JAN 26/15</td> </tr> </table>	REV	DESCRIPTION	DWN	CHK	APP	DATE	1	ADDED 1A, REMOVED #5, CHANGED NOTES	LK	AA	AA	APR 13/15	0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15	A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15
REV	DESCRIPTION	DWN	CHK	APP	DATE																			
1	ADDED 1A, REMOVED #5, CHANGED NOTES	LK	AA	AA	APR 13/15																			
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15																			
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15																			



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1597 MM	
2	3/4	PIPE, SMLS, SCH XS, ASTM A333-6	102 MM	
FITTINGS				
3	2X2	TEE, SCH XS, ASTM A420-WPL-6	1	
4	2X1	SWAGE CONC, SCH XS, ASTM A420-WPL-6 BLE PSE	2	
5	2X3/4	OLET, SW, 300LB, ASTM A350-LF2-CL. 1	1	
FLANGES				
6	2	FLG RFWN, 300LB, SCH XS, ASTM A350-LF2-CL. 1	1	
7	1	FLG RFSW, 300LB, SCH XS, ASTM A350-LF2-CL. 1	2	
8	3/4	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	1	
INSTRUMENTS				
9	1	CONTROL VALVE, FLG, REF. 338716-100 ITEM #10	1	

ERECTION MATERIALS

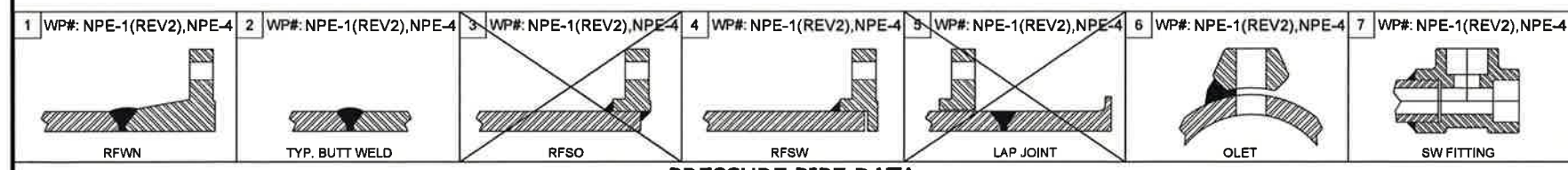
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
10	1	GASKET, 300LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	2	
BOLTS				
11	1X3 3/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	
12	1X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	1378	2
	102	3/4
<C>	219	2

ISSUED FOR CONSTRUCTION

15/04/15
DATE: YY/MM/DD
[Signature]
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PRESSURE PIPE DATA

SPECIFICATION: SHELL E20W CLASS 300	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 1110 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 680 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

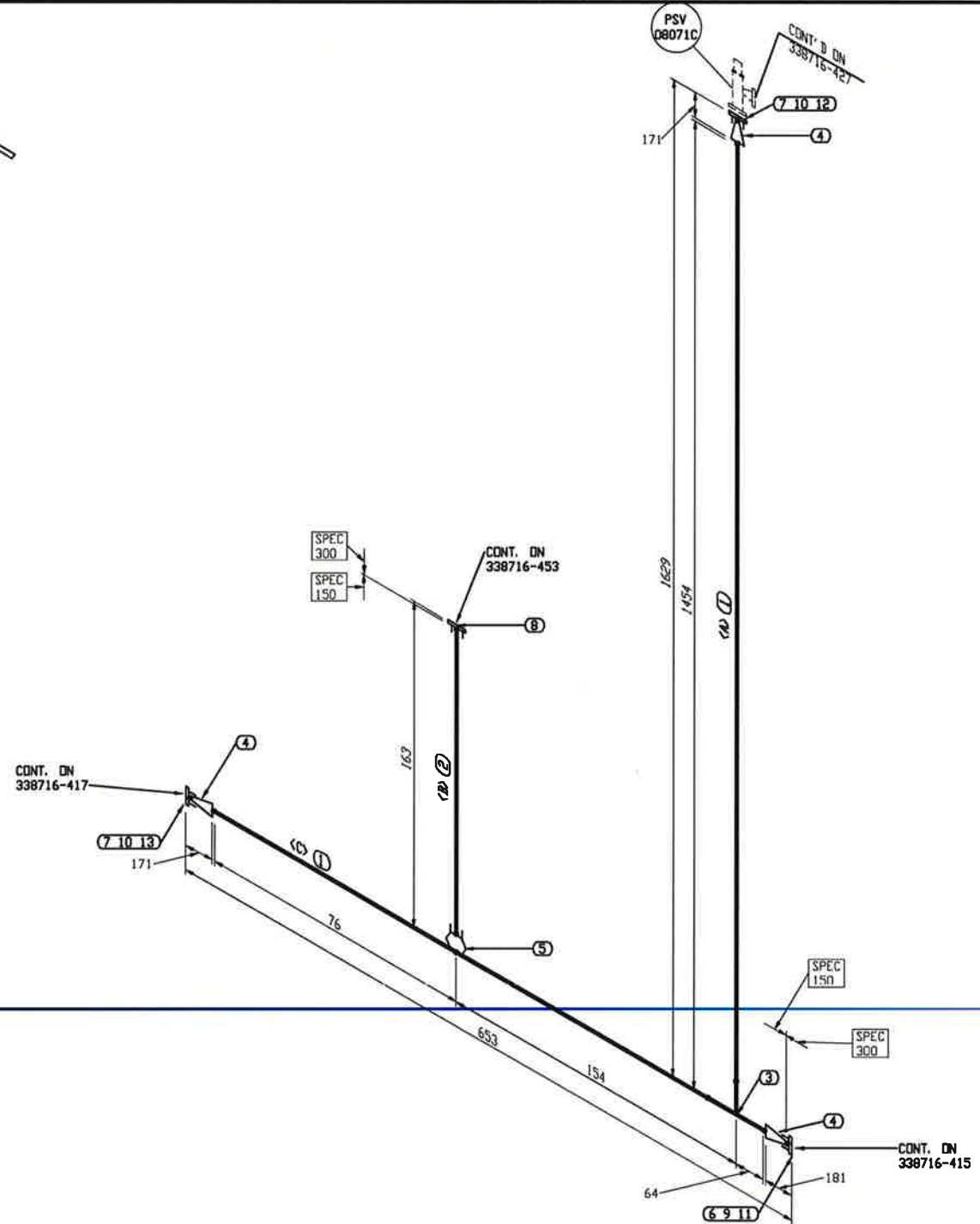
- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.



PROJECT NAME: CARMON CREEK PROJECT	CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2	TAG: 0735A-08030
SLS#: 338716	QUOTE: CGY2014-85
PO#: 4512-109-130	DWG #: 338716-415-Rev0
DWN: LK	DATE: APR 06/15
CHK: AA	DATE: APR 09/15
APP: AA	DATE: APR 09/15
PAGE: 1 OF 1	CAD: N/A

GAS OUTLET SPOOL DETAIL



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1550 MM	
2	3/4	PIPE, SMLS, SCH XS, ASTM A333-6	102 MM	
FITTINGS				
3	2X2	TEE, SCH XS, ASTM A420-WPL-6	1	
4	2X1	SWAGE CONDC, SCH XS, ASTM A420-WPL-6 BLE PSE	3	
5	2X3/4	OLET, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
FLANGES				
6	1	FLG RFSW, 300LB, SCH XS, ASTM A350-LF2-CL. 1	1	
7	1	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL. 1	2	
8	3/4	FLG RFSW, 300LB, SCH XS, ASTM A350-LF2-CL. 1	1	

ERECTION MATERIALS

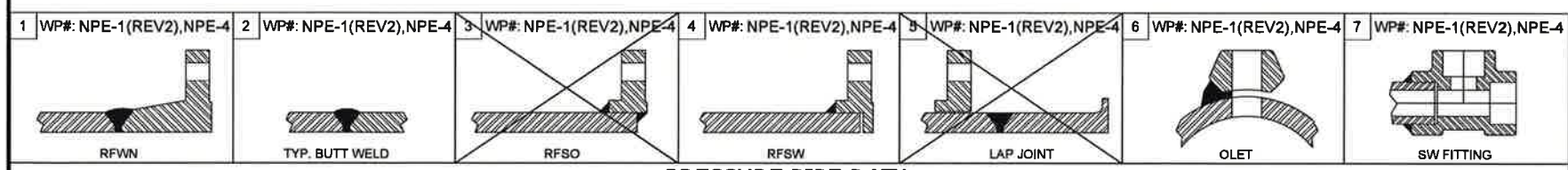
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
9	1	GASKET, 300LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
10	1	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	2	
BOLTS				
11	1X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	
12	1X3 1/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	
13	1X2 3/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	1387	2
	102	3/4
<C>	163	2

ISSUED FOR CONSTRUCTION

15/09/15
DATE:YY/MM/DD
SIGNATURE



PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

GENERAL NOTES

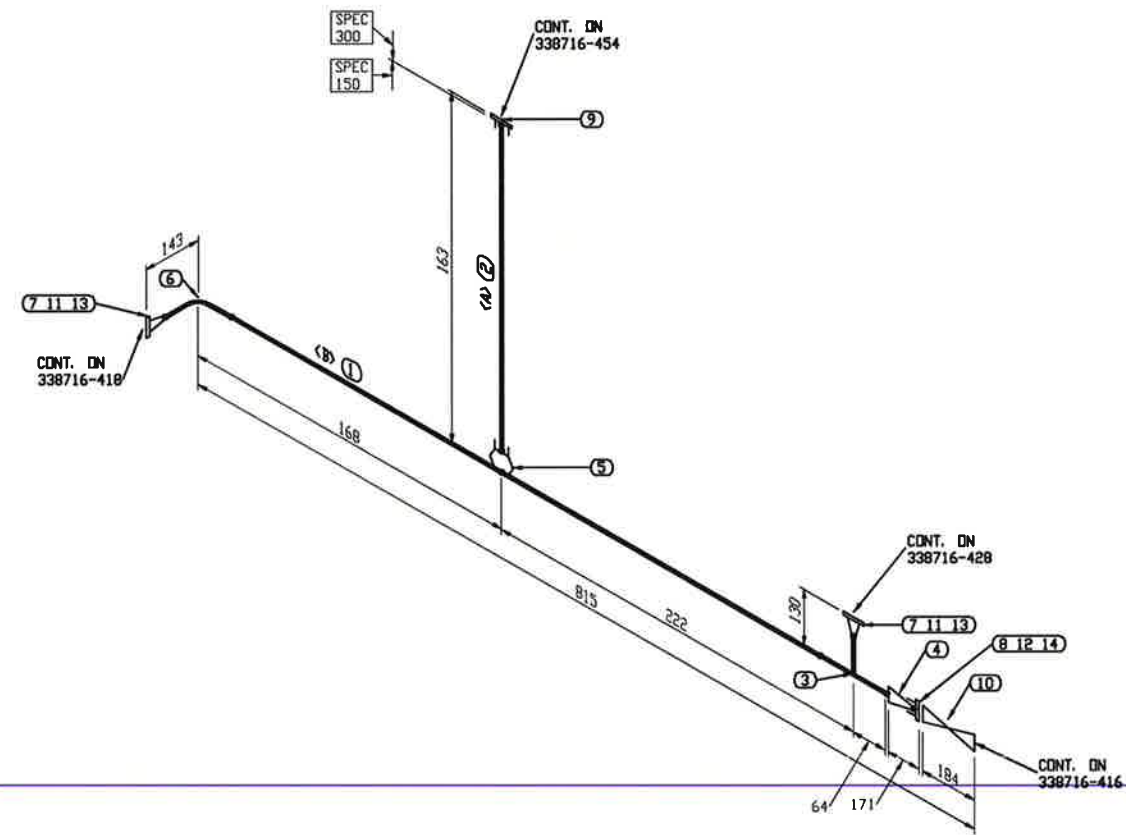
- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT	CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2	TAG: 0735A-08030
SLS#: 338716	QUOTE: CGY2014-85
PO#: 4512-109-130	
DWG#: 338716-416 -Rev0	
DATE: APR 06/15	
DATE: APR 09/15	
DATE: APR 09/15	
PAGE: 1 OF 1	CAD: N/A

GAS OUTLET SPOOL DETAIL



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	243 MM	
2	3/4	PIPE, SMLS, SCH XS, ASTM A333-6	102 MM	
FITTINGS				
3	2X2	TEE, SCH XS, ASTM A420-WPL-6	1	
4	2X1	SWAGE CONC, SCH XS, ASTM A420-WPL-6 BLE PSE	1	
5	2X3/4	OLET, SW, 300LB, ASTM A350-LF2-CL. 1	1	
6	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	1	
FLANGES				
7	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL. 1	2	
8	1	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL. 1	1	
9	3/4	FLG RFSW, 300LB, SCH XS, ASTM A350-LF2-CL. 1	1	
INSTRUMENTS				
10	1	CONTROL VALVE, FLG, REF. 338716-100 ITEM #11	1	

ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
11	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	2	
12	1	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
BOLTS				
13	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
14	1X2 3/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	102	3/4
	243	2

ISSUED FOR CONSTRUCTION

15/04/15
DATE:YY/MM/DD
AA
SIGNATURE



1	WP#: NPE-1(REV2),NPE-4	2	WP#: NPE-1(REV2),NPE-4	3	WP#: NPE-1(REV2),NPE-4	4	WP#: NPE-1(REV2),NPE-4	5	WP#: NPE-1(REV2),NPE-4	6	WP#: NPE-1(REV2),NPE-4	7	WP#: NPE-1(REV2),NPE-4
RFWN		TYP. BUTT WELD		RFSO		RFSW		LAP JOINT		OLET		SW FITTING	

PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

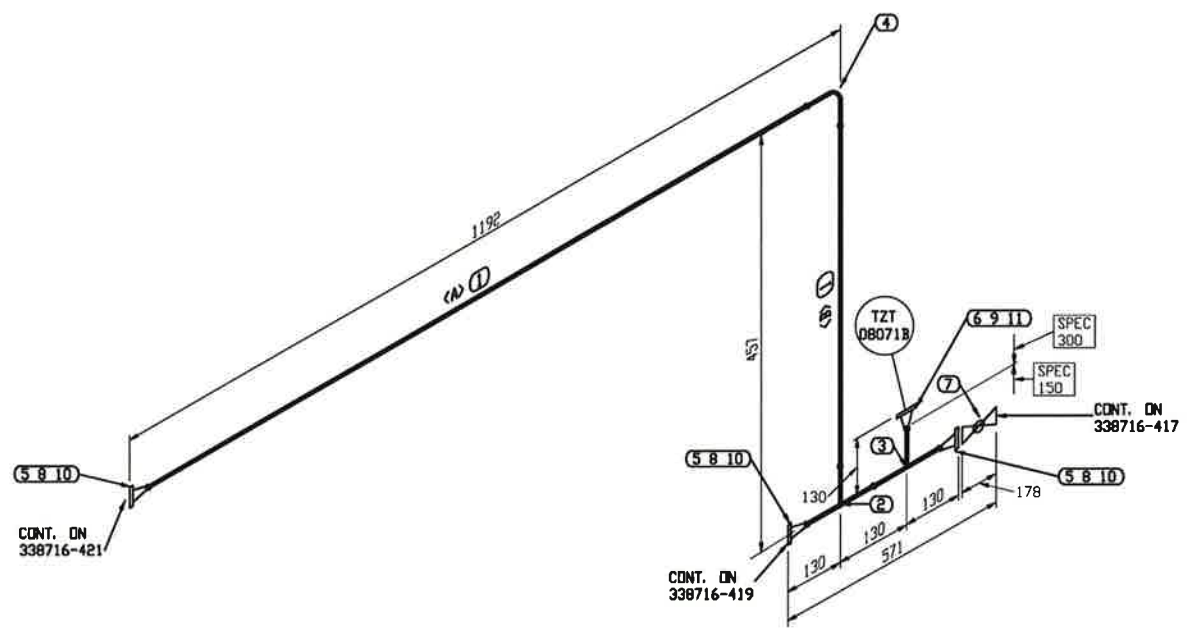
- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.



PROJECT NAME: CARMON CREEK PROJECT	CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2	TAG: 0735A-08030
SLS#: 338716	QUOTE: CGY2014-85
PO#: 4512-109-130	DWG #: 338716-417 -Rev0
DATE: APR 06/15	DATE: APR 09/15
DATE: APR 09/15	PAGE: 1 OF 1
CAD: N/A	

GAS OUTLET SPOOL DETAIL



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1357 MM	
FITTINGS				
2	2X2	TEE, SCH XS, ASTM A420-WPL-6	1	
3	2X1 1/2	TEE RED, SCH XS, ASTM A420-WPL-6	1	
4	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	1	
FLANGES				
5	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL.1	3	
6	1 1/2	FLG RFWN, 300LB, SCH XS, ASTM A350-LF2-CL.1	1	
VALVES / IN-LINE ITEMS				
7	2	BALL VALVE, FLG, REF. 338716-100 ITEM #20	1	

ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
8	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	3	
9	1 1/2	GASKET, 300LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
10	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	12	
11	1 1/2X3 3/4	3/4" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	1045	2
	312	2

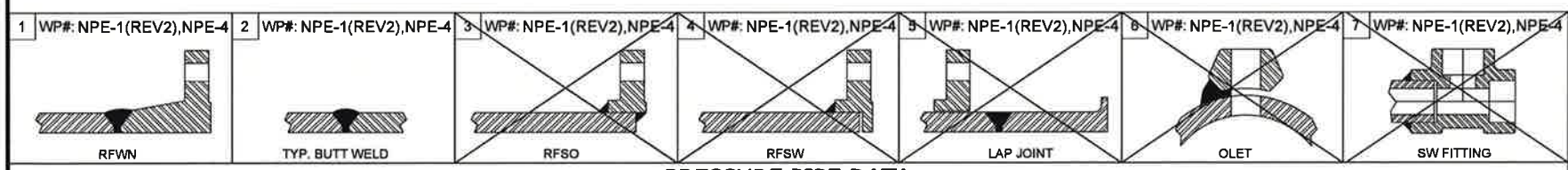
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15/04/15
DATE:YY/MM/DD

MJD
SIGNATURE



NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.



PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

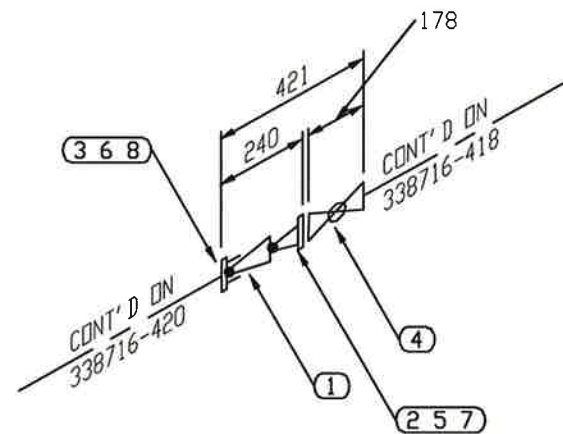
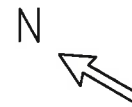
- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.



PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
OWN: LK DATE: APR 06/15 DWG #: 338716-418-Rev0
CHK: AA DATE: APR 09/15
APP: AA DATE: APR 09/15 PAGE: 1 OF 1 CAD: N/A

GAS OUTLET SPOOL DETAIL



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
FITTINGS				
1	2X3/4	SWAGE CONC, SCH XS, ASTM A420-WPL-6 BLE PSE	1	
FLANGES				
2	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL. 1	1	
3	1/2	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL. 1	1	
VALVES / IN-LINE ITEMS				
4	2	BALL VALVE, FLG, REF. 338716-100 ITEM #20	1	

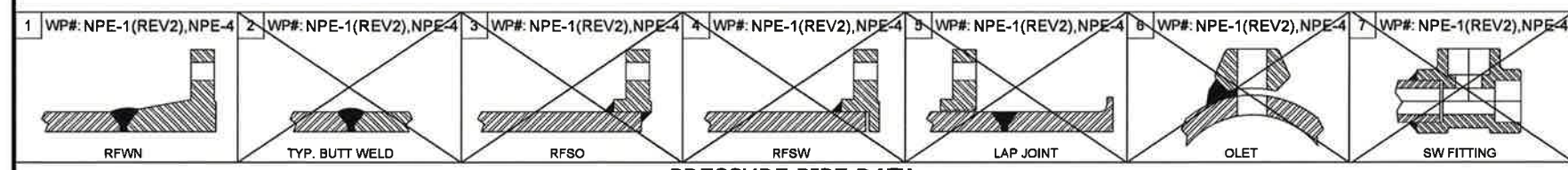
ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
6	1/2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
BOLTS				
7	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	
8	1/2X2 1/2	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

ISSUED FOR CONSTRUCTION
15/04/15
DATE:YY/MM/DD
SIGNATURE
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PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

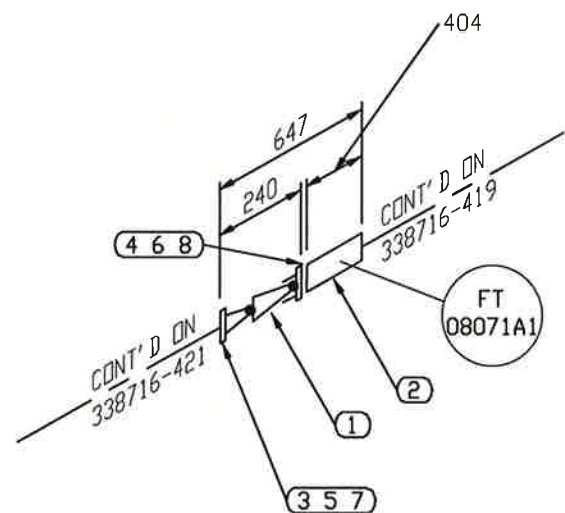
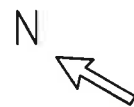
GAS OUTLET SPOOL DETAIL

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PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
SLS#: 338716 QUOTE: CGY2014-85 POF: 4512-109-130

DWG#: GG DATE: JUL 04/14 DWG#: 338716-419-Rev1
DWN: ET DATE: JUL 04/14
APP: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A



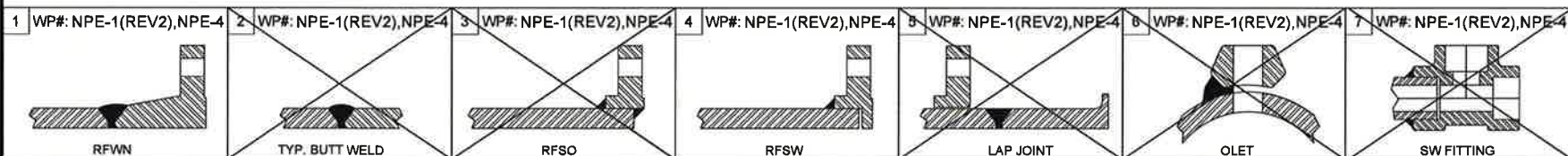
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
FITTINGS				
1	2X3/4	SWAGE CONC, SCH XS, ASTM A420-WPL-6 BLE PSE	1	
2	1/2	FLOW METER, FLG, REF. 338716-100 ITEM #16	1	
FLANGES				
3	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL.1	1	
4	1/2	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL.1	1	

ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
6	1/2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
BOLTS				
7	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	
8	1/2X2 1/2	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

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 15/04/15
 DATE:YY/MM/DD
 [Signature]
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- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

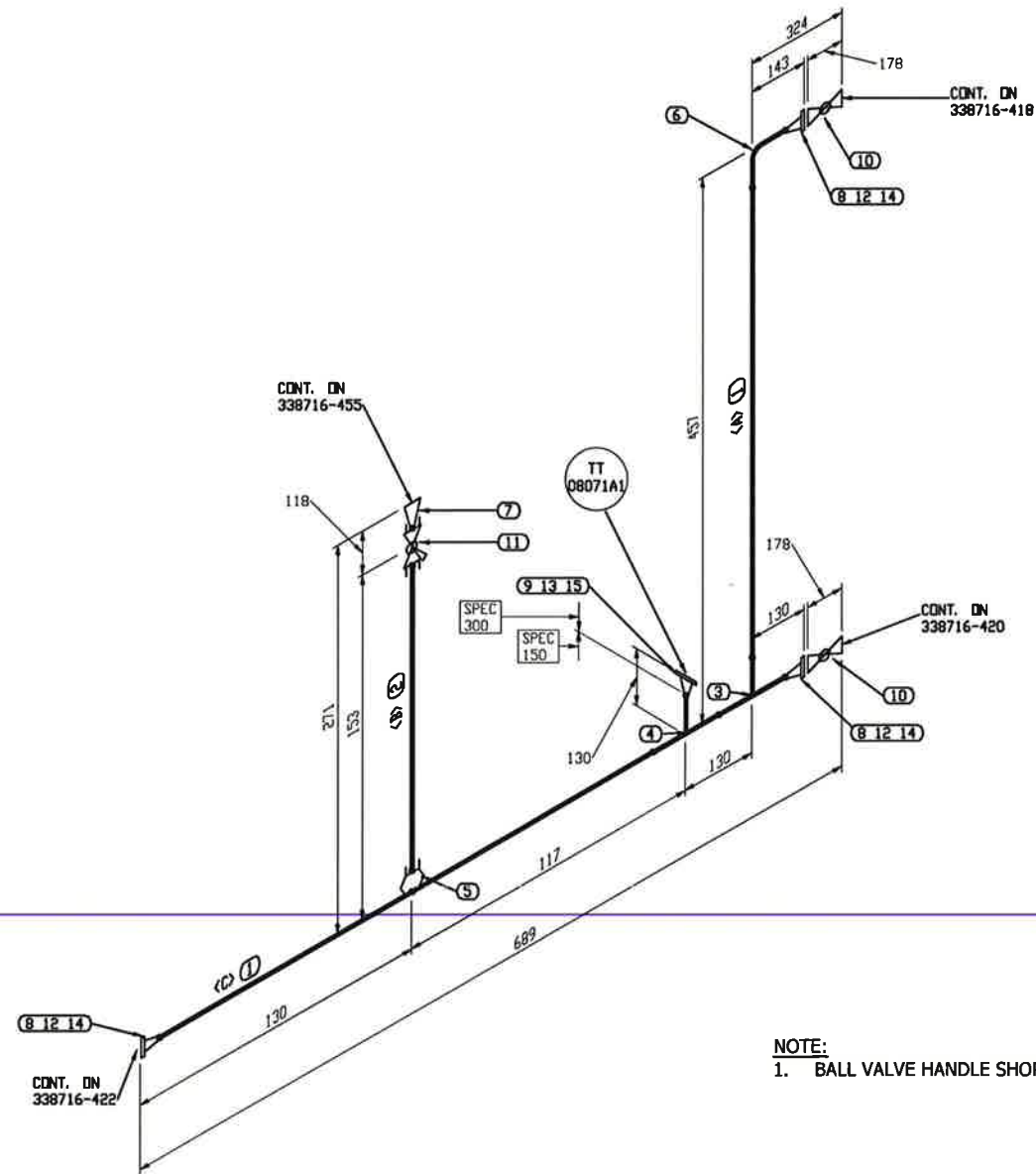
GAS OUTLET SPOOL DETAIL

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 BLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

DWBY: GG DATE: JUL 04/14 DWG #: 338716-420-Rev1
 DWBY: ET DATE: JUL 04/14
 APPBY: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A



NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	426 MM	
2	1/2	PIPE, SMLS, SCH XS, ASTM A333-6	76 MM	
FITTINGS				
3	2X2	TEE, SCH XS, ASTM A420-WPL-6	1	
4	2X1 1/2	TEE RED, SCH XS, ASTM A420-WPL-6	1	
5	2X1/2	OLET, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
6	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	1	
7	1X1/2	SWAGE CONC, SCH XS, ASTM A420-WPL-6 PBE	1	
FLANGES				
8	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL. 1	3	
9	1 1/2	FLG RFWN, 300LB, SCH XS, ASTM A350-LF2-CL. 1	1	
VALVES / IN-LINE ITEMS				
10	2	BALL VALVE, FLG, REF. 338716-100 ITEM #20	2	
11	1/2	BALL VALVE, SW, REF. 338716-100 ITEM #25A	1	

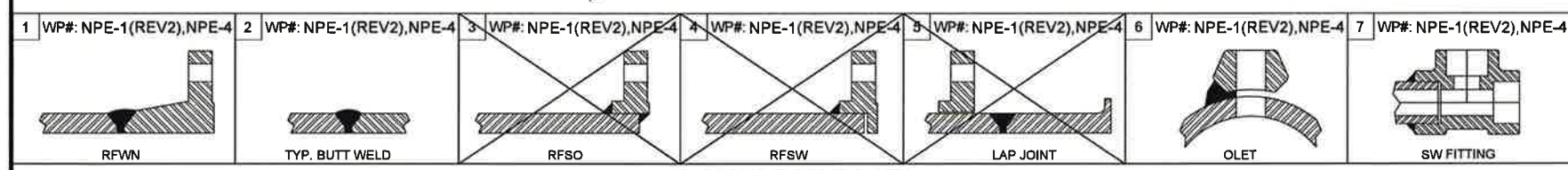
ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
12	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	3	
13	1 1/2	GASKET, 300LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
14	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	12	
15	1 1/2X3 3/4	3/4" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	312	2
	76	1/2
<C>	114	2

ISSUED FOR CONSTRUCTION
15/04/15
DATE:YY/MM/DD
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SIGNATURE



PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

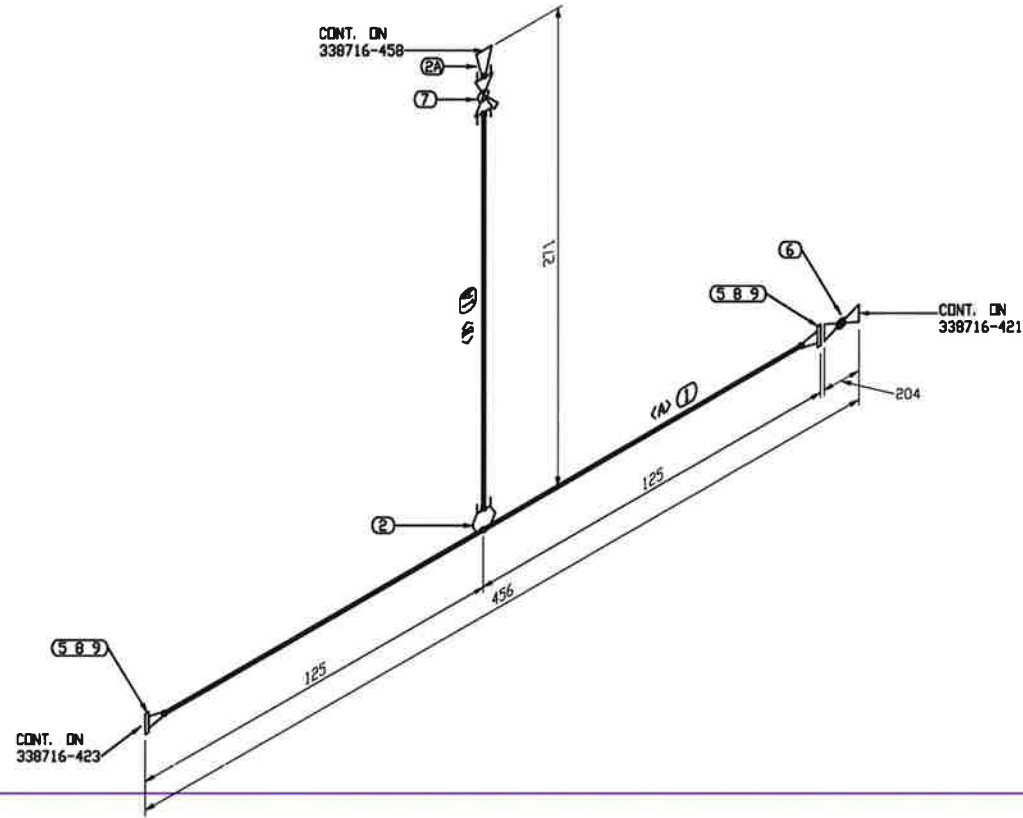
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PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
SLS#: 338716 QUOTE: CGY2014-85 PDR: 4512-109-130

OWN: LK DATE: APR 06/15 DWG #: 338716-421-Rev0
CHK: AA DATE: APR 09/15
APP: AA DATE: APR 09/15 PAGE: 1 OF 1 CAD: N/A

GAS OUTLET SPOOL DETAIL



NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	116 MM	
1A	1/2	PIPE, SMLS, SCH XS, ASTM A333-6	76 MM	
FITTINGS				
2	2X1/2	OLET, SW, 3000LB, ASTM A350-LF2-CL.1	1	
2A	1X1/2	SWAGE CONC, SCH XS, ASTM A420-WPL-6 PBE	1	
3	-	REMOVED	-	
4	-	REMOVED	-	
FLANGES				
5	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL.1	2	
VALVES / IN-LINE ITEMS				
6	2	GLOBE VALVE, FLG, REF. 338716-100 ITEM #15A	1	
7	1/2	BALL VALVE, SW, REF. 338716-100 ITEM #25A	1	

ERECTION MATERIALS

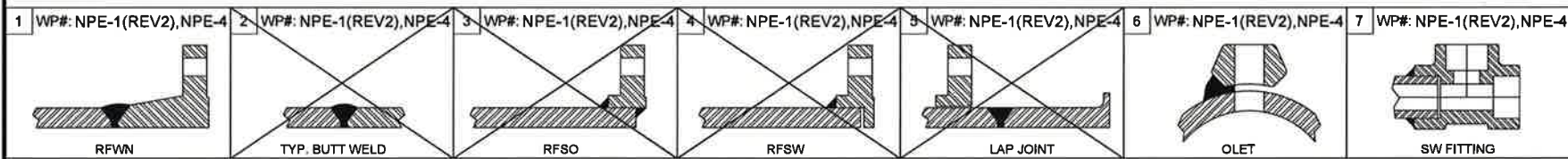
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
8	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	2	
BOLTS				
9	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	116	2
	76	1/2

ISSUED FOR CONSTRUCTION
15/04/18
DATE:YY/MM/DD
SIGNATURE
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- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

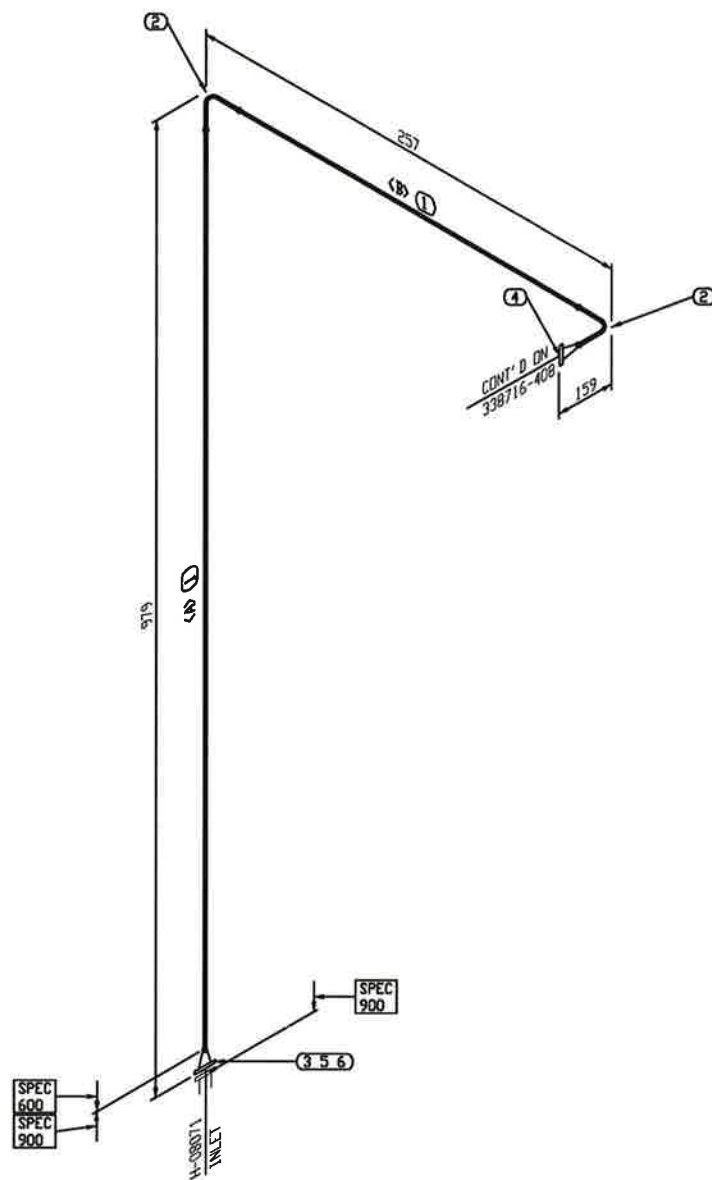
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PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
DWN: GG DATE: JUL 04/14 DWG #: 338716-422-Rev1
CHK: ET DATE: JUL 04/14
APP: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	ADDED ITEM 1A & 2A; REMOVED ITEM #3 & 4; CHANGED NOTES	LK	AA	AA	APR 08/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 28/15

GAS OUTLET SPOOL DETAIL



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	888 MM	
FITTINGS				
2	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	2	
FLANGES				
3	2	FLG RFWN, 1500LB, SCH XS, ASTM A350-LF2-CL. 1	1	
4	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL. 1	1	

ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	2	GASKET, 1500LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
6	2X5 3/4	7/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	789	2
	99	2

ISSUED FOR CONSTRUCTION

15/04/15
DATE:YY/MM/DD

AS
SIGNATURE

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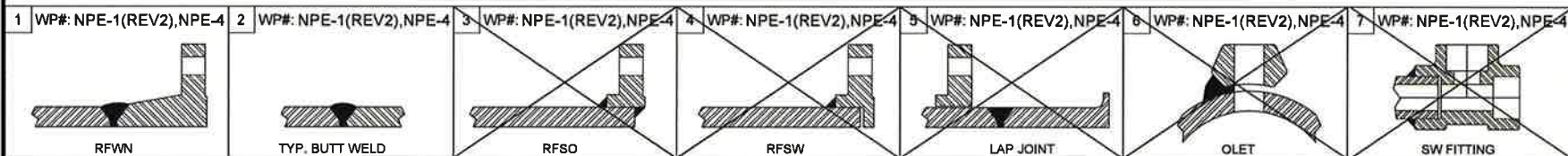
GENERAL NOTES

- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCAW ALLOWED BY SHELL.

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.



PROJECT NAME:	CARMON CREEK PROJECT
CUSTOMER:	SHELL CANADA c/o JACOBS ENGINEERING
LOCATION:	CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG:	0735A-08030
BLG#:	338716
QUOTE:	CGY2014-85
PO#:	4512-109-130
DWN BY:	GG
DATE:	JUL 04/14
DWG#:	338716-409-Rev1
CHK BY:	ET
DATE:	JUL 04/14
APP BY:	COG
DATE:	JUL 04/14
PAGE:	1 OF 1
CAD:	N/A

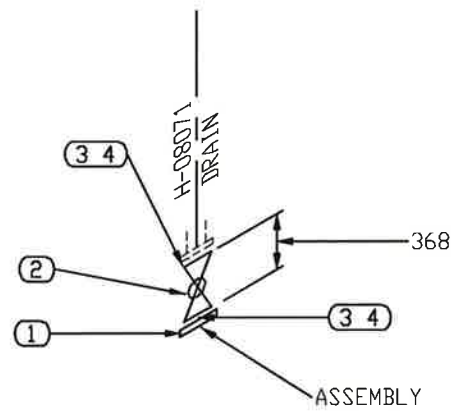
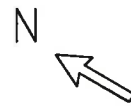


PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

DESCRIPTION	DWN	CHK	APP	DATE
1 CHANGED NOTES	LK	AA	AA	APR 13/15
0 ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

**GAS TO H-08071
SPOOL DETAIL**



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
VALVES / IN-LINE ITEMS				
1	2	FLG BLIND, RF, 1500LB, ASTM A350-LF2-CL.1	1	
2	2	BALL VALVE, FLG, REF. 338716-100 ITEM #22	1	

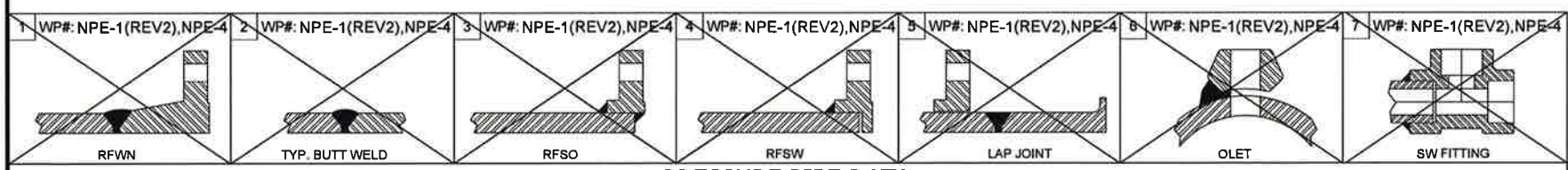
ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
3	2	GASKET, 1500LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	2	
BOLTS				
4	2X5 3/4	7/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	16	

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE:YY/MM/DD
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NOTE:
 1. BALL VALVE HANDLE SHOP CUT TO FIT.

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL C20W CLASS 900	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 3330 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 2035 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 28/15

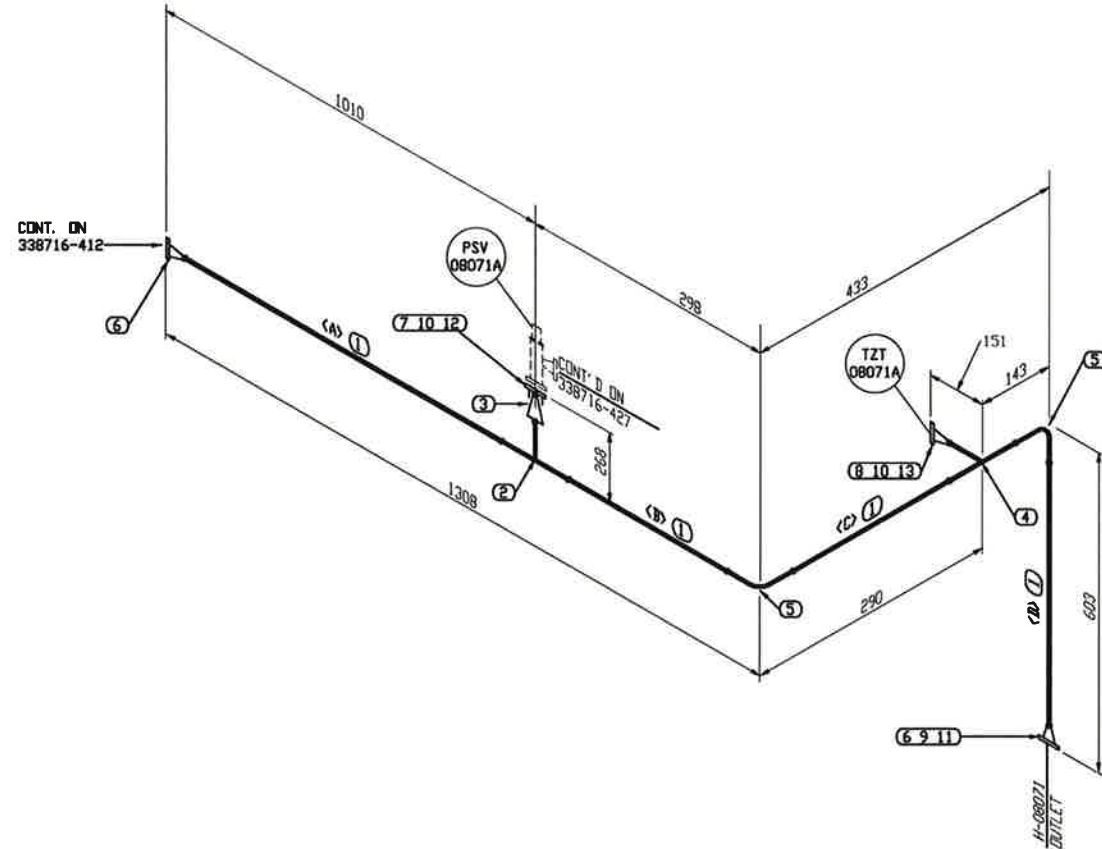
**H-08071 DRAIN
SPOOL DETAIL**

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

DMR BY: GG DATE: JUL 04/14 DWG #: 338716-433-Rev1
 CHK BY: ET DATE: JUL 04/14
 APP BY: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1543	MM
FITTINGS				
2	2X2	TEE, SCH XS, ASTM A420-WPL-6	1	
3	2X1 1/2	SWAGE CONC, SCH XS, ASTM A420-WPL-6 BLE PSE	1	
4	2X1 1/2	TEE RED, SCH XS, ASTM A420-WPL-6	1	
5	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	2	
FLANGES				
6	2	FLG RFWN, 1500LB, SCH XS, ASTM A350-LF2-CL. 1	2	
7	1 1/2	FLG RFSW, 1500LB, SCH XS, ASTM A350-LF2-CL. 1	1	
8	1 1/2	FLG RFWN, 1500LB, SCH XS, ASTM A350-LF2-CL. 1	1	

ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
9	2	GASKET, 1500LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
10	1 1/2	GASKET, 1500LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	2	
BOLTS				
11	2X5 3/4	7/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
12	1 1/2X6 1/4 1"	STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	
13	1 1/2X5 1/2 1"	STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	832	2
	153	2
<C>	145	2
<D>	413	2

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15/04/15
DATE:YY/MM/DD
SIGNATURE

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1 WP#: NPE-1(REV2),NPE-4	2 WP#: NPE-1(REV2),NPE-4	3 WP#: NPE-1(REV2),NPE-4	4 WP#: NPE-1(REV2),NPE-4	5 WP#: NPE-1(REV2),NPE-4	6 WP#: NPE-1(REV2),NPE-4	7 WP#: NPE-1(REV2),NPE-4
RFWN	TYP. BUTT WELD	RFSO	RFSW	LAP JOINT	OLET	SW FITTING

PRESSURE PIPE DATA

SPECIFICATION: SHELL C20W CLASS 900	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 3330 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 2035 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

GENERAL NOTES

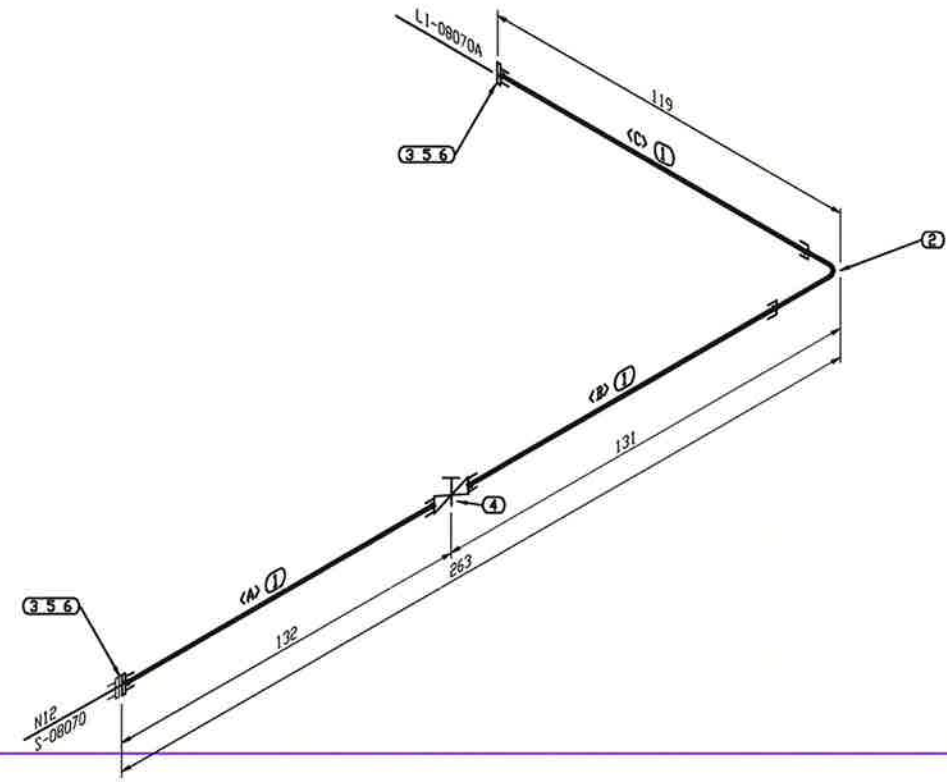
- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT	CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2	TAG: 0735A-08030
SLS#: 338716	QUOTE: CGY2014-85
PO#: 4512-109-130	
DWN#: LK	DATE: APR 06/15
OK#: AA	DATE: APR 09/15
APP#: AA	DATE: APR 09/15
DWG#: 338716-411-Rev0	PAGE: 1 OF 1
CAD: N/A	

**H-08071 OUTLET
SPOOL DETAIL**



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	3/4	PIPE, SMLS, SCH XS, ASTM A333-6	229 MM	
FITTINGS				
2	3/4	90 ELL, SW, 3000LB, ASTM A350-LF2-CL.1	1	
FLANGES				
3	3/4	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL.1	2	
VALVES / IN-LINE ITEMS				
4	3/4	GATE VALVE, SW, REF. 338716-100 ITEM #26	1	

ERECTION MATERIALS

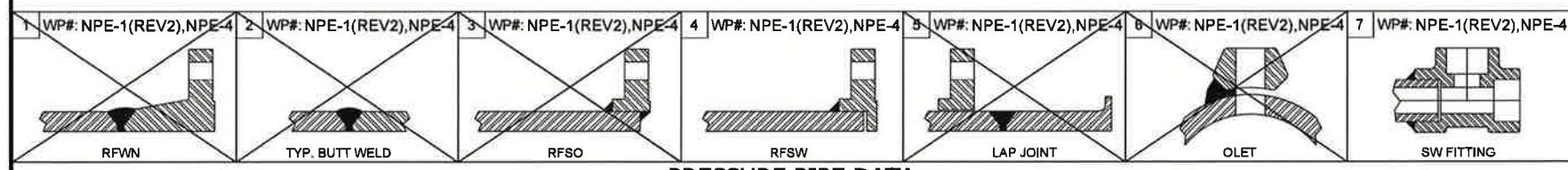
BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	3/4	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	2	
BOLTS				
6	3/4X3 1/2	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	77	3/4
	76	3/4
<C>	76	3/4

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 15/04/15
 DATE:YY/MM/DD
 SIGNATURE
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PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

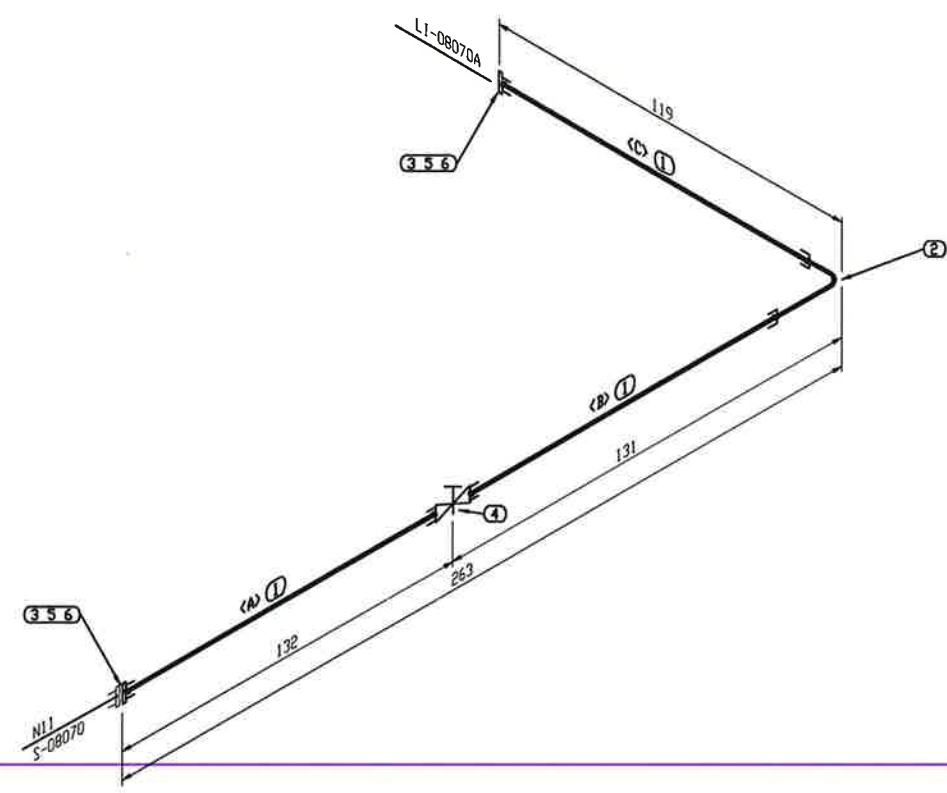
- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT	CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2	TAG: 0735A-08030
SLS#: 338716	QUOTE: CGY2014-85
PO#: 4512-109-130	
DWN BY: LK	DATE: APR 06/15
CHK BY: AA	DATE: APR 09/15
APP BY: AA	DATE: APR 09/15
DWG #: 338716-445-Rev0	PAGE: 1 OF 1
CAD: N/A	

**LI-08070A INLET
SPOOL DETAIL**



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	3/4	PIPE, SMLS, SCH XS, ASTM A333-6	229	
FITTINGS				
2	3/4	90 ELL, SW, 3000LB, ASTM A350-LF2-CL.1	1	
FLANGES				
3	3/4	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL.1	2	
VALVES / IN-LINE ITEMS				
4	3/4	GATE VALVE, SW, REF. 338716-100 ITEM #26	1	

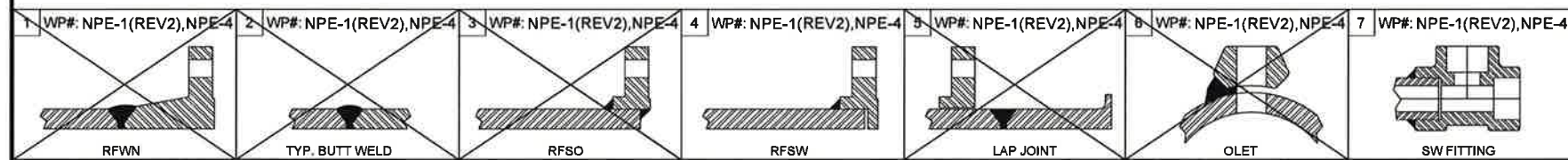
ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	3/4	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	2	
BOLTS				
6	3/4X3 1/2	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	77	3/4
	76	3/4
<C>	76	3/4

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE:YY/MM/DD
 SIGNATURE: [Signature]
 natpro



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

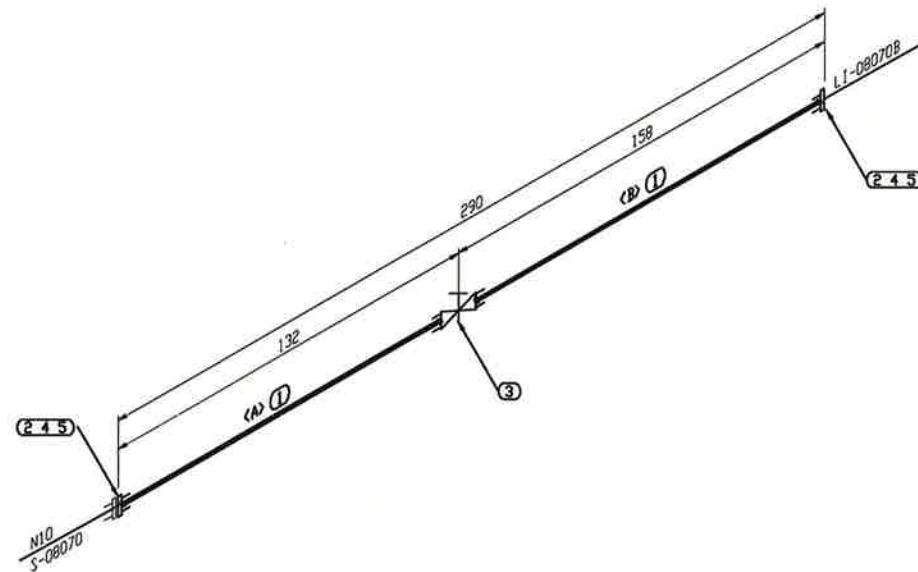
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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PDR: 4512-109-130
 DWN: LK DATE: APR 06/15
 CHK: AA DATE: APR 09/15
 APP: AA DATE: APR 09/15

338716-446-Rev0
 1 OF 1
 CAD: N/A

LI-08070A INLET SPOOL DETAIL



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
<u>PIPE</u>				
1	3/4	PIPE, SMLS, SCH XS, ASTM A333-6	179 MM	
<u>FLANGES</u>				
2	3/4	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	2	
<u>VALVES / IN-LINE ITEMS</u>				
3	3/4	GATE VALVE, SW, REF. 338716-100 ITEM #26	1	

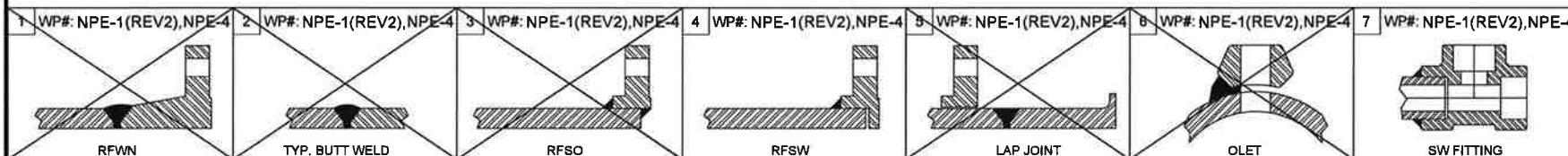
ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
<u>GASKETS</u>				
4	3/4	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS DR SS OUTER RING	2	
<u>BOLTS</u>				
5	3/4X3 1/2	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	77	3/4
	102	3/4

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE: YY/MM/DD
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PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CJ M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

GENERAL NOTES

- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCAW ALLOWED BY SHELL.

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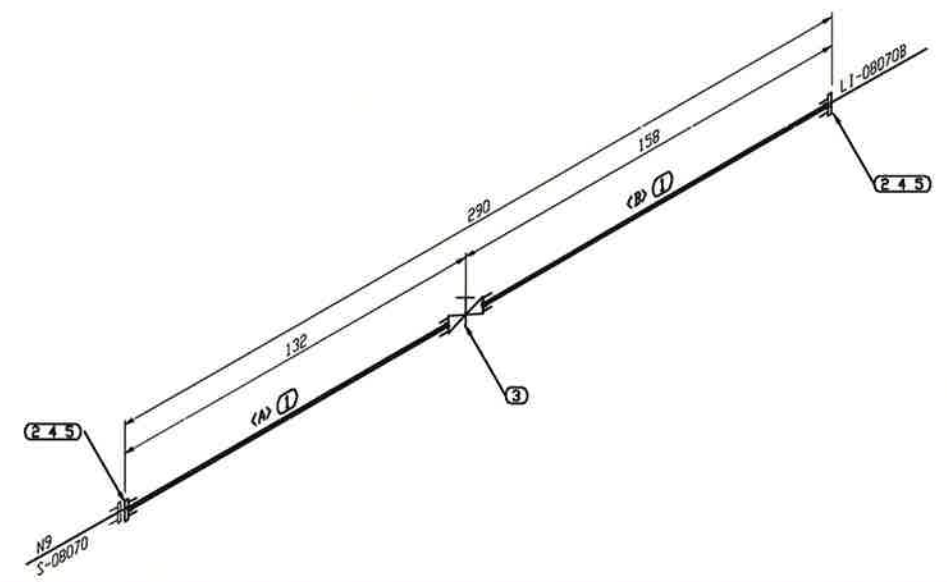


PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030

0	ISSUED FOR CONSTRUCTION	LK	AA	AA	APR 09/15
	DESCRIPTION	DWN	CHK	APP	DATE

LI-08070B INLET
 SPOOL DETAIL

SLS#: 338716	QUOTE: CGY2014-85	PO#: 4512-109-130
DWR: LK	DATE: APR 06/15	DWG#: 338716-447-Rev0
CHK: AA	DATE: APR 09/15	
APP: AA	DATE: APR 09/15	PAGE: 1 OF 1 CAD: N/A



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	3/4	PIPE, SMLS, SCH XS, ASTM A333-6	179 MM	
FLANGES				
2	3/4	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	2	
VALVES / IN-LINE ITEMS				
3	3/4	GATE VALVE, SW, REF. 338716-100 ITEM #26	1	

ERECTION MATERIALS

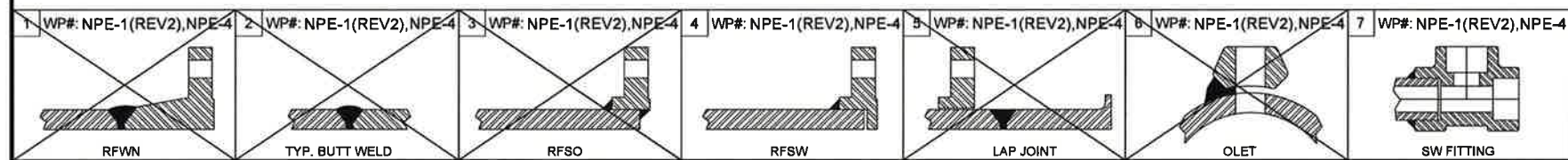
BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
4	3/4	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	2	
BOLTS				
5	3/4X3 1/2	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	77	3/4
	102	3/4

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE:YY/MM/DD
 SIGNATURE: *[Signature]*
 natpro



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

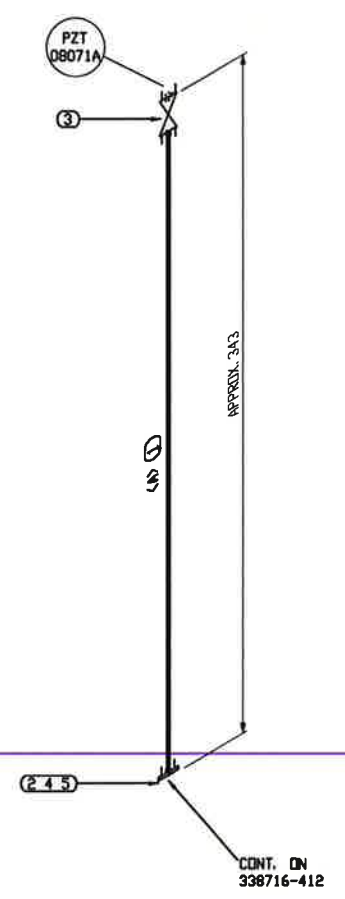
- GENERAL NOTES**
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 - NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PDR: 4512-109-130
 DWN BY: LK DATE: APR 06/15 DWG#: 338716-448-Rev0
 CHK BY: AA DATE: APR 09/15
 APP BY: AA DATE: APR 09/15 PAGE: 1 OF 1 CAD: N/A

**LI-08070B INLET
SPOOL DETAIL**



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	3/4	PIPE, SMLS, SCH XS, SS316/L	76 MM	
FLANGES				
2	3/4	FLG RFSW, 1500LB, SCH XS, SS316/L	1	
VALVES / IN-LINE ITEMS				
3	3/4	MANIFOLD, SW/NPT, REF. 338716-100 ITEM #31	1	

ERECTION MATERIALS

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
4	3/4	GASKET, 1500LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
5	3/4X4 1/2	3/4" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

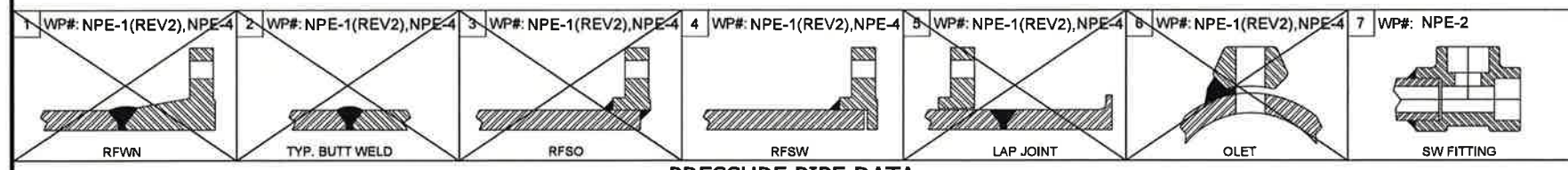
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	76	3/4

ISSUED FOR CONSTRUCTION

15/04/15
DATE:YY/MM/DD

[Signature]
SIGNATURE

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- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

PRESSURE PIPE DATA

SPECIFICATION: SHELL C20W CLASS 900	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: N/A
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 3330 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 2035 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 100%LPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CJ M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

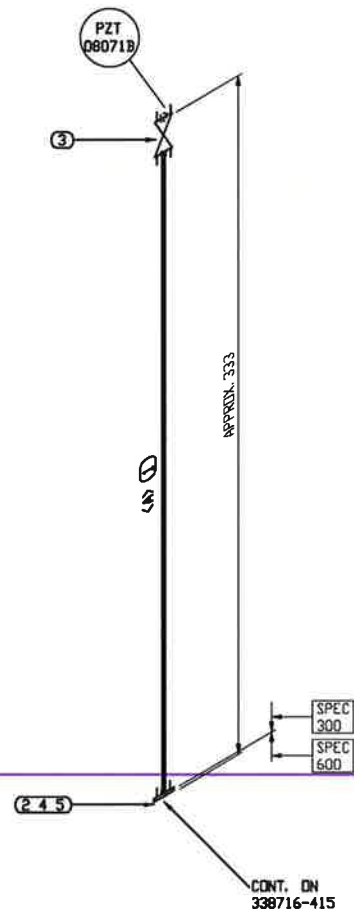
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natpro

PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030

SLS#: 338716	QUOTE: CGY2014-85	PO#: 4512-109-130
DWNR: LK	DATE: APR 06/15	DWG#: 338716-451-Rev0
CHKY: AA	DATE: APR 09/15	
APPY: AA	DATE: APR 09/15	PAGE: 1 OF 1

MANIFOLD CONNECTION SPOOL DETAIL



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	3/4	PIPE, SMLS, SCH XS, SS316/L	77 MM	
FLANGES				
2	3/4	FLG RFSW, 600LB, SCH XS, SS316/L	1	
VALVES / IN-LINE ITEMS				
3	3/4	MANIFOLD, SW/NPT, REF. 338716-100 ITEM #31	1	

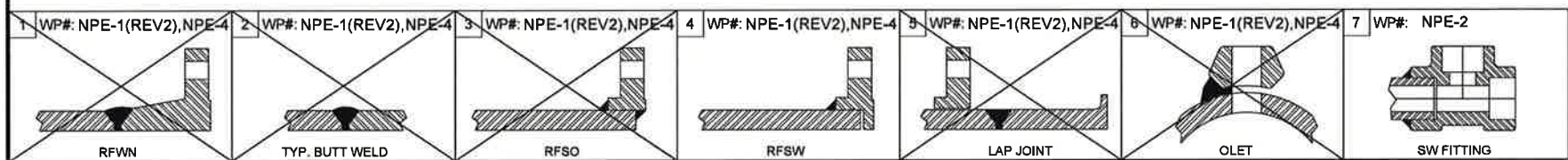
ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
4	3/4	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
5	3/4X3 1/2	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	77	3/4

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE: YY/MM/DD
 natpro



PRESSURE PIPE DATA

SPECIFICATION: SHELL E20W CLASS 300	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: N/A
DESIGN CODE Z662	TEST PRESSURE/TEMP/DURATION: 1110 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 680 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 100%LPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

GENERAL NOTES

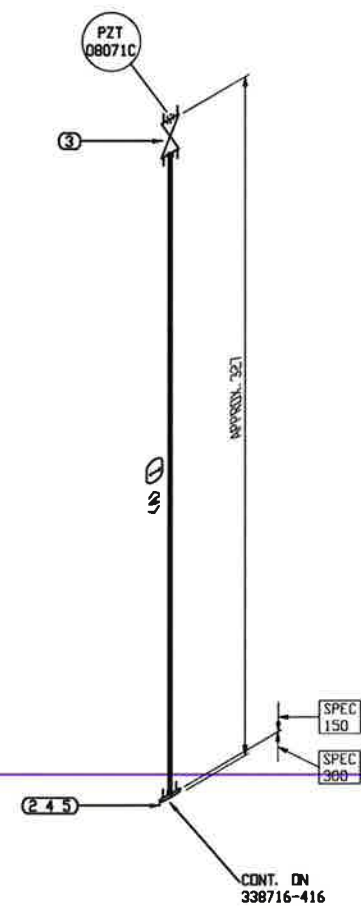
1. ALL DIMENSIONS ARE IN mm U.N.O.
2. FABRICATION TOLERANCE +/- 3mm U.N.O.
3. CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
4. ROOT GAP TO BE 1.6mm MAX.
5. NO FCAW ALLOWED BY SHELL.

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.



PROJECT NAME: CARMON CREEK PROJECT			
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING			
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2			
TAG: 0735A-08030			
SLS# 338716	QUOTE CGY2014-85	PO# 4512-109-130	
DRN BY: LK	DATE: APR 06/15	DWG #: 338716-452-Rev0	
CHK BY: AA	DATE: APR 09/15		
APP BY: AA	DATE: APR 09/15	PAGE: 1 OF 1	CAD: N/A

0	ISSUED FOR CONSTRUCTION	LK	AA	AA	APR 09/15
	DESCRIPTION	OWN	CHK	APP	DATE
MANIFOLD CONNECTION SPOOL DETAIL					



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	3/4	PIPE, SMLS, SCH XS, SS316/L	76 MM	
FLANGES				
2	3/4	FLG RFSW, 300LB, SCH XS, SS316/L	1	
VALVES / IN-LINE ITEMS				
3	3/4	MANIFOLD, SW/NPT, REF. 338716-100 ITEM #31	1	

ERECTION MATERIALS

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
4	3/4	GASKET, 300LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
5	3/4X3	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

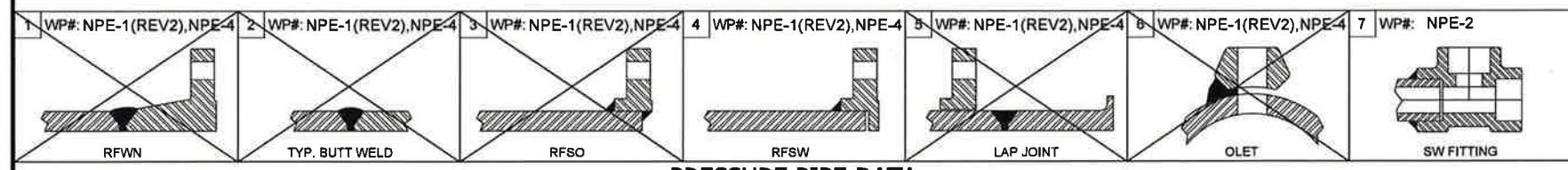
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	76	3/4

ISSUED FOR CONSTRUCTION

15/04/15

DATE:YY/MM/DD

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PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: N/A
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: (SW) 100%LPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

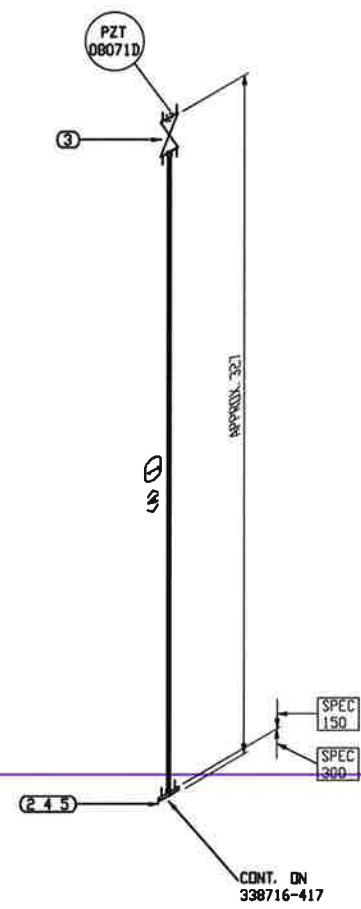
- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT			
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING			
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2			
TAG: 0735A-08030			
SLS#: 338716	QUOTE: CGY2014-85	PO#: 4512-109-130	
DWN: LK	DATE: APR 06/15	DWG#: 338716-453-Rev0	
CHK: AA	DATE: APR 09/15		
APP: AA	DATE: APR 09/15	PAGE: 1 OF 1	CAD: N/A

ISSUED FOR CONSTRUCTION			
DESCRIPTION	DWN	CHK	APP
			DATE
MANIFOLD CONNECTION SPOOL DETAIL			



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	3/4	PIPE, SMLS, SCH XS, SS316/L	76 MM	
FLANGES				
2	3/4	FLG RFSW, 300LB, SCH XS, SS316/L	1	
VALVES / IN-LINE ITEMS				
3	3/4	MANIFOLD, SW/NPT, REF. 338716-100 ITEM #31	1	

ERECTION MATERIALS

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
4	3/4	GASKET, 300LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
5	3/4X3	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

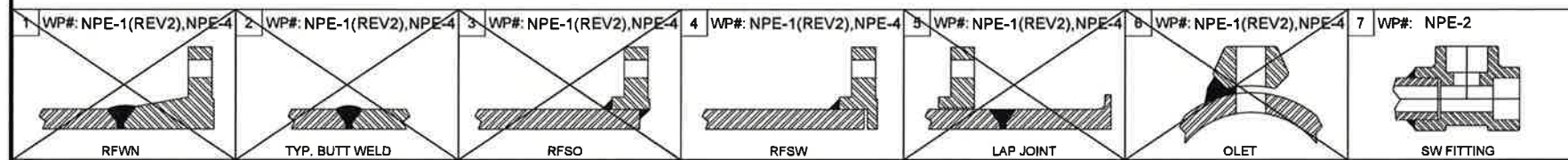
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	76	3/4

ISSUED FOR CONSTRUCTION

15/04/15
DATE: Y/M/WD

[Signature]
SIGNATURE

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PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: N/A
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: (SW) 100%LPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

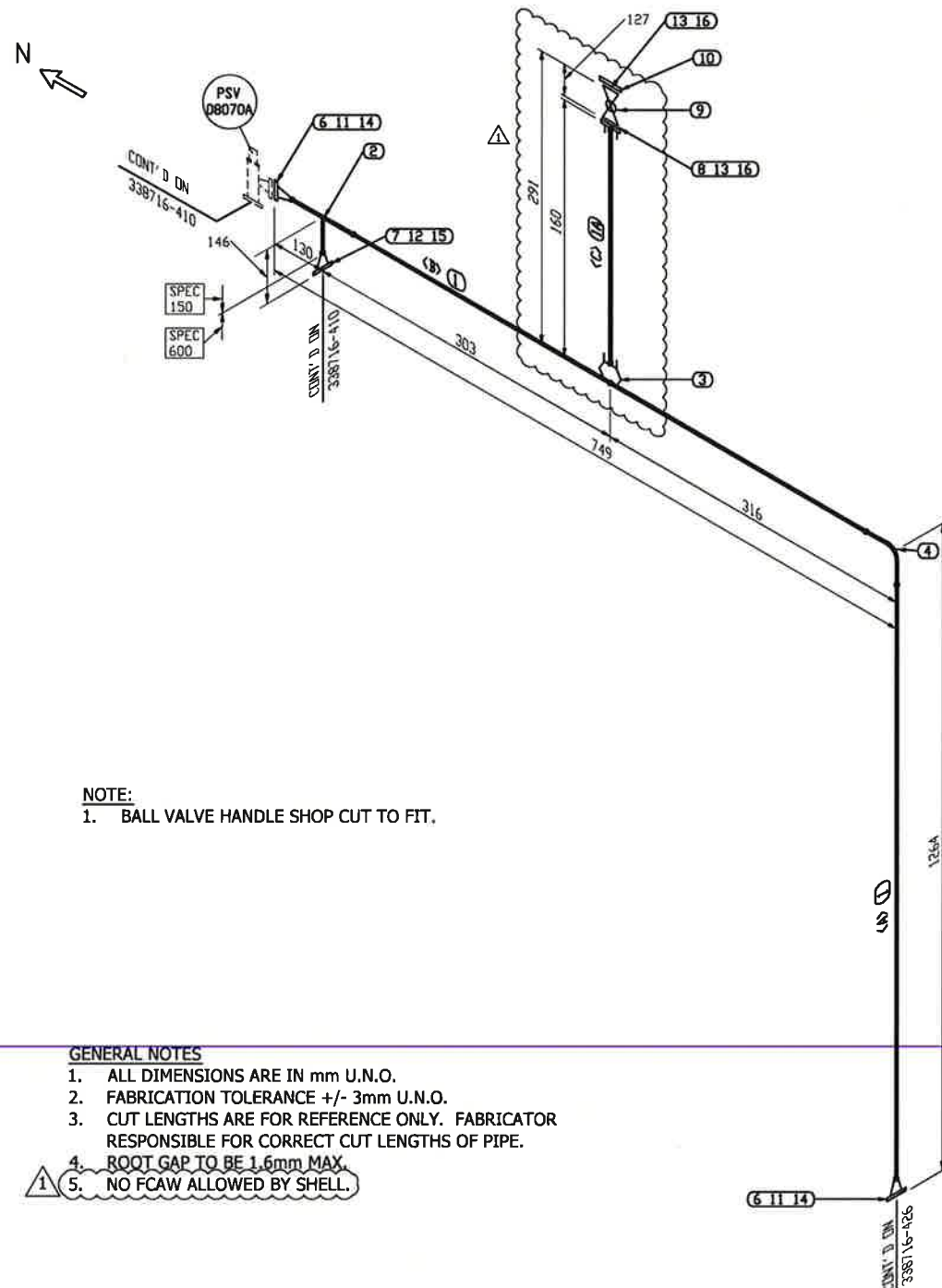
- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
 DWN: LK DATE: APR 06/15 DWO#: 338716-454-Rev0
 CHK: AA DATE: APR 09/15
 APP: AA DATE: APR 09/15 PAGE: 1 OF 1 CAD: N/A

**MANIFOLD CONNECTION
SPOOL DETAIL**



NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

- GENERAL NOTES
1. ALL DIMENSIONS ARE IN mm U.N.O.
 2. FABRICATION TOLERANCE +/- 3mm U.N.O.
 3. CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 4. ROOT GAP TO BE 1.6mm MAX.
 5. NO FCAW ALLOWED BY SHELL.

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1592 MM	
1A	1	PIPE, SMLS, SCH XS, ASTM A333-6	101 MM	
FITTINGS				
2	2X2	TEE, SCH XS, ASTM A420-WPL-6	1	
3	2X1	OLET, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
4	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	1	
5	-	REMOVED	-	
FLANGES				
6	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL. 1	2	
7	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL. 1	1	
8	1	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL. 1	1	
VALVES / IN-LINE ITEMS				
9	1	BALL VALVE, FLG, REF. 338716-100 ITEM #25	1	
10	1	FLG BLIND, RF, 150LB, ASTM A350-LF2-CL. 1	1	

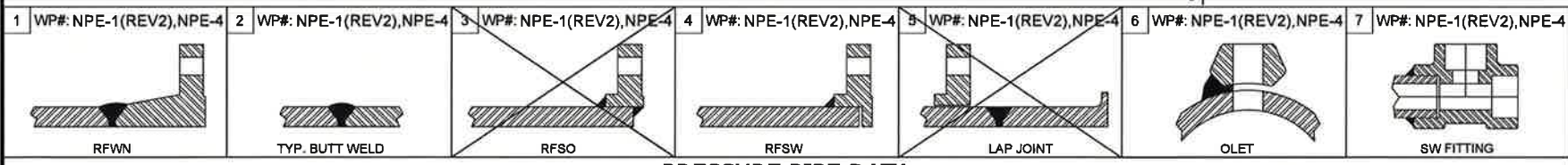
BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
11	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	2	
12	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
13	1	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	2	
BOLTS				
14	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
15	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
16	1X2 3/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	1118	2
	474	2
<C>	101	1

ISSUED FOR CONSTRUCTION
15/04/15
DATE: YYY/MM/DD
SIGNATURE



PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

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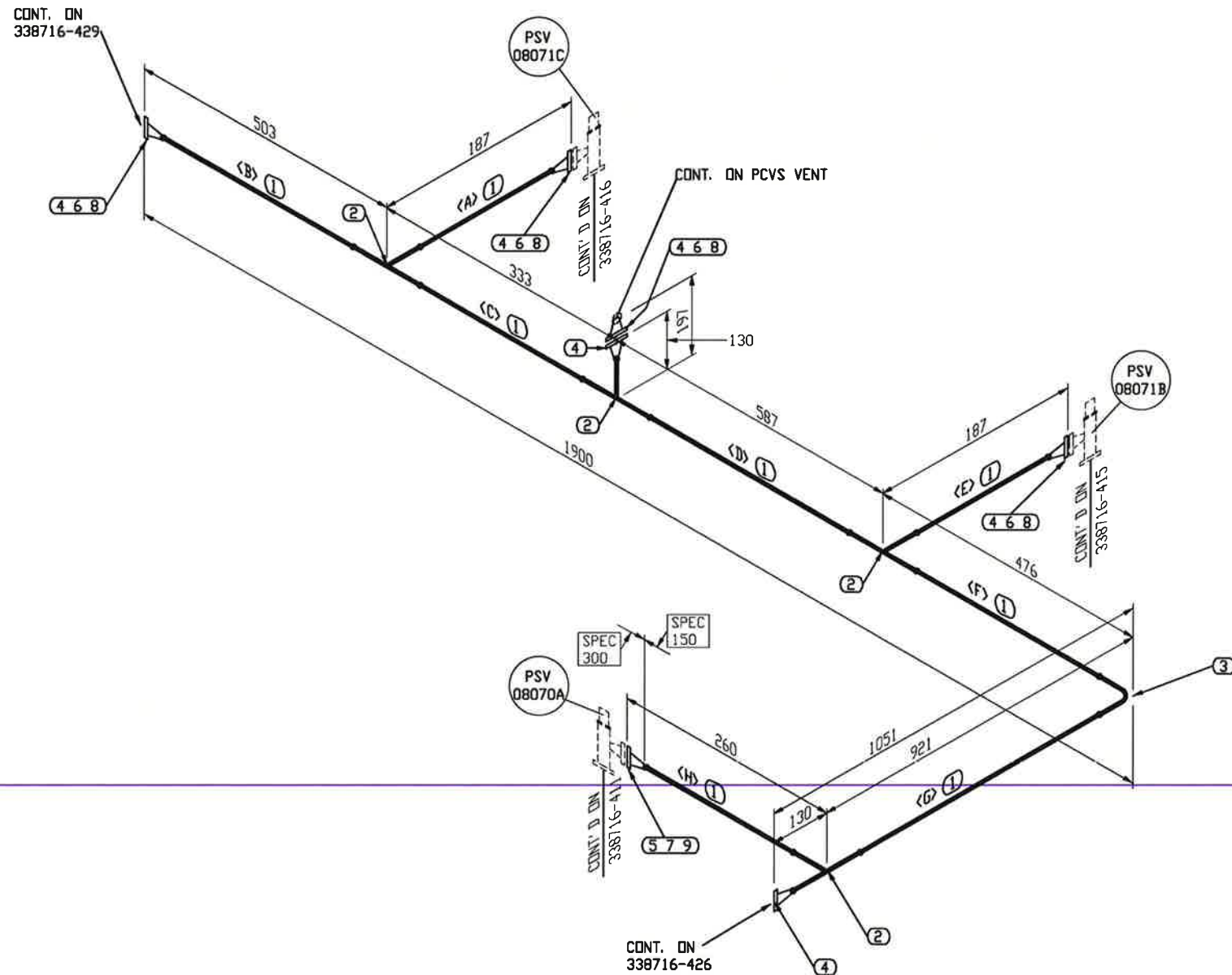
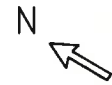


PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

DWN: GG	DATE: JUL 04/14	DWG #: 338716-425-Rev1
CHK: ET	DATE: JUL 04/14	
APP: COG	DATE: JUL 04/14	PAGE: 1 OF 1 CAD: N/A

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	ADDED ITEM #1A; REMOVED ITEM #5; CHANGED NOTES	LK	AA	AA	APR 09/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

PSV OUTLET
SPOOL DETAIL



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#

PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	2357	MM
FITTINGS				
2	2X2	TEE, SCH XS, ASTM A420-WPL-6	4	
3	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	1	
FLANGES				
4	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL.1	6	
5	2	FLG RFWN, 300LB, SCH XS, ASTM A350-LF2-CL.1	1	

ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#

GASKETS				
6	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	4	
7	2	GASKET, 300LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
8	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	16	
9	2X3 1/2	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH

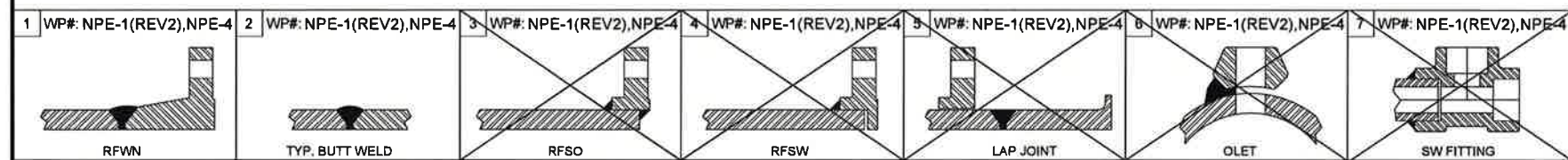
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	53	2
	370	2
<C>	200	2
<D>	454	2
<E>	53	2
<F>	331	2
<G>	776	2
<H>	120	2

ISSUED FOR CONSTRUCTION

15/04/15
DATE:YY/MM/DD

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- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

PSV OUTLET SPOOL DETAIL

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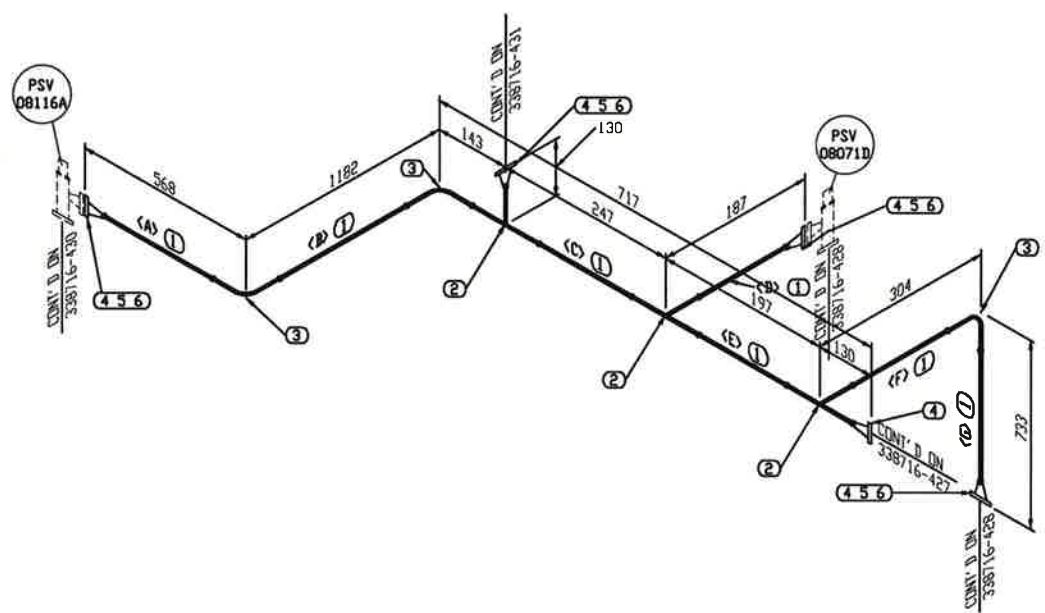
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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

DWG #: 338716-427-Rev1

DWN BY: GG DATE: JUL 04/14
 CK BY: ET DATE: JUL 04/14
 APP BY: COG DATE: JUL 04/14

PAGE: 1 OF 1 CAD: N/A



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	2420 MM	

FITTINGS				
2	2X2	TEE, SCH XS, ASTM A420-WPL-6	3	
3	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	3	

FLANGES				
4	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL. 1	5	

ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	4	

BOLTS				
6	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	16	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	421	2
	1023	2
<C>	114	2
<D>	53	2
<E>	64	2
<F>	158	2
<G>	587	2

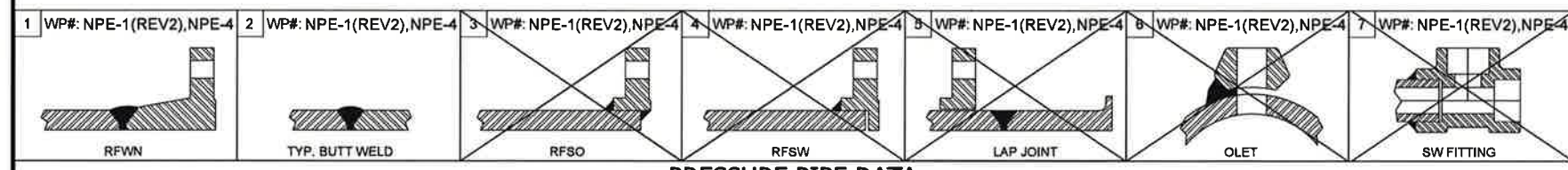
ISSUED FOR CONSTRUCTION
 15/04/15
 DATE:YY/MM/DD
 SIGNATURE
 natpro

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAM ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT			
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING			
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2			
TAG: 0735A-08030			
SLS#: 338716	QUOTE: CGY2014-85	PDR: 4512-109-130	
OWN: GG	DATE: JUL 04/14	DWG #: 338716-429-Rev1	
CHK: ET	DATE: JUL 04/14	PAGE: 1 OF 1	
APP: COG	DATE: JUL 04/14	CAD: N/A	

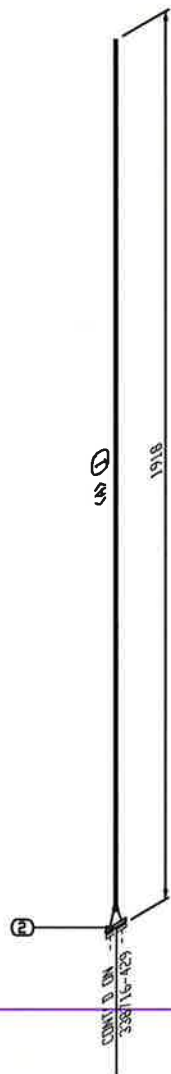


PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

PSV OUTLET SPOOL DETAIL

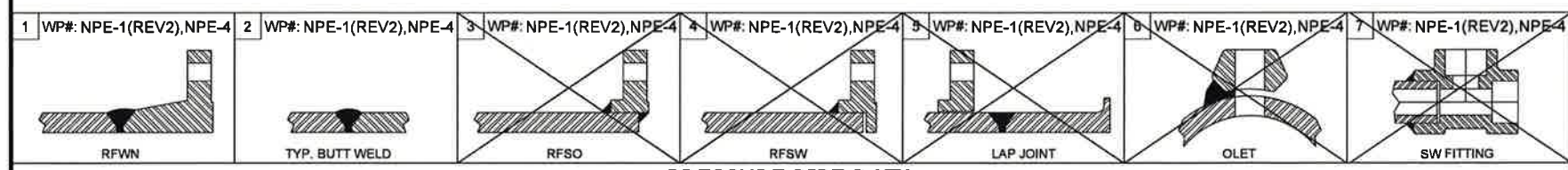


BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1852 MM	
FLANGES				
2	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL. 1	1	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	1852	2

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE:YY/MM/DD
 SIGNATURE: *NA*
 natpro

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX
 - NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

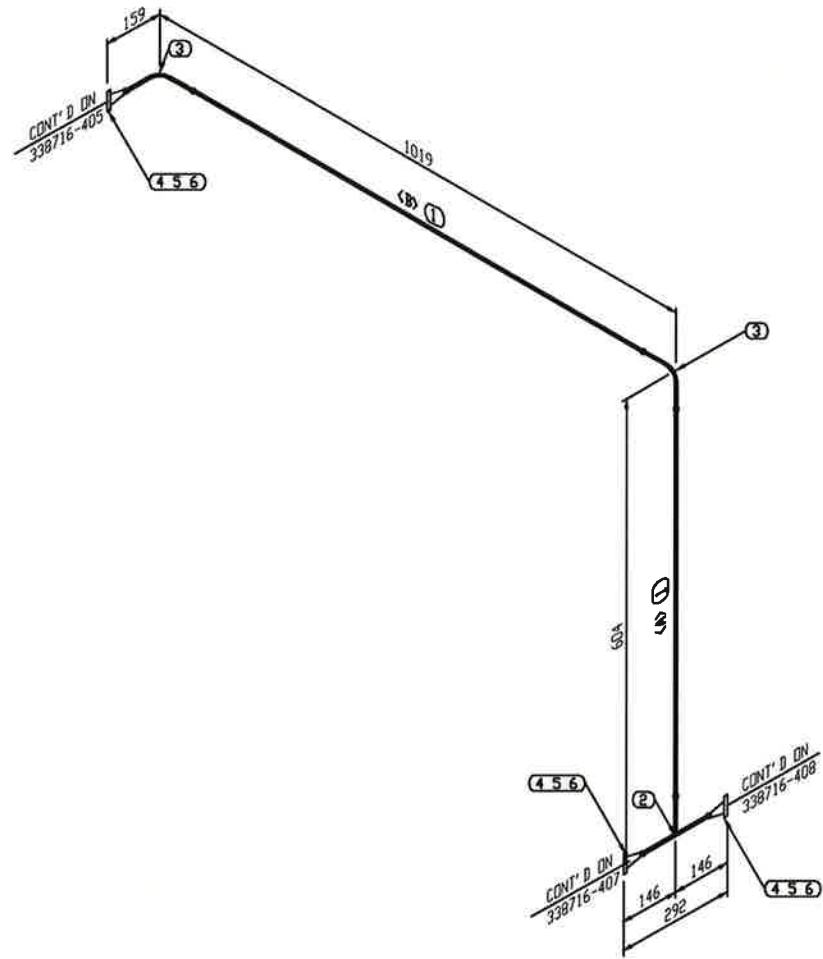
REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

**PSV OUTLET
SPOOL DETAIL**

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
 DWN: GG DATE: JUL 04/14 DWG #: 338716-431-Rev1
 CHK: ET DATE: JUL 04/14
 APP: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1319 MM	
FITTINGS				
2	2X2	TEE, SCH XS, ASTM A420-WPL-6	1	
3	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	2	
FLANGES				
4	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL. 1	3	

ERECTION MATERIALS

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	3	
BOLTS				
6	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	24	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	458	2
	861	2

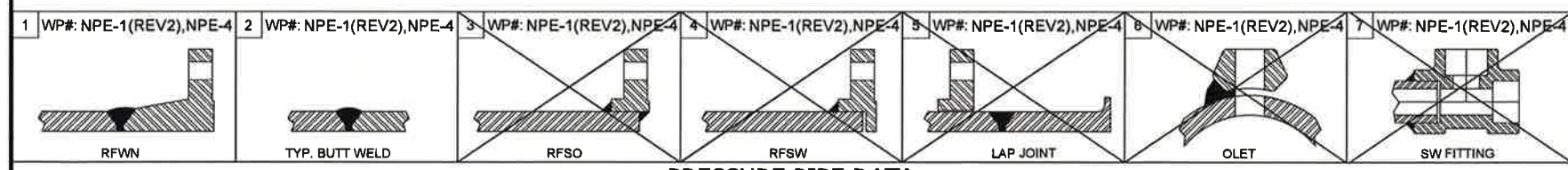
- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX
 - NO FCAW ALLOWED BY SHELL.

ISSUED FOR CONSTRUCTION

15/04/14
DATE:YY/MM/DD

AD
SIGNATURE

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PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

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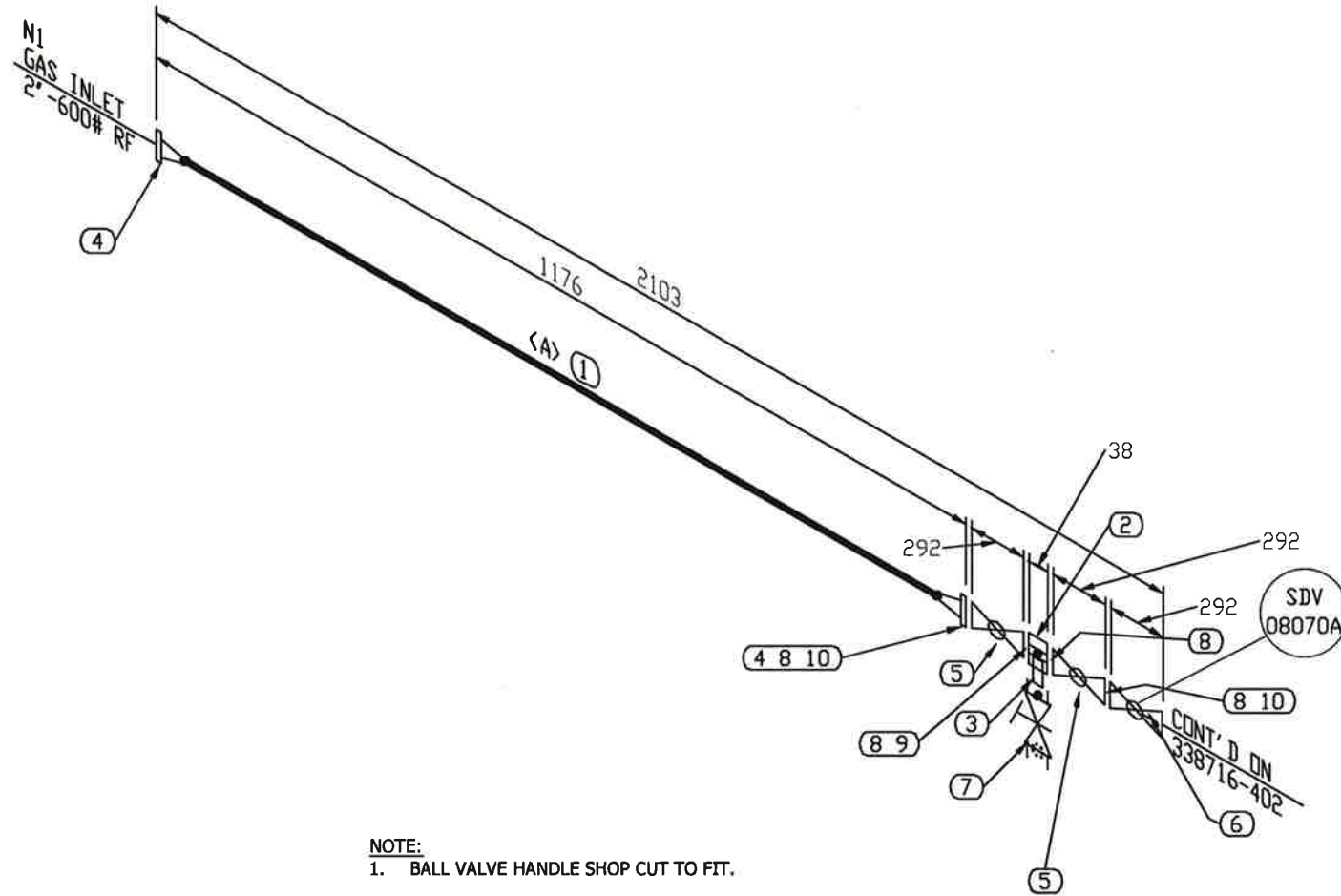
natpro

PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

OWN: GG	DATE: JUL 04/14	DWG #: 338716-406-Rev1
CHK: ET	DATE: JUL 04/14	
APP: COG	DATE: JUL 04/14	PAGE: 1 OF 1 CAD: N/A

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 28/15

S-08070 GAS INLET SPOOL DETAIL



NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1011 MM	
FITTINGS				
2	2	BLEED RING, REF. 338716-100 ITEM #34	1	
3	3/4	NIPPLE, SCH 160, ASTM A333-6 PBE (4' LG)	1	
FLANGES				
4	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL. 1	2	
VALVES / IN-LINE ITEMS				
5	2	BALL VALVE, FLG, REF. 338716-100 ITEM #21	2	
6	2	BALL VALVE, FLG, REF. 338716-100 ITEM #1	1	
7	3/4	GATE VALVE, SW/NPT, REF. 338716-100 ITEM #27	1	

ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
8	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	4	
BOLTS				
9	2X6	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
10	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	16	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	1011	2

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 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE: Y/M/00
 SIGNATURE
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PROJECT NAME: CARMON CREEK PROJECT

CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING

LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

TAG: 0735A-08030

SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

OWN: GG DATE: JUL 04/14 DWG #: 338716-401-Rev1

CHK: ET DATE: JUL 04/14

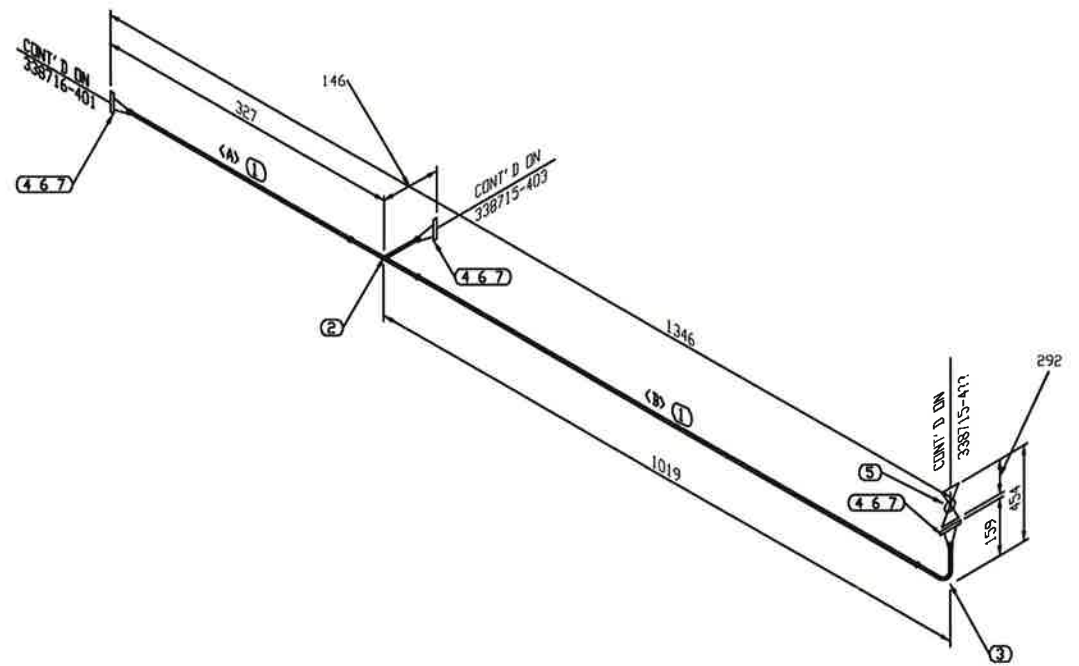
APP: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A

1 WP#: NPE-1(REV2),NPE-4	2 WP#: NPE-1(REV2),NPE-4	3 WP#: NPE-1(REV2),NPE-4	4 WP#: NPE-1(REV2),NPE-4	5 WP#: NPE-1(REV2),NPE-4	6 WP#: NPE-1(REV2),NPE-4	7 WP#: NPE-1(REV2),NPE-4
RFWN	TYP. BUTT WELD	RFSO	RFSW	LAP JOINT	OLET	SW FITTING

PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

S-08070 GAS INLET SPOOL DETAIL



NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1051 MM	
FITTINGS				
2	2X2	TEE, SCH XS, ASTM A420-WPL-6	1	
3	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	1	
FLANGES				
4	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL.1	3	
VALVES / IN-LINE ITEMS				
5	2	BALL VALVE, FLG, REF. 338716-100 ITEM #21	1	

ERECTION MATERIALS

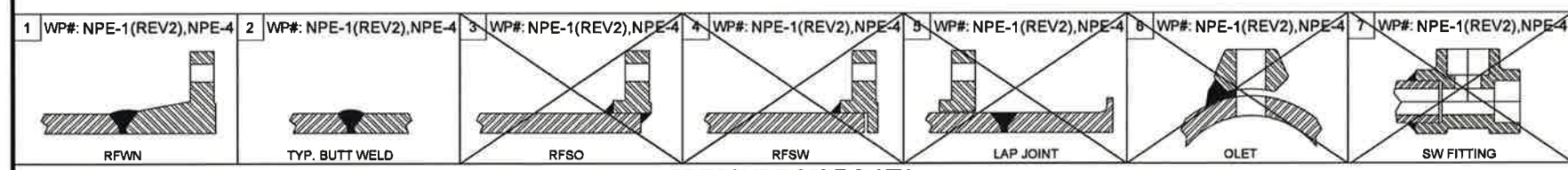
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
6	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS DR SS OUTER RING	3	
BOLTS				
7	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	24	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	178	2
	873	2

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 - RQOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

ISSUED FOR CONSTRUCTION
15/04/15
DATE:YY/MM/DD
SIGNATURE
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PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

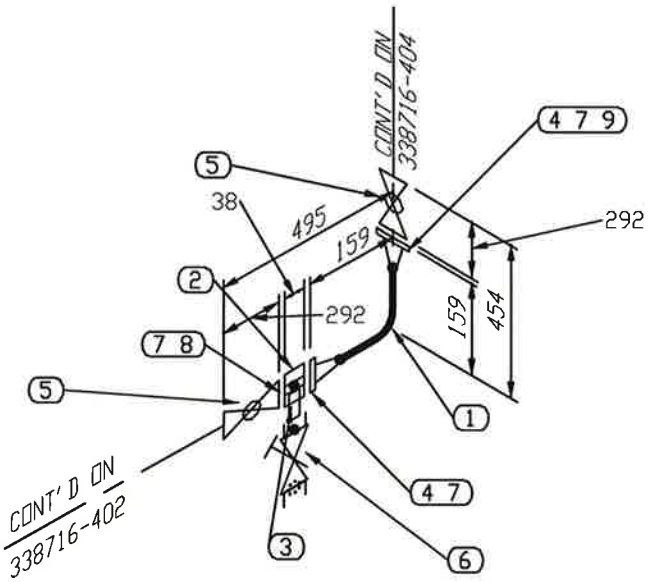
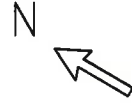
**S-08070 GAS INLET
SPOOL DETAIL**

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PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
SLS#: 338716 QUOTE: CGY2014-85 PDR: 4512-109-130

OWN: GG DATE: JUL 04/14 DNG #: 338716-402-Rev1
CHK: ET DATE: JUL 04/14
APP: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A



NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

BILL OF MATERIAL

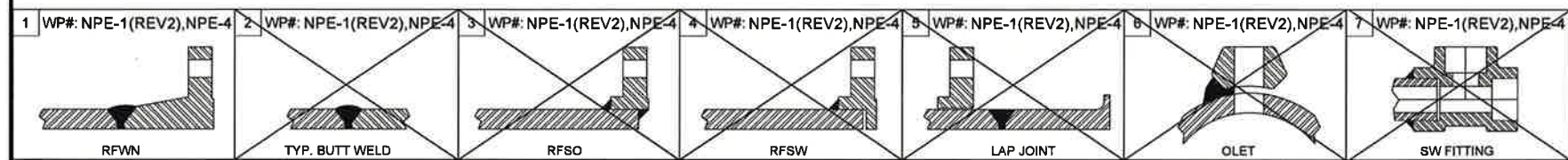
MARK	SIZE	DESCRIPTION	QTY	HT#
FITTINGS				
1	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	1	
2	2	BLEED RING, REF. 338716-100 ITEM #34	1	
3	3/4	NIPPLE, SCH 160, ASTM A333-6 PBE < 4' LG	1	
FLANGES				
4	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL. 1	2	
VALVES / IN-LINE ITEMS				
5	2	BALL VALVE, FLG, REF. 338716-100 ITEM #21	2	
6	3/4	GATE VALVE, SW/NPT, REF. 338716-100 ITEM #27	1	

ERECTION MATERIALS

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
7	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	3	
BOLTS				
8	2X6	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
9	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE:YY/MM/DD
 SIGNATURE
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- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
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 - NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

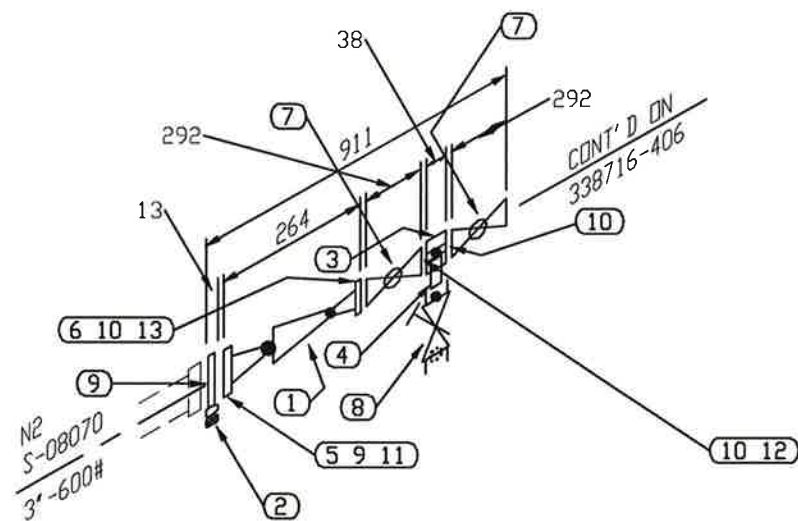
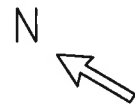
REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 14/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 28/15

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
 DWN BY: GG DATE: JUL 04/14 DWG #: 338716-403-Rev1
 CHK BY: ET DATE: JUL 04/14
 APP BY: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A

**S-08070 GAS INLET
SPOOL DETAIL**



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
FITTINGS				
1	3X2	RED CONC, SCH STD/XS, ASTM A420-WPL-6	1	
2	3	SPECTACLE BLIND, REF. 338716-100 ITEM #29	1	
3	2	BLEED RING, REF. 338716-100 ITEM #34	1	
4	3/4	NIPPLE, SCH 160, ASTM A333-6 PBE (4' LG)	1	
FLANGES				
5	3	FLG RFWN, 600LB, SCH STD, ASTM A350-LF2-CL.1	1	
6	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL.1	1	
VALVES / IN-LINE ITEMS				
7	2	BALL VALVE, FLG, REF. 338716-100 ITEM #21	2	
8	3/4	GATE VALVE, SW/NPT, REF. 338716-100 ITEM #27	1	

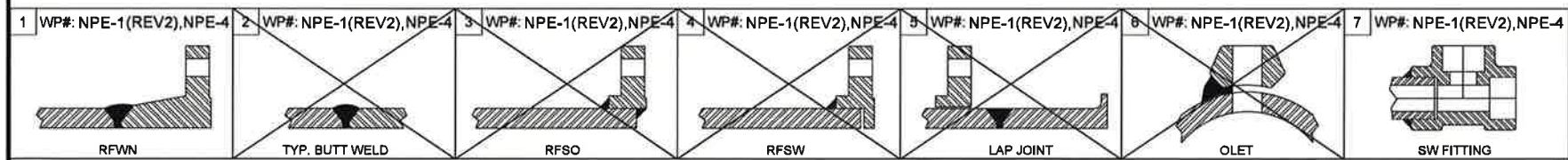
ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
9	3	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	2	
10	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	3	
BOLTS				
11	3X5 3/4	3/4" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
12	2X6	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
13	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

ISSUED FOR CONSTRUCTION
15/04/15
DATE:YY/MM/DD
[Signature]
SIGNATURE
natpro



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	OWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 14/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

**S-08070 GAS INLET
SPOOL DETAIL**

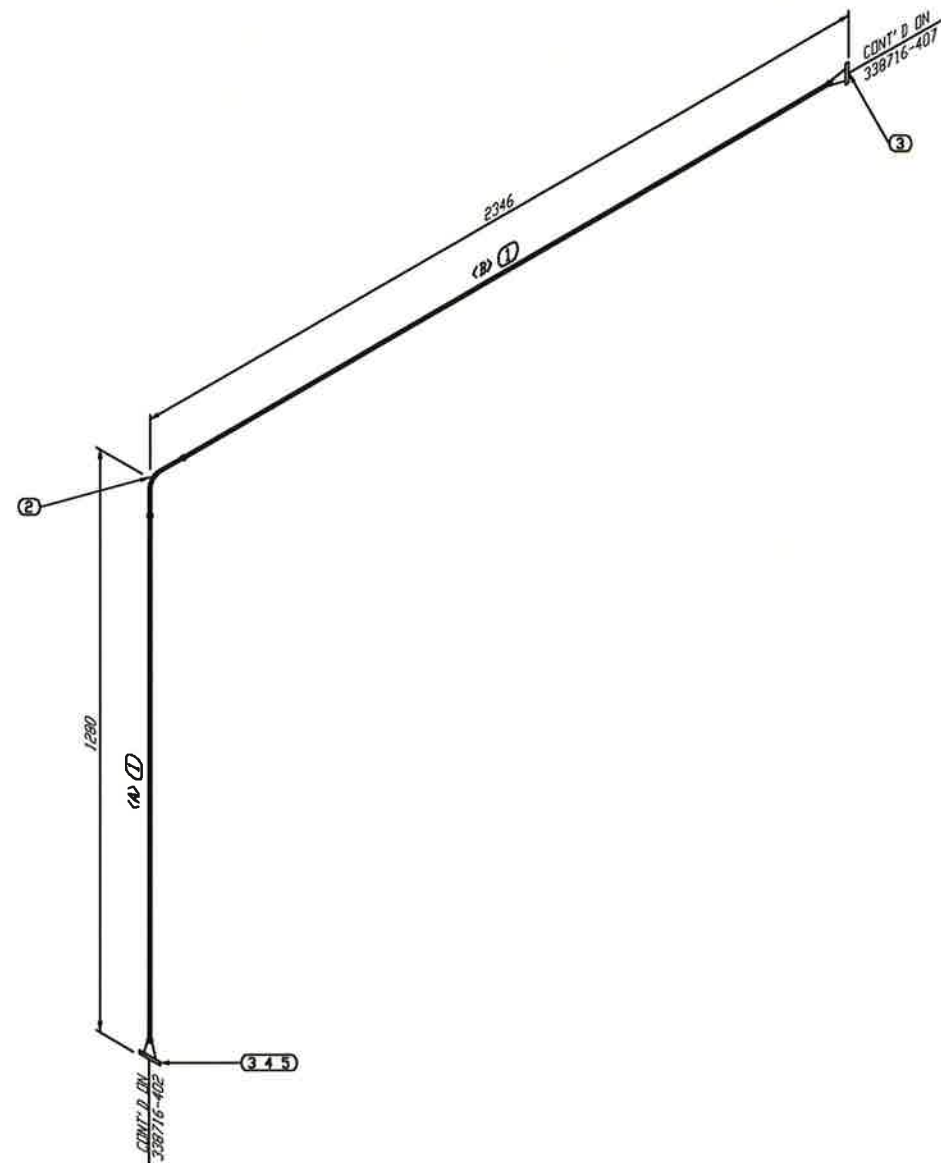
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PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030

BL# 338716 QUOTE: CGY2014-85 PO# 4512-109-130

DWG #: 338716-405-Rev1
PAGE: 1 OF 1
CAD: N/A



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	3302 MM	
FITTINGS				
2	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	1	
FLANGES				
3	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL. 1	2	

ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
4	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
5	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	1117	2
	2185	2

ISSUED FOR CONSTRUCTION

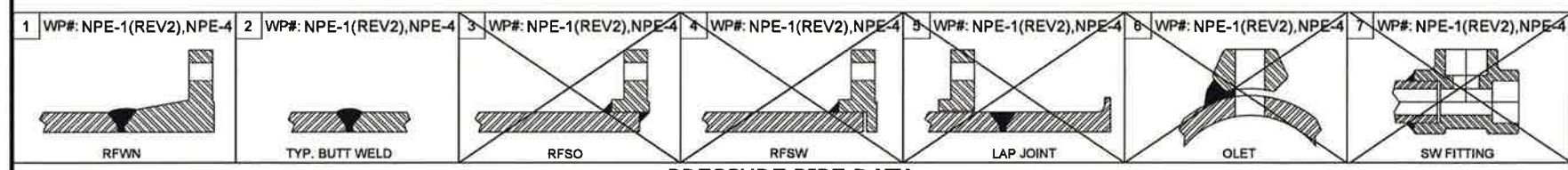
15/04/15
 DATE:YY/MM/DD
 SIGNATURE
 natpro

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX
 - NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PDR: 4512-109-130



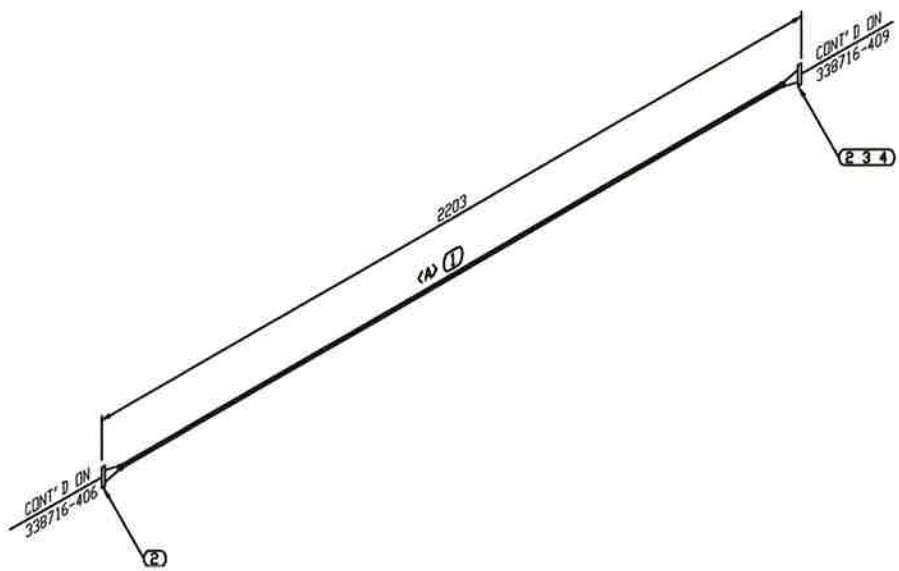
PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

S-08070 GAS INLET
 SPOOL DETAIL

DWN BY: GG DATE: JUL 04/14 DWO#: 338716-407-Rev1
 CHK BY: ET DATE: JUL 04/14
 APP BY: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	2037 MM	
FLANGES				
2	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL. 1	2	

ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
3	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
4	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH

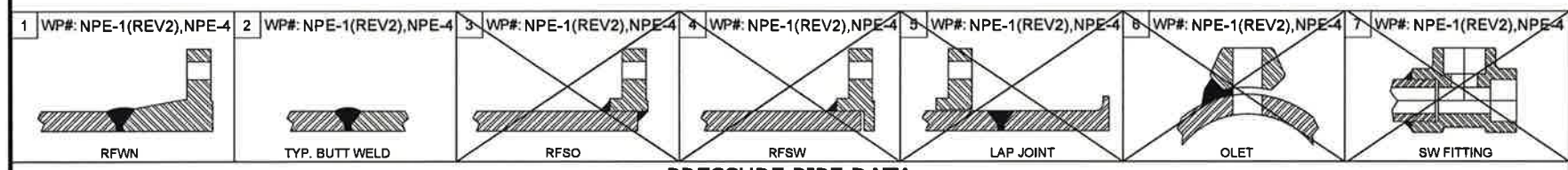
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	2037	2

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE:YY/MM/DD
 SIGNATURE
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GENERAL NOTES

- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCAW ALLOWED BY SHELL.

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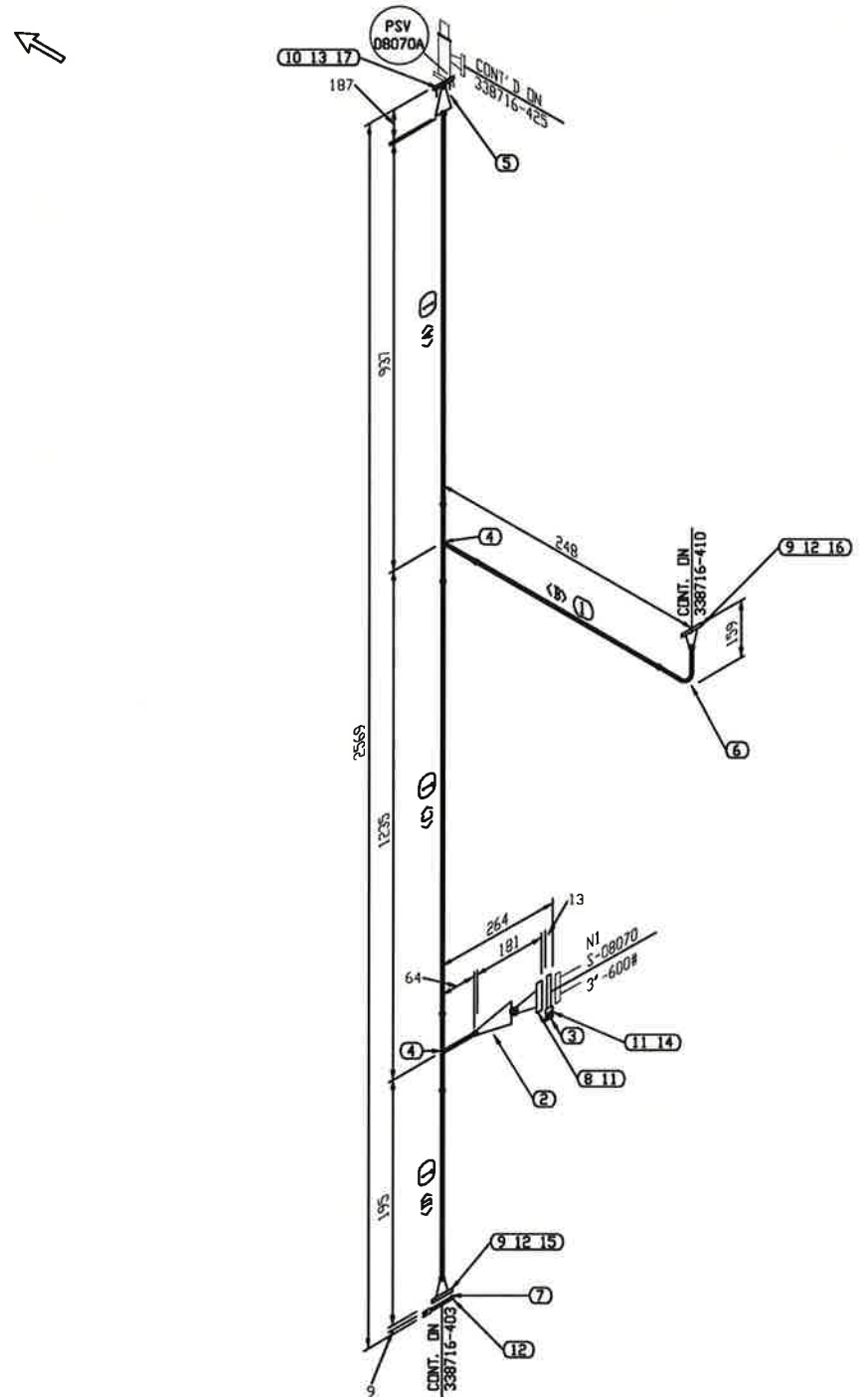


PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

PROJECT NAME: CARMON CREEK PROJECT		CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING	
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2		TAG: 0735A-08030	
SLS#: 338716	QUOTE: CGY2014-85	PO#: 4512-109-130	
DWN: GG	DATE: JUL 04/14	DWO #: 338716-408-Rev0	
CHK: ET	DATE: JUL 04/14		
APP: COG	DATE: JUL 04/14	PAGE: 1 OF 1	CAD: N/A

**GAS TO H-08071
SPOOL DETAIL**



- GENERAL NOTES**
1. ALL DIMENSIONS ARE IN mm U.N.O.
 2. FABRICATION TOLERANCE +/- 3mm U.N.O.
 3. CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 4. ROOT GAP TO BE 1.6mm MAX.
 5. NO FCAW ALLOWED BY SHELL.

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	2117	MM
FITTINGS				
2	3X2	RED CONC, SCH STD/XS, ASTM A420-WPL-6	1	
3	3	RING SPACER, REF. 338716-100 ITEM #3B	1	
4	2X2	TEE, SCH XS, ASTM A420-WPL-6	2	
5	2X1	SWAGE CONC, SCH XS, ASTM A420-WPL-6 BLE PSE	1	
6	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	1	
7	2	SPECTACLE BLIND, REF. 338716-100 ITEM #29A	1	
FLANGES				
8	3	FLG RFWN, 600LB, SCH STD, ASTM A350-LF2-CL.1	1	
9	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL.1	2	
10	1	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL.1	1	

ERECTOR MATERIALS

BILL OF MATERIAL

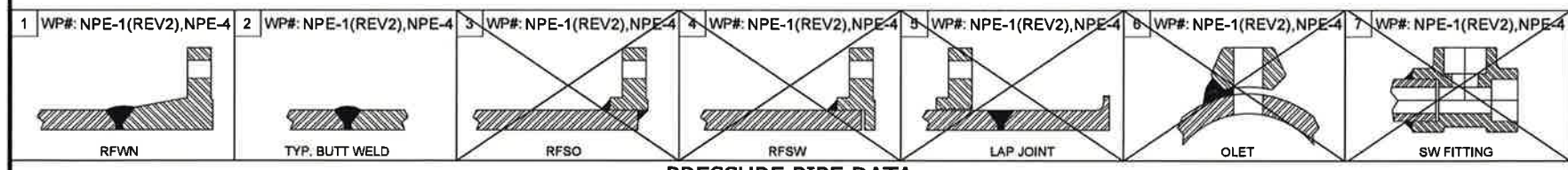
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
11	3	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	2	
12	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	3	
13	1	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
14	3X5 3/4	3/4" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
15	2X5	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
16	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
17	1X3 3/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	870	2
	101	2
<C>	1101	2
<D>	45	2

ISSUED FOR CONSTRUCTION

15/04/15 *NA*
 DATE:YY/MM/DD SIGNATURE
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PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI-RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

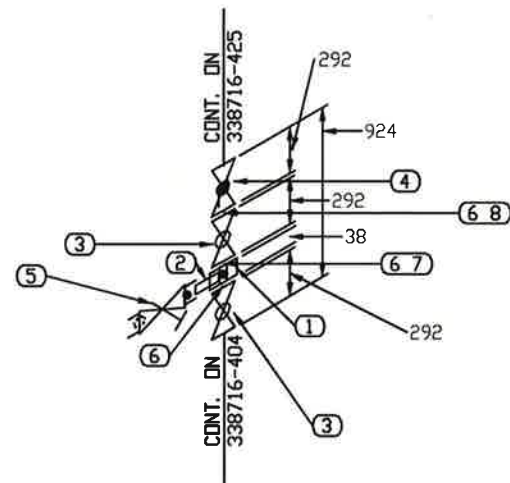
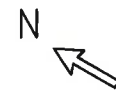
SPOOL DETAIL

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PDR: 4512-109-130
 DWN BY: GG DATE: JUL 04/14 DWO #: 338716-404-Rev1
 CHK BY: ET DATE: JUL 04/14
 APP BY: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A



NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
FITTINGS				
1	2	BLEED RING, REF. 338716-100 ITEM #34	1	
2	3/4	NIPPLE, SCH 160, ASTM A333-6 PBE (4' LG)	1	
VALVES / IN-LINE ITEMS				
3	2	BALL VALVE, FLG, REF. 338716-100 ITEM #21	2	
4	2	GLOBE VALVE, FLG, REF. 338716-100 ITEM #36	1	
5	3/4	GATE VALVE, SW/NPT, REF. 338716-100 ITEM #27	1	

ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
6	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS DR SS OUTER RING	3	
BOLTS				
7	2X6	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
8	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

GENERAL NOTES

- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCAW ALLOWED BY SHELL.

ISSUED FOR CONSTRUCTION

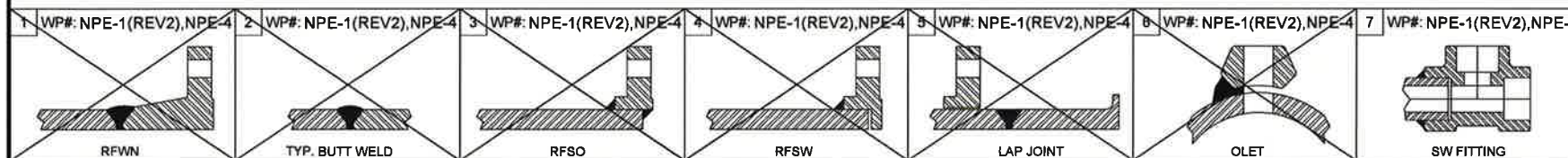
15/04/15
DATE:YY/MM/DD
SIGNATURE

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PROJECT NAME: CARMON CREEK PROJECT			
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING			
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2			
TAG: 0735A-08030			
SLS#: 338716	QUOTE: CGY2014-85	PO#: 4512-109-130	
OWN BY: GG	DATE: JUL 04/14	DWG #: 338716-410-Rev1	
CHK BY: ET	DATE: JUL 04/14		
APP BY: COG	DATE: JUL 04/14	PAGE: 1 OF 1	CAD: N/A

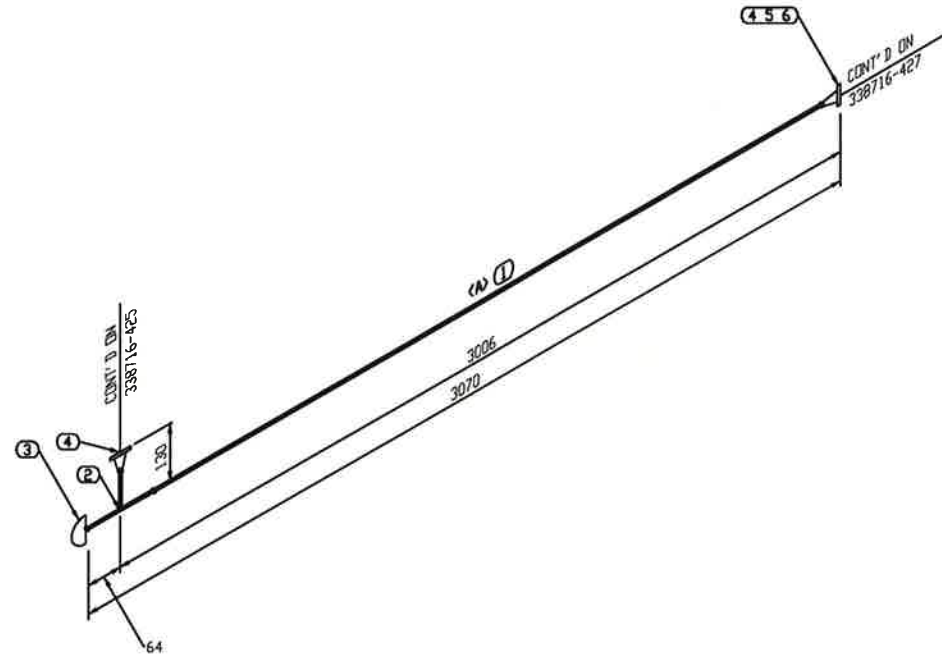


PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	OWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 14/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 28/15

SPOOL DETAIL



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	2873 MM	
FITTINGS				
2	2X2	TEE, SCH XS, ASTM A420-WPL-6	1	
3	2	WELD CAP, SCH XS, ASTM A420-WPL-6	1	
FLANGES				
4	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL. 1	2	

ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
BOLTS				
6	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

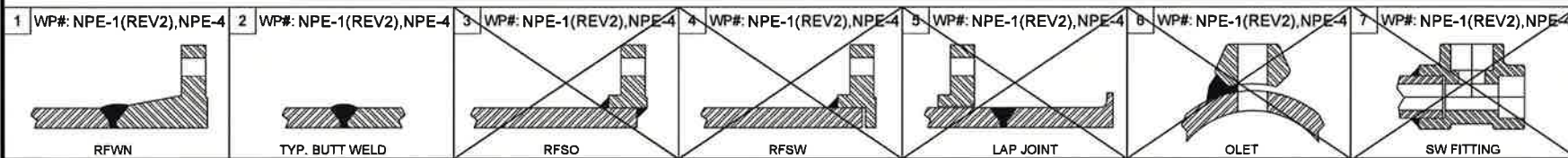
CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	2873	2

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE YY/MM/DD
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GENERAL NOTES

- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX
- NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

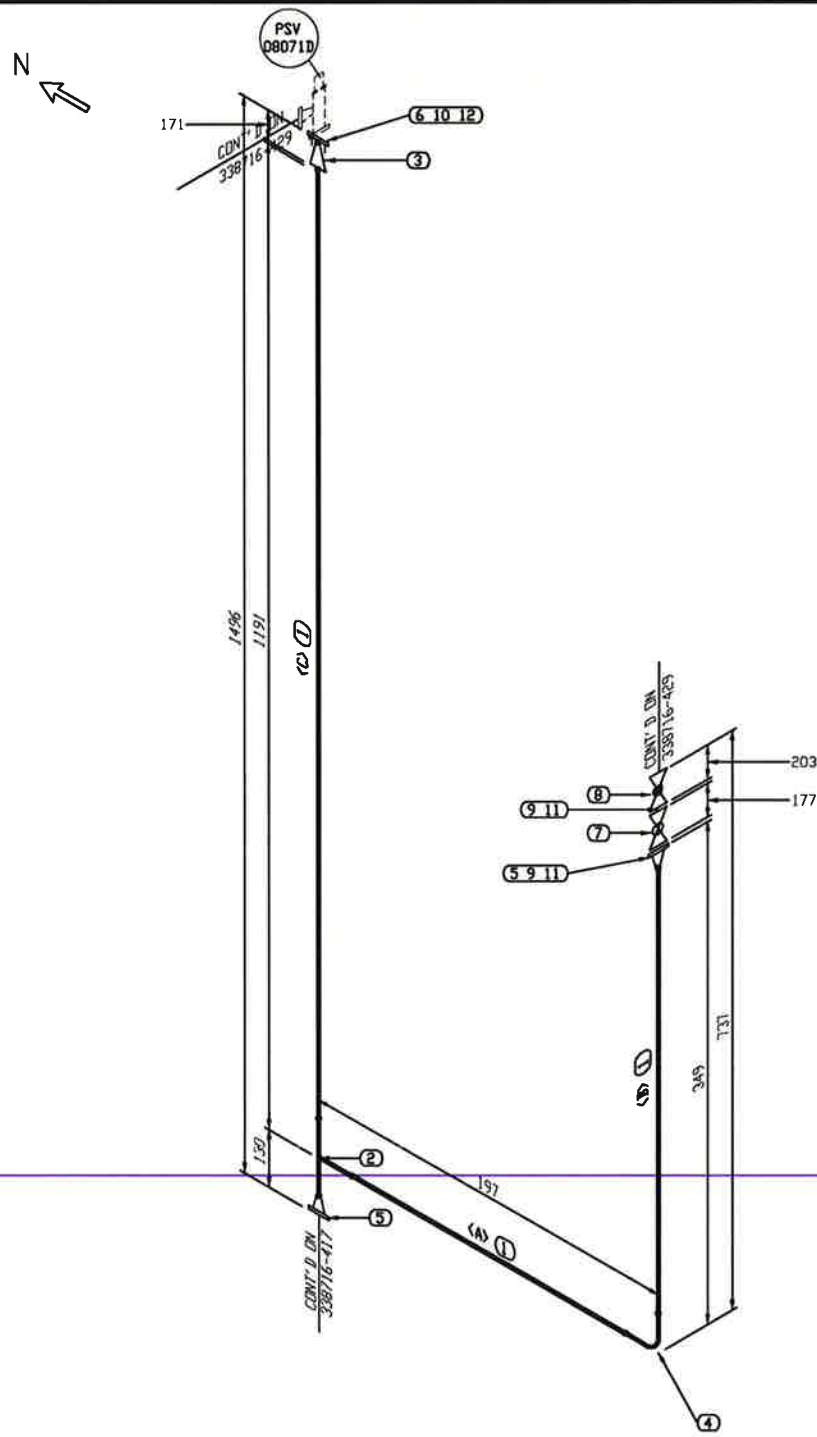
SPOOL DETAIL

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PDR: 4512-109-130

OWNR: GG DATE: JUL 04/14 DWG #: 338716-426-Rev1
 CHK: ET DATE: JUL 04/14
 APP: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A



NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	1377	MM
FITTINGS				
2	2X2	TEE, SCH XS, ASTM A420-WPL-6	1	
3	2X1	SWAGE CONC, SCH XS, ASTM A420-WPL-6 BLE PSE	1	
4	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	1	
FLANGES				
5	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL. 1	2	
6	1	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL. 1	1	
VALVES / IN-LINE ITEMS				
7	2	BALL VALVE, FLG, REF. 338716-100 ITEM #20	1	
8	2	GLOBE VALVE, FLG, REF. 338716-100 ITEM #15A	1	

ERECTION MATERIALS

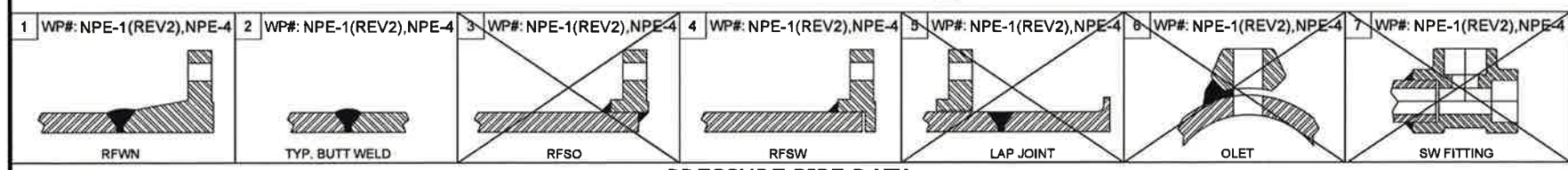
BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
9	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	2	
10	1	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
BOLTS				
11	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
12	1X2 3/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	50	2
	203	2
<C>	1124	2

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX
 - NO FCAW ALLOWED BY SHELL.

ISSUED FOR CONSTRUCTION
15/04/15
DATE:YY/MM/DD
180
SIGNATURE
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PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

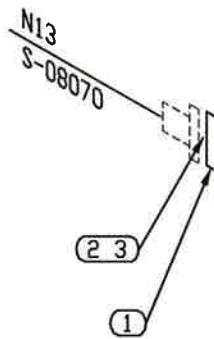
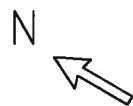
SPOOL DETAIL

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PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

DWN BY: GG DATE: JUL 04/14 DWO #: 338716-428-Rev1
CHK BY: ET DATE: JUL 04/14
APP BY: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
------	------	-------------	-----	-----

VALVES / IN-LINE ITEMS

1	3	FLG BLIND, RF, 600LB, ASTM A350-LF2-CL. 1	1	
---	---	---	---	--

ERECTION MATERIALS

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
------	------	-------------	-----	-----


GASKETS

2	3	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
---	---	--	---	--

BOLTS

3	3X5	3/4" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
---	-----	--	---	--

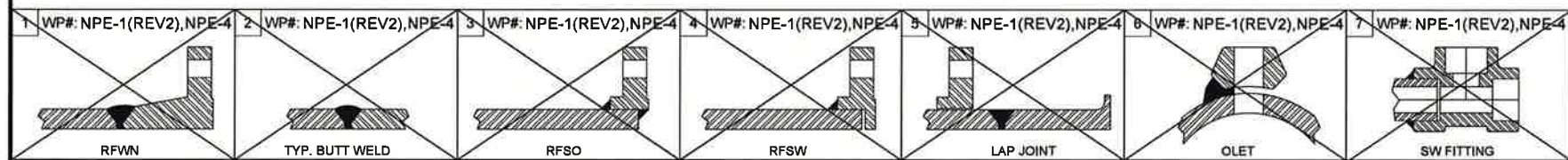
ISSUED FOR CONSTRUCTION

15/04/15 
 DATE:YY/MM/DD SIGNATURE



GENERAL NOTES

- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

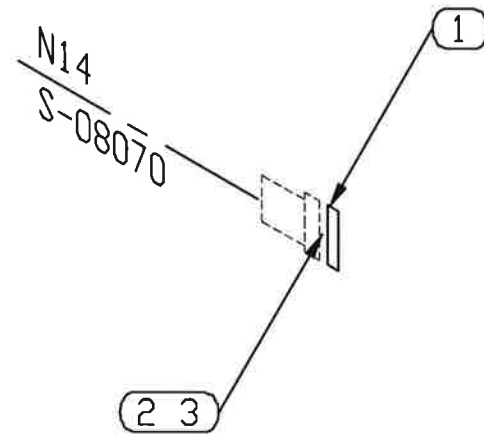
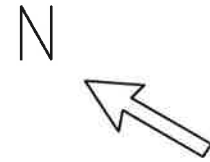
REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

SPOOL DETAIL

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.



PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
 DWN BY: GG DATE: JUL 04/14 DWG #: 338716-434A-Rev1
 CHK BY: ET DATE: JUL 04/14
 APP BY: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#

VALVES / IN-LINE ITEMS

1	2	FLG BLIND, RF, 600LB, ASTM A350-LF2-CL.1	1	
---	---	--	---	--

ERECTOR MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#

GASKETS

2	2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
---	---	--	---	--

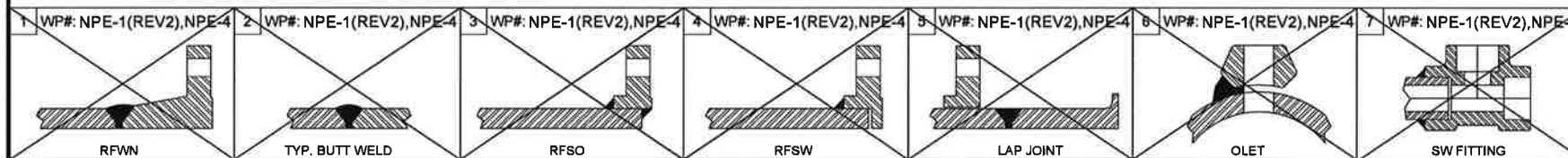
BOLTS

3	2X4 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	
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ISSUED FOR CONSTRUCTION
 15/04/15
 DATE:YY/MM/DD
 SIGNATURE: *[Signature]*
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GENERAL NOTES

- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX
- NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

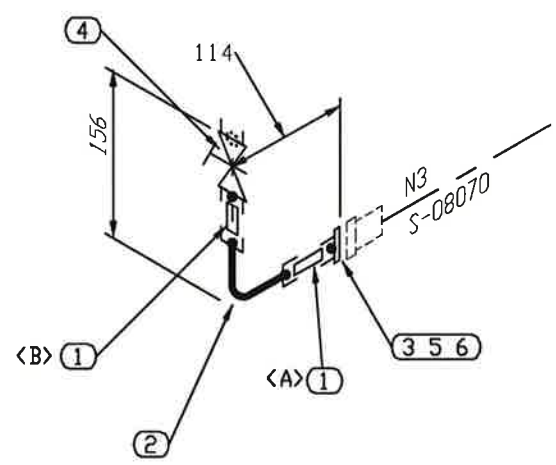
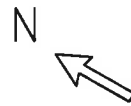
SPOOL DETAIL

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

DWG #: 338716-434B-Rev1
 DWG BY: GG DATE: JUL 04/14
 CHK BY: ET DATE: JUL 04/14
 APP BY: COG DATE: JUL 04/14
 PAGE: 1 OF 1 CAD: N/A



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
△ 1	1/2	PIPE, SMLS, SCH XS, ASTM A333-6	152 MM	
FITTINGS				
2	1/2	90 ELL, SW, 3000LB, ASTM A350-LF2-CL.1	1	
FLANGES				
△ 3	1/2	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL.1	1	
VALVES / IN-LINE ITEMS				
4	1/2	GATE VALVE, SW/NPT, REF. 338716-100 ITEM #32	1	

ERECTION MATERIALS

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	1/2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
6	1/2X3 1/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	76	1/2
	76	1/2

ISSUED FOR CONSTRUCTION!

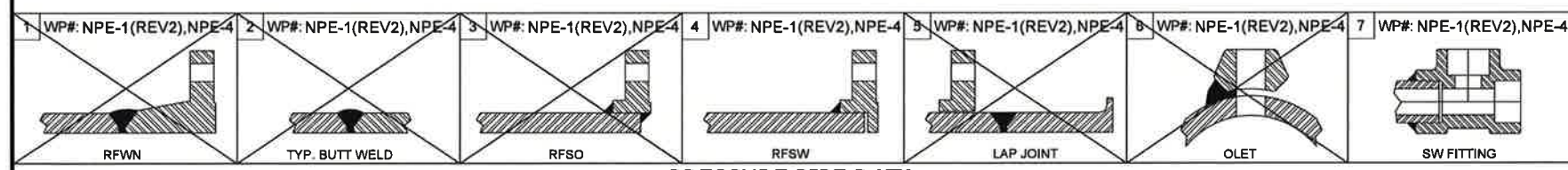
15/04/15

DATE:YY/MM/DD

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SIGNATURE

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - RQOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED #1 FROM NIPPLE TO PIPE, SCHEDULE OF #3 & NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

SPOOL DETAIL

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.

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PROJECT NAME: CARMON CREEK PROJECT

CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING

LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

TAG: 0735A-08030

SLS#: 338716 QUOTE: CGY2014-85 PDF: 4512-109-130

OWN: GG DATE: JUL 04/14 DWD #: 338716-435-Rev1

DW: ET DATE: JUL 04/14

APP: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A

BILL OF MATERIAL

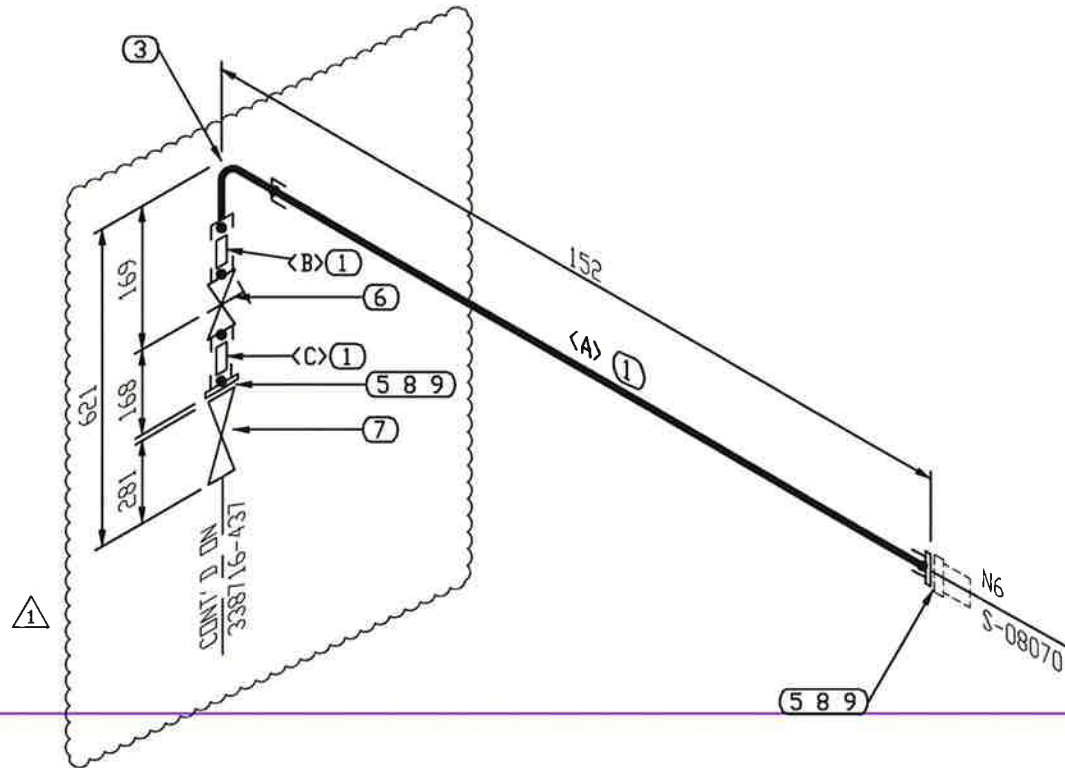
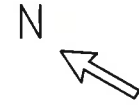
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
△ 1	1	PIPE, SMLS, SCH XS, ASTM A333-6	310 MM	
FITTINGS				
△ 2	-	REMOVED	-	
3	1	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
FLANGES				
△ 4	-	REMOVED	-	
△ 5	1	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	2	
VALVES / IN-LINE ITEMS				
6	1	GATE VALVE, SW, REF. 338716-100 ITEM #23	1	
INSTRUMENTS				
7	1	CHOKER VALVE, FLG, REF. 338716-100 ITEM #2	1	

ERECTION MATERIALS

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
8	1	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	2	
BOLTS				
9	1X3 3/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	106	1
	102	1
<C>	102	1



ISSUED FOR CONSTRUCTION

15/04/15
DATE:YY/MM/DD

SIGNATURE
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- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT

CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING

LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

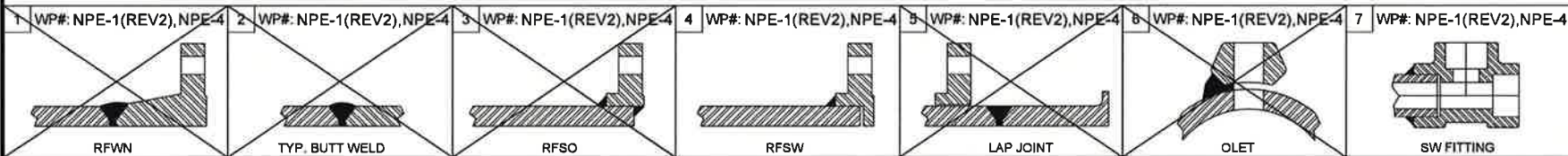
TAG: 0735A-08030

SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

DNBY: GG DATE: JUL 04/14 DMD#: 338716-436-Rev1

CHK BY: ET DATE: JUL 04/14

APP BY: COG DATE: JUL 04/14 PAGE: 1 OF 1 GRD: N/A

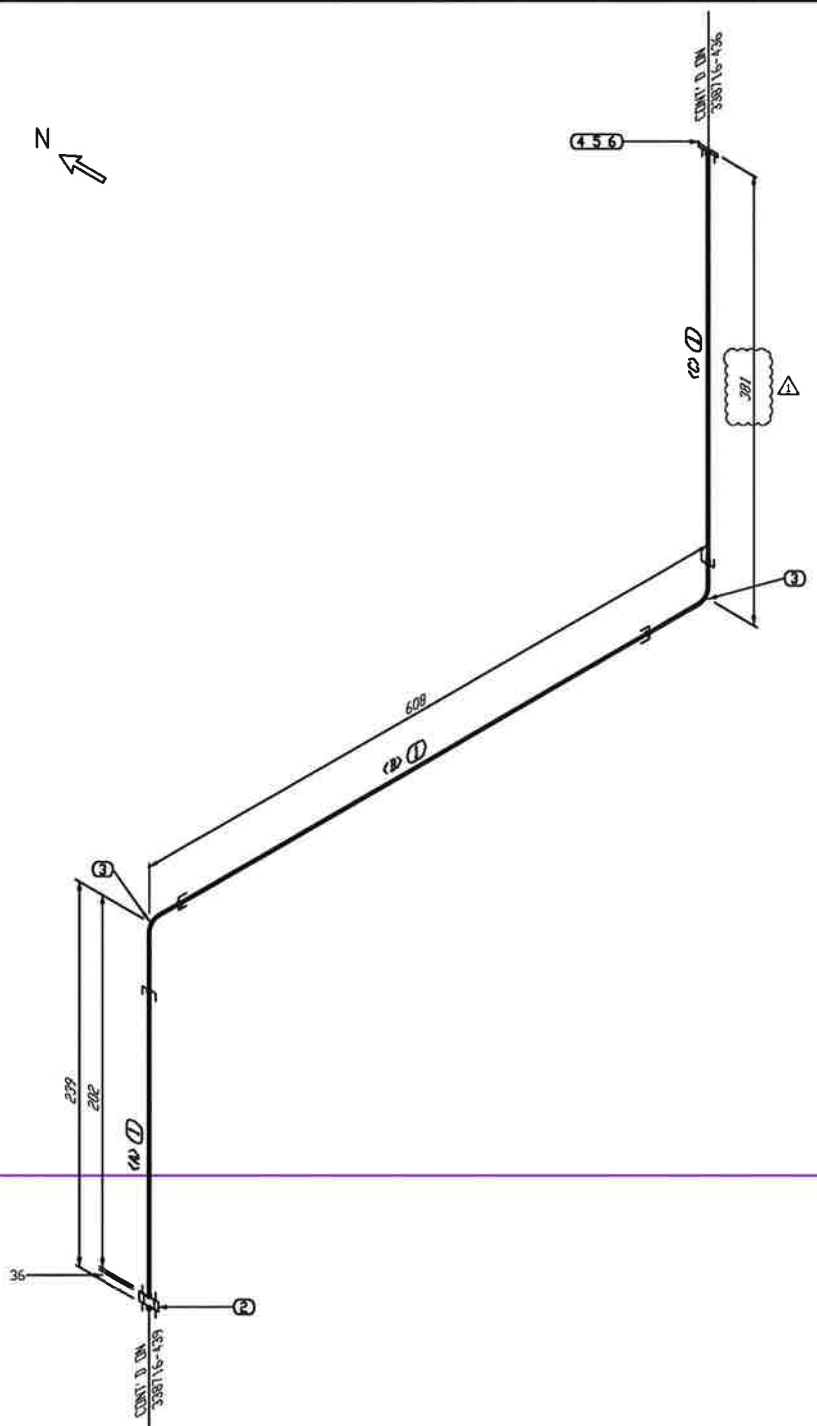


PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

SPOOL DETAIL

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED QTY OF #1 & 5 AND NOTES; REMOVED #2 & 4	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
△ 1	1	PIPE, SMLS, SCH XS, ASTM A333-6	1072 MM	
FITTINGS				
2	1	UNION, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
3	1	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	2	
FLANGES				
4	1	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	1	

ERECTOR MATERIALS

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	1	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
6	1X3 3/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	177	1
	560	1
△ <C>	335	1

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

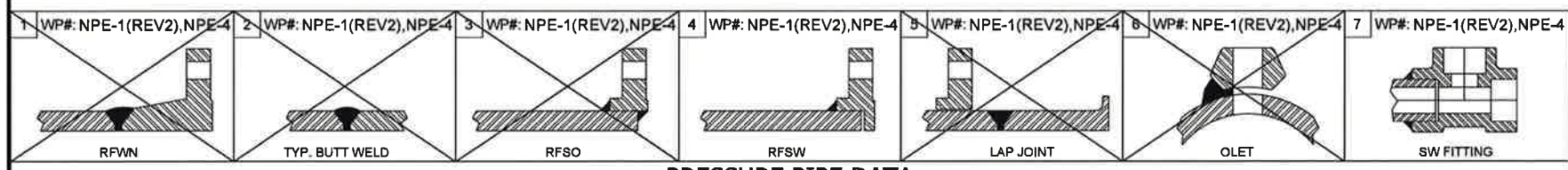
ISSUED FOR CONSTRUCTION

15/04/15

DATE/Y/M/WD

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SIGNATURE



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	OWN	CHK	APP	DATE
1	CHANGED QTY OF #1 & NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

SPOOL DETAIL

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.

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PROJECT NAME: CARMON CREEK PROJECT

CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING

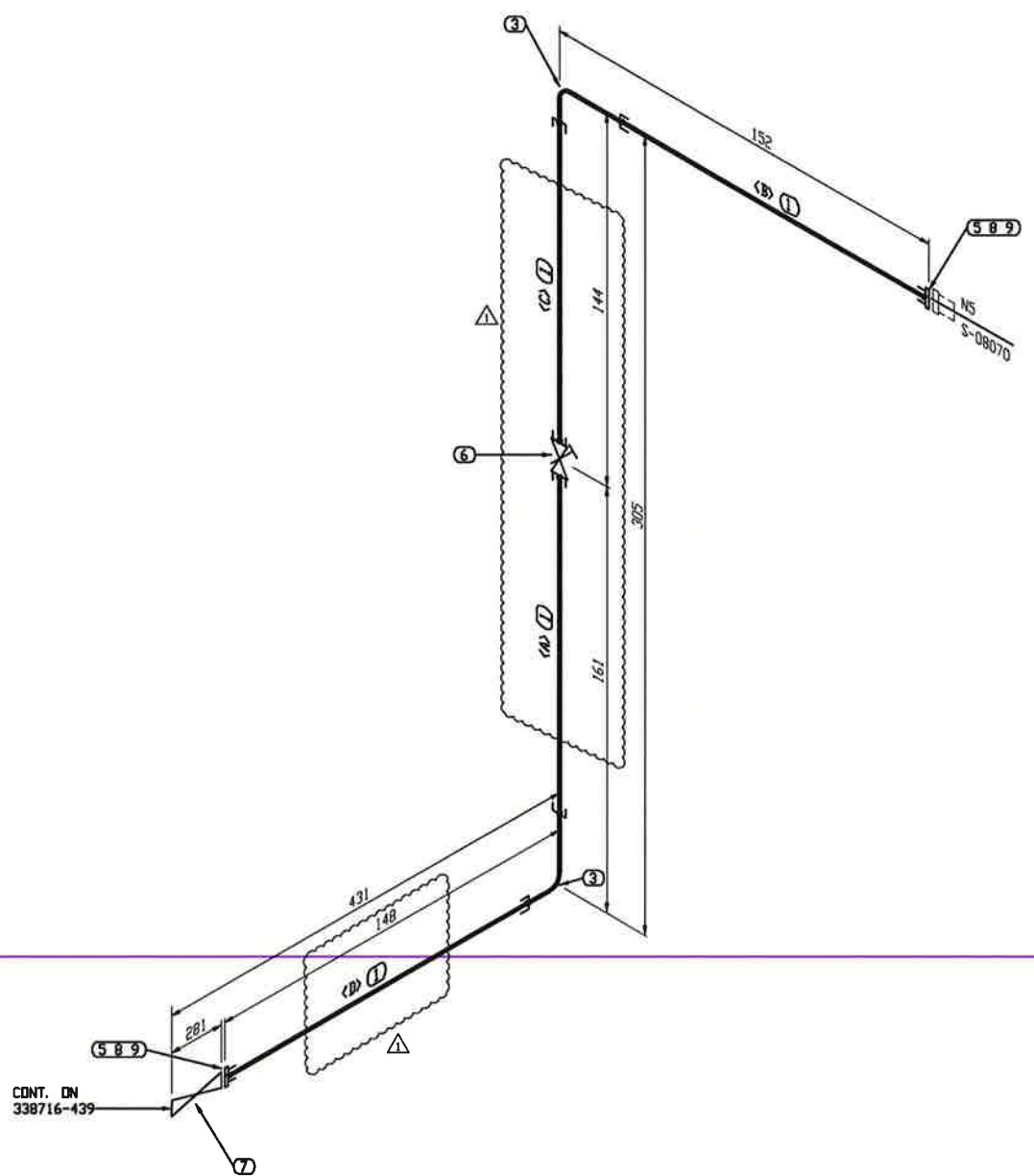
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

TAG: 0735A-08030

SL# 338716 QUOTE: CGY2014-85 PG# 4512-109-130

DWG BY: GG	DATE: JUL 04/14	DWG #:	338716-437-Rev1
CHK BY: ET	DATE: JUL 04/14		
APP BY: COG	DATE: JUL 04/14	PAGE: 1 OF 1	

CAD: N/A



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	1	PIPE, SMLS, SCH XS, ASTM A333-6	377 MM	
FITTINGS				
2	-	REMOVED	-	
3	1	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	2	
4	-	REMOVED	-	
FLANGES				
5	1	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	2	
5A	-	REMOVED	-	
VALVES / IN-LINE ITEMS				
6	1	GATE VALVE, SW, REF. 338716-100 ITEM #23	1	
INSTRUMENTS				
7	1	CHOKE VALVE, FLG, REF. 338716-100 ITEM #2	1	

ERECTION MATERIALS

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
8	1	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	2	
BOLTS				
9	1X3 3/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	93	1
	106	1
<C>	76	1
<D>	101	1

GENERAL NOTES

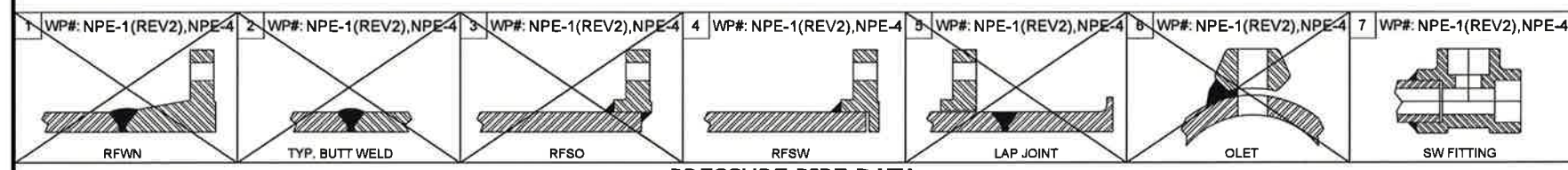
- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCAW ALLOWED BY SHELL.

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 DATE:YY/MM/DD
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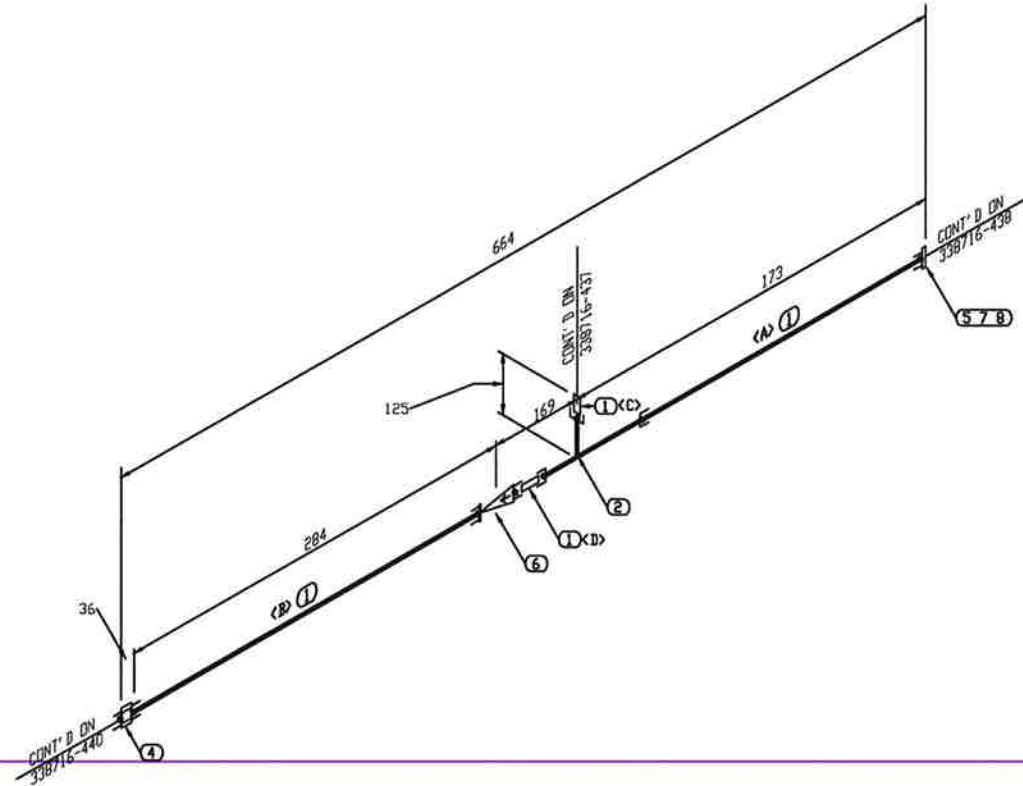
PROJECT NAME:	CARMON CREEK PROJECT
CUSTOMER:	SHELL CANADA c/o JACOBS ENGINEERING
LOCATION:	CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG:	0735A-08030
SLS#: 338716	QUOTE: CGY2014-85
PO#: 4512-109-130	
DWNR: GG	DATE: JUL 04/14
CHKR: ET	DATE: JUL 04/14
APPY: COG	DATE: JUL 04/14
DWG #:	338716-438-Rev1
PAGE:	1 OF 1
CAD:	N/A



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

SPOOL DETAIL



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
△ 1	1	PIPE, SMLS, SCH XS, ASTM A333-6	571 MM	
FITTINGS				
2	1X1	TEE, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
△ 3		REMOVED		
4	1	UNION, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
FLANGES				
5	1	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	1	
VALVES / IN-LINE ITEMS				
6	1	CHECK VALVE, SW, REF. 338716-100 ITEM #28	1	

ERECTION MATERIALS

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
7	1	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
8	1X3 3/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

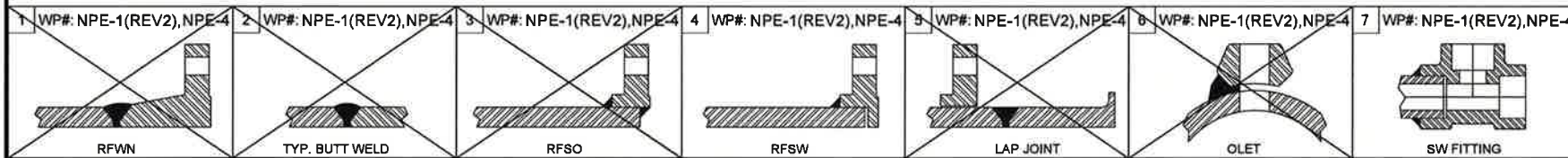
CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	127	1
	240	1
<C>	102	1
<D>	102	1

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE:YY/MM/DD
 natpro
 SIGNATURE

GENERAL NOTES

- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

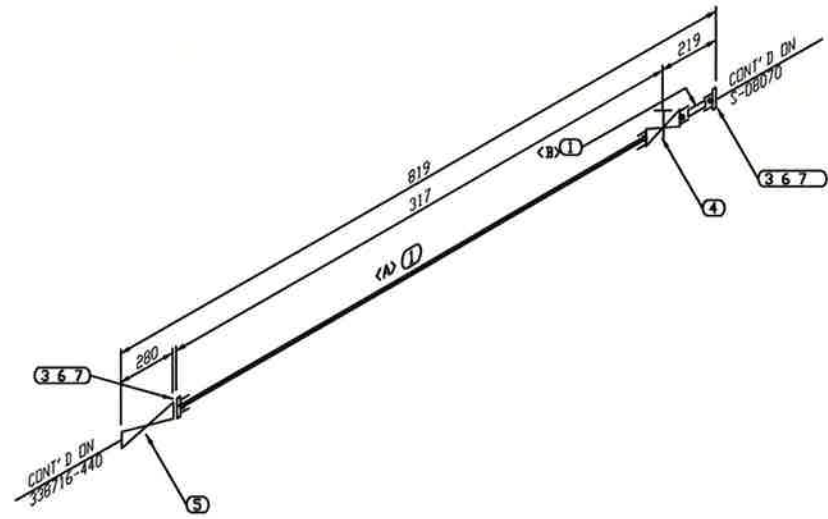
SPOOL DETAIL

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	ADDED 1<C> & 1<D>, REMOVED #3, CHANGED QTY OF #1 & NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 28/15

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
 DWN: GG DATE: JUL 04/14 DWG #: 338716-439-Rev1
 CHK: ET DATE: JUL 04/14
 APP: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
△ 1	1	PIPE, SMLS, SCH XS, ASTM A333-6	403 MM	
FITTINGS				
△ 2	-	REMOVED	-	
FLANGES				
△ 3	1	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL 1	2	
△ 3A	-	REMOVED	-	
VALVES / IN-LINE ITEMS				
4	1	GATE VALVE, SW, REF. 338716-100 ITEM #23	1	
INSTRUMENTS				
5	1	CHOKE VALVE, FLG, REF. 338716-100 ITEM #2	1	

ERECTION MATERIALS

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
6	1	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	2	
BOLTS				
7	1X3 3/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	8	

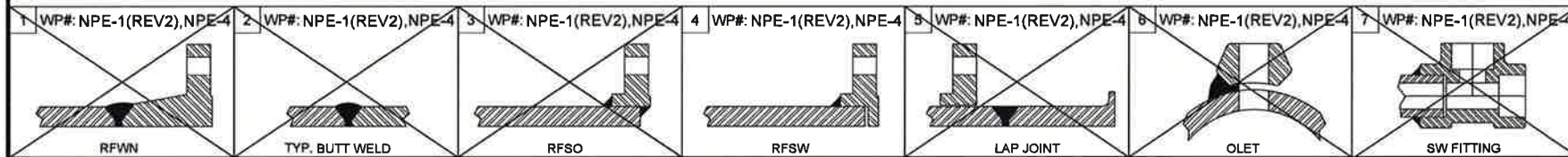
CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	250	1
△ 	153	1

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE:YY/MM/DD
 natpro
 SIGNATURE

GENERAL NOTES

- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

SPOOL DETAIL

1	ADDED 1, REMOVED #2&3A, CHANGED QTY #1&3 AND NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15
REV	DESCRIPTION	DWN	CHK	APP	DATE

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
 DWN BY: GG DATE: JUL 04/14 DWS #: 338716-441-Rev1
 DKB BY: ET DATE: JUL 04/14
 APP BY: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	1/2	PIPE, SMLS, SCH XS, ASTM A333-6	76 MM	
FLANGES				
2	1/2	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	1	
VALVES / IN-LINE ITEMS				
3	1/2	GATE VALVE, SW/NPT, REF. 338716-100 ITEM #32	1	

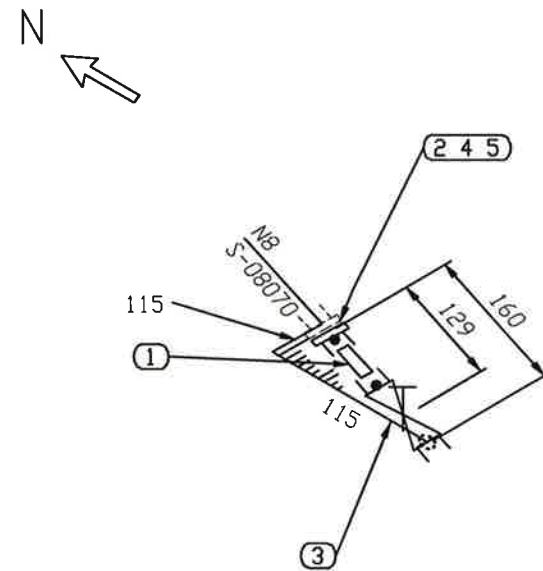
ERECTION MATERIALS

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
4	1/2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
5	1/2X3 1/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	76	1/2



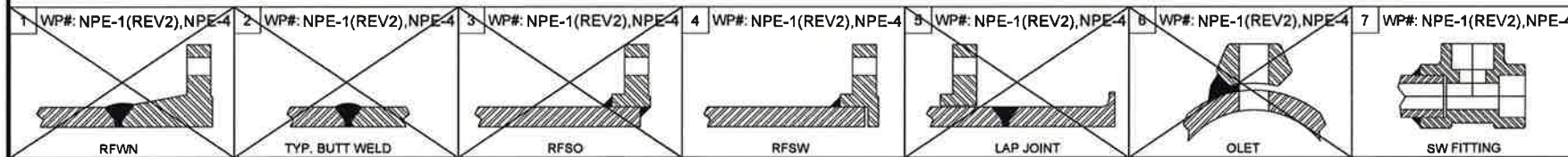
ISSUED FOR CONSTRUCTION

15/04/15
DATE:YY/MM/DD

natpro

GENERAL NOTES

- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

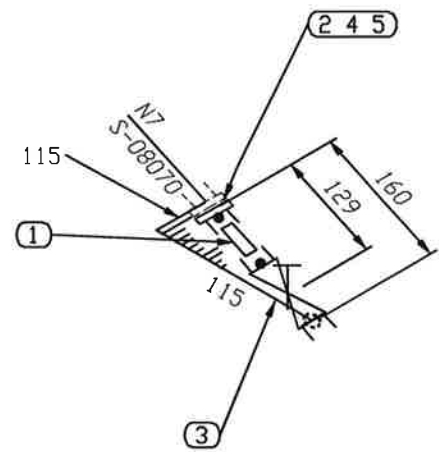
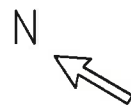
REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED #1 FROM NIPPLE TO PIPE & NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 28/15

SPOOL DETAIL

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
 DWN: GG DATE: JUL 04/14 DWG #: 338716-449-Rev1
 CHK: ET DATE: JUL 04/14
 APP: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	1/2	PIPE, SMLS, SCH XS, ASTM A333-6	76 MM	
FLANGES				
2	1/2	FLG RFSW, 600LB, SCH XS, ASTM A350-LF2-CL. 1	1	
VALVES / IN-LINE ITEMS				
3	1/2	GATE VALVE, SW/NPT, REF. 338716-100 ITEM #32	1	

ERECTION MATERIALS

BILL OF MATERIAL

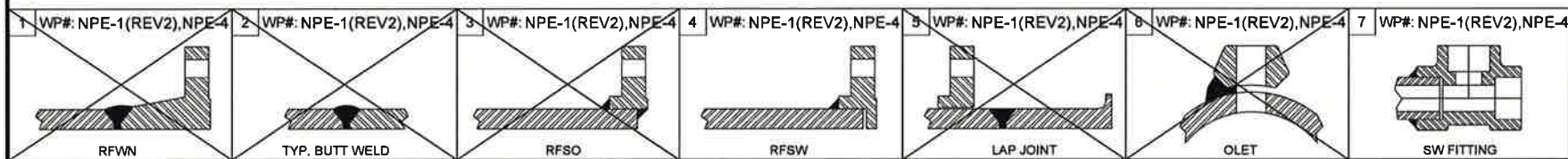
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
4	1/2	GASKET, 600LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
5	1/2X3 1/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	76	1/2

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE: YYMMDD
 SIGNATURE: *[Signature]*
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- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.



PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93 °C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED #1 FROM NIPPLE TO PIPE & NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 26/15

SPOOL DETAIL

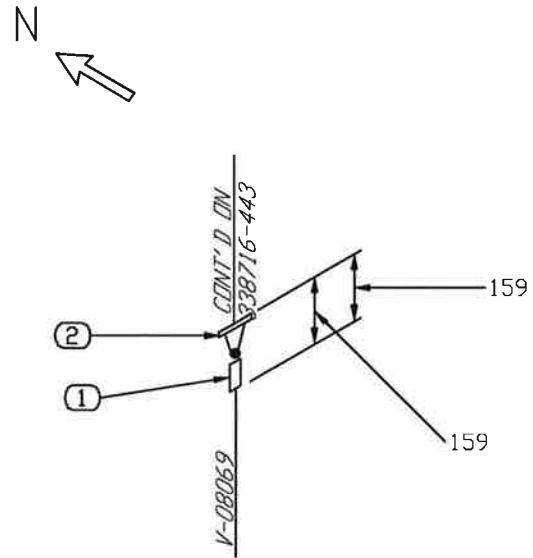
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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
 DWG#: 338716-450-Rev1
 DATE: JUL 04/14
 APPBY: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
<u>FITTINGS</u>				
1	2	NIPPLE, SCH XS, ASTM A333-6 BDE TOE (3' LG)	1	
<u>FLANGES</u>				
2	2	FLG RFWN, 600LB, SCH XS, ASTM A350-LF2-CL. 1	1	



ISSUED FOR CONSTRUCTION

15/04/15

DATE: YY/MM/DD

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GENERAL NOTES

1. ALL DIMENSIONS ARE IN mm U.N.O.
2. FABRICATION TOLERANCE +/- 3mm U.N.O.
3. CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
4. ROOT GAP TO BE 1.6mm MAX.
5. NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT

CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING

LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

TAG: 0735A-08030

SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

OWN BY: GG DATE: JUL 04/14 DWG #: 338716-444-Rev1

CHK BY: ET DATE: JUL 04/14

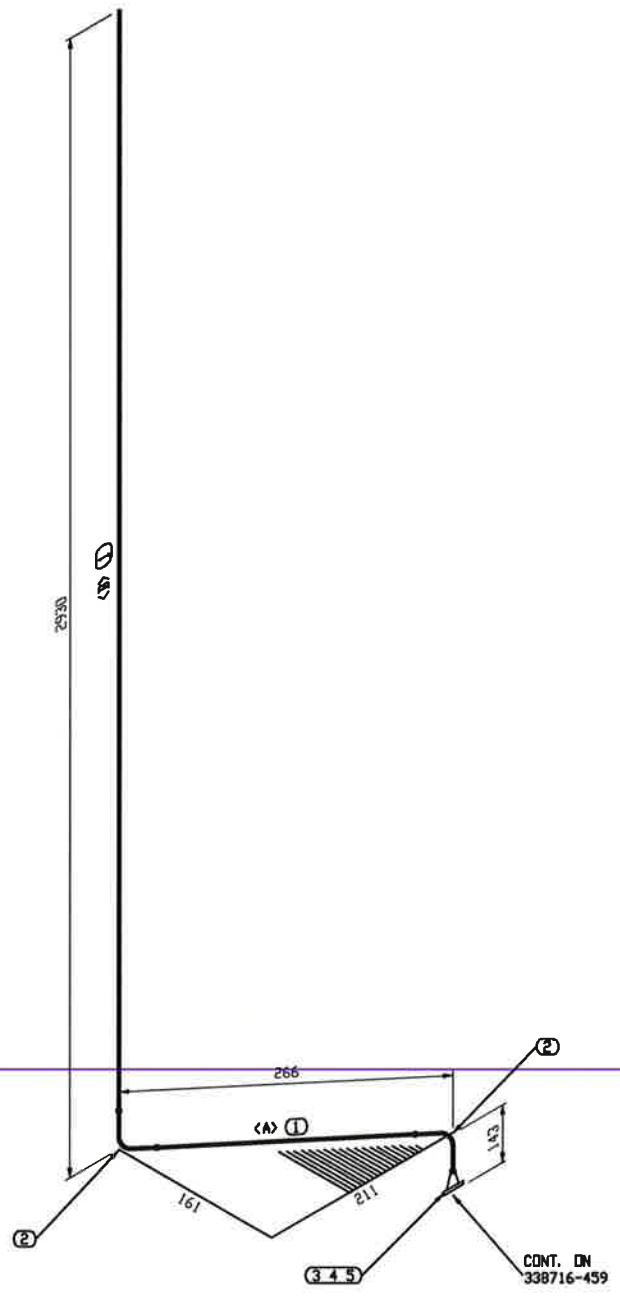
APP BY: COG DATE: JUL 04/14 PAGE: 1 OF 1 CAD: N/A

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RFWN		TYP. BUTT WELD		RFSO		RFSW		LAP JOINT		OLET		SW FITTING	

PRESSURE PIPE DATA

SPECIFICATION: SHELL D20W CLASS 600	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 100% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 2220 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 1360 PSIG @ 93°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 93°C	MPI / LPI EXTENT %: (SW) 10%MPI+RT ON JOINT GAP, 1/8" MAX. AFTER WELDING	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

V-08069 INLET
SPOOL DETAIL



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
<u>PIPE</u>				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	2958 MM	
<u>FITTINGS</u>				
2	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	2	
<u>FLANGES</u>				
3	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL.1	1	

ERECTION MATERIALS

BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	HT#
<u>GASKETS</u>				
4	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
<u>BOLTS</u>				
5	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

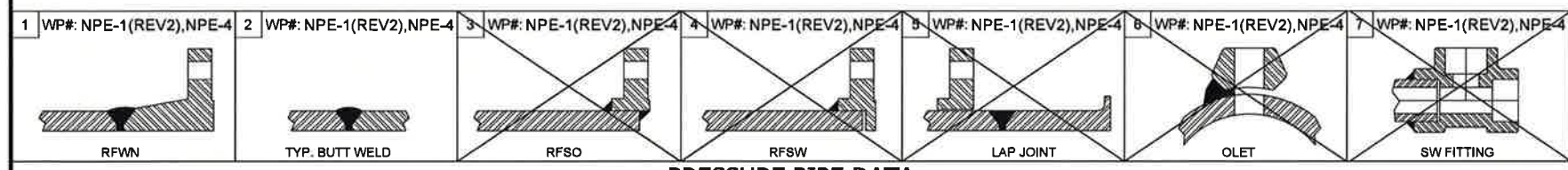
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	107	2
	2851	2

ISSUED FOR CONSTRUCTION

15/04/15 *AS*

DATE: YY/MM/DD SIGNATURE: E

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PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT

CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING

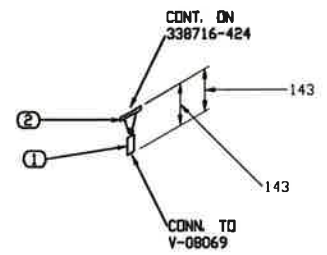
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

TAG: 0735A-08030

SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

DRN: LK	DATE: APR 06/15	DWG #: 338716-424-Rev0
CHK: AA	DATE: APR 09/15	
APP: AA	DATE: APR 09/15	PAGE: 1 OF 1 CAD: N/A

ISSUED FOR CONSTRUCTION	LK	AA	AA	APR 09/15
DESCRIPTION	DWN	CHK	APP	DATE
V-08069 VENT OUTLET SPOOL DETAIL				

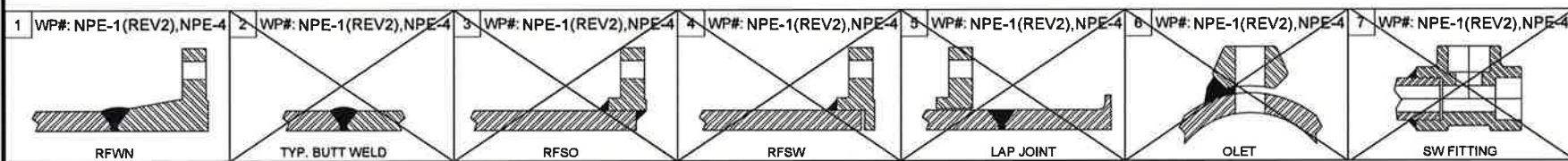


BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
<u>FITTINGS</u>				
1	2	NIPPLE, SCH XS, ASTM A333-6 BDE TDE (3' LG)	1	
<u>FLANGES</u>				
2	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL. 1	1	

ISSUED FOR CONSTRUCTION

15/04/15 *AA*
 DATE:YY/MM/DD SIGN

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PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

GENERAL NOTES

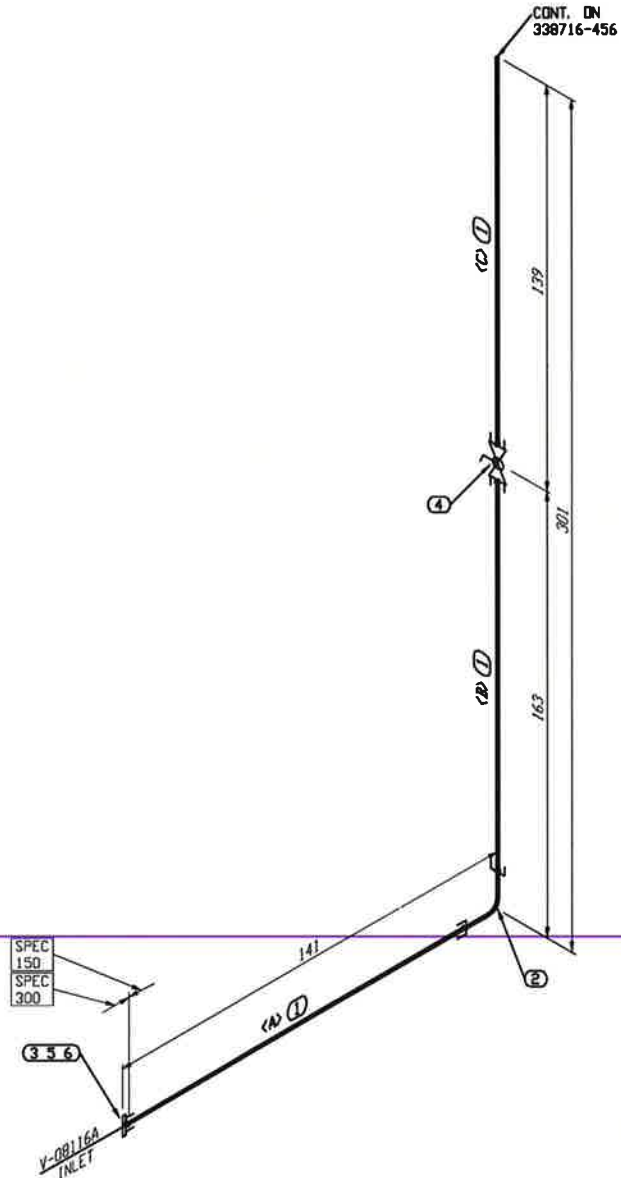
1. ALL DIMENSIONS ARE IN mm U.N.O.
2. FABRICATION TOLERANCE +/- 3mm U.N.O.
3. CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
4. ROOT GAP TO BE 1.6mm MAX.
5. NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030

SLS#: 338716	QUOTE: CGY2014-85	PO#: 4512-109-130
DWN: LK	DATE: APR 06/15	DWG #: 338716-459-Rev0
CHK: AA	DATE: APR 09/15	PAGE: 1 OF 1
APP: AA	DATE: APR 09/15	CAD: N/A

ISSUED FOR CONSTRUCTION				
DESCRIPTION	DWN	CHK	APP	DATE
V-08069 VENT OUTLET SPOOL DETAIL				APR 09/15



NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	1	PIPE, SMLS, SCH XS, ASTM A333-6	304 MM	
FITTINGS				
2	1	90 ELL, SW, 3000LB, ASTM A350-LF2-CL.1	1	
FLANGES				
3	1	FLG RFSW, 300LB, SCH XS, ASTM A350-LF2-CL.1	1	
VALVES / IN-LINE ITEMS				
4	1	BALL VALVE, SW, REF. 338716-100 ITEM #24	1	

ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	1	GASKET, 300LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
6	1X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

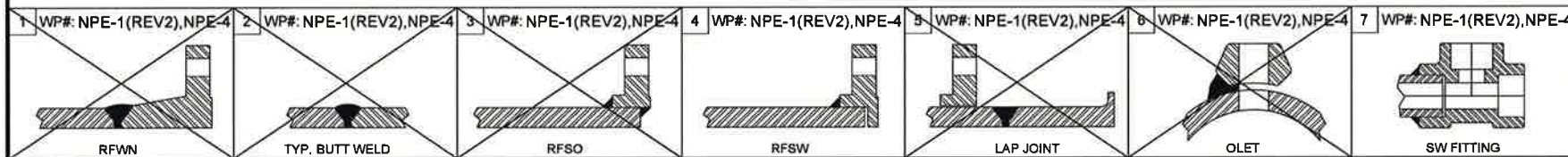
CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	102	1
	101	1
<C>	101	1

ISSUED FOR CONSTRUCTION

15/04/15
DATE:YY/MM/DD

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PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

GENERAL NOTES

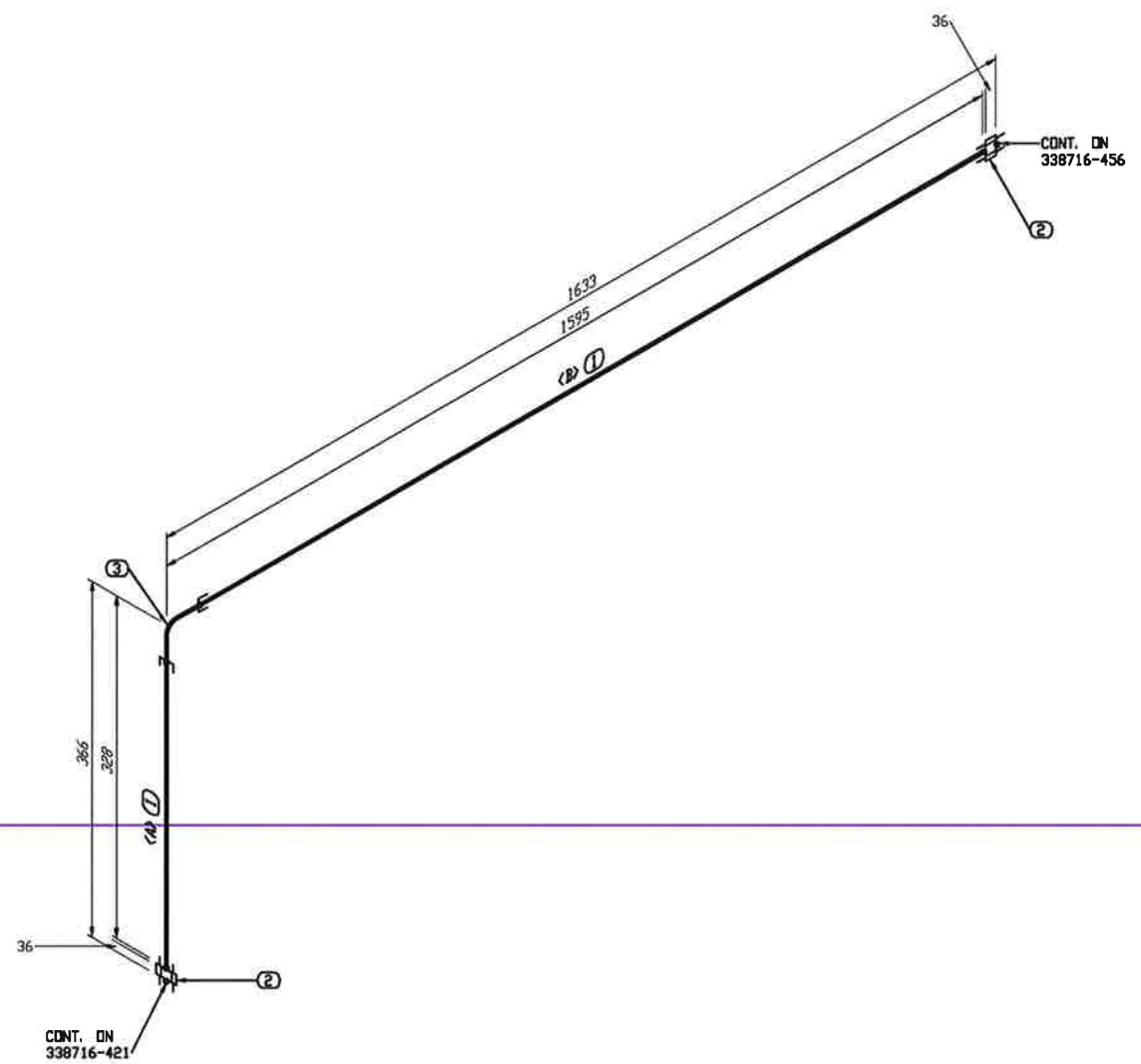
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- FABRICATION TOLERANCE +/- 3mm U.N.O.
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- NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PDR: 4512-109-130
 DWN: LK DATE: APR 06/15 DNG#: 338716-432-Rev0
 CHK: AA DATE: APR 09/15
 APP: AA DATE: APR 09/15 PAGE: 1 OF 1 CAD: N/A

V-08116A INLET
SPOOL DETAIL



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	1	PIPE, SMLS, SCH XS, ASTM A333-6	1875 MM	
FITTINGS				
2	1	UNION, SW, 3000LB, ASTM A350-LF2-CL. 1	2	
3	1	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	1	

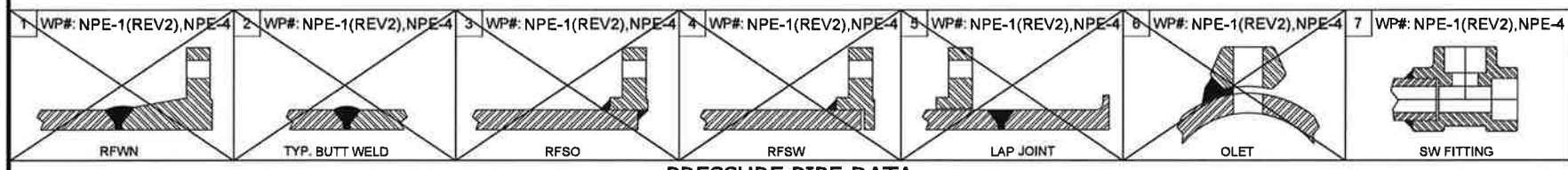
CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	304	1
	1571	1

ISSUED FOR CONSTRUCTION

15/04/15

DATE:YY/MM/DD

natpro



- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

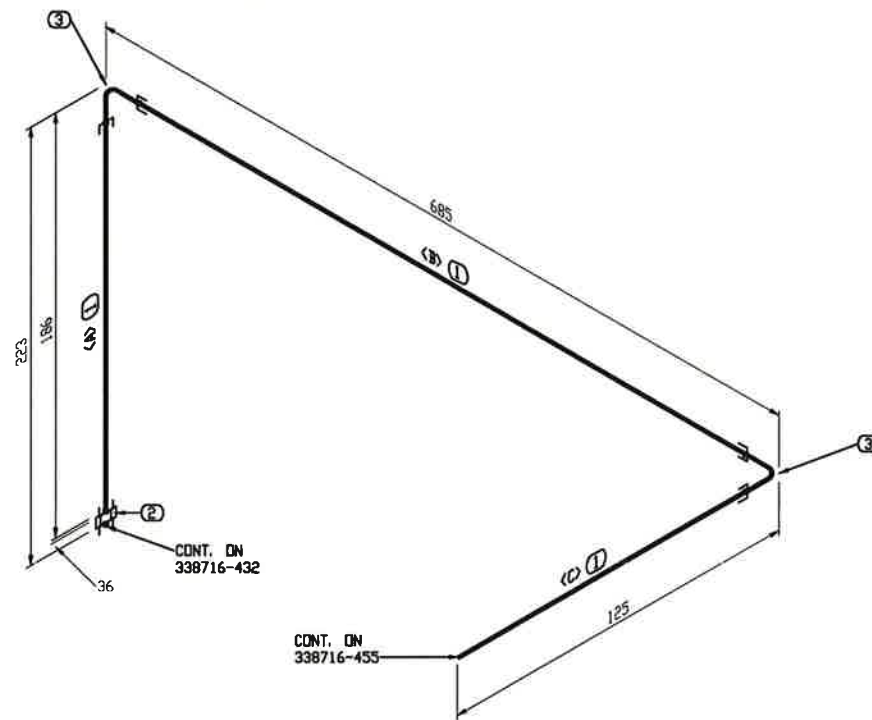
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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PDR# 4512-109-130
 DWN BY: LK DATE: APR 06/15 DWG #: 338716-455-Rev0
 DWN BY: AA DATE: APR 09/15
 APP BY: AA DATE: APR 09/15 PAGE: 1 OF 1 CAD: N/A

PRESSURE PIPE DATA		
SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	DWN	CHK	APP	DATE
0	ISSUED FOR CONSTRUCTION	LK	AA	AA	APR 09/15

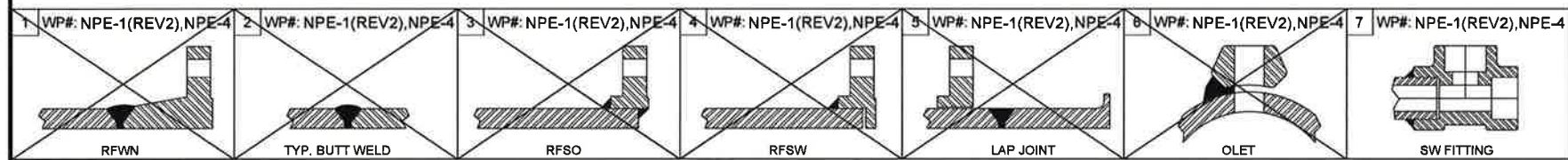
V-08116A INLET
SPOOL DETAIL



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	1	PIPE, SMLS, SCH XS, ASTM A333-6	900 MM	
FITTINGS				
2	1	UNION, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
3	1	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	2	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	162	1
	637	1
<C>	101	1

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE:YY/MM/DD
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- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

PRESSURE PIPE DATA		
SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CJ M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030

SLS#: 338716 QUOTE: CGY2014-85 PDR# 4512-109-130

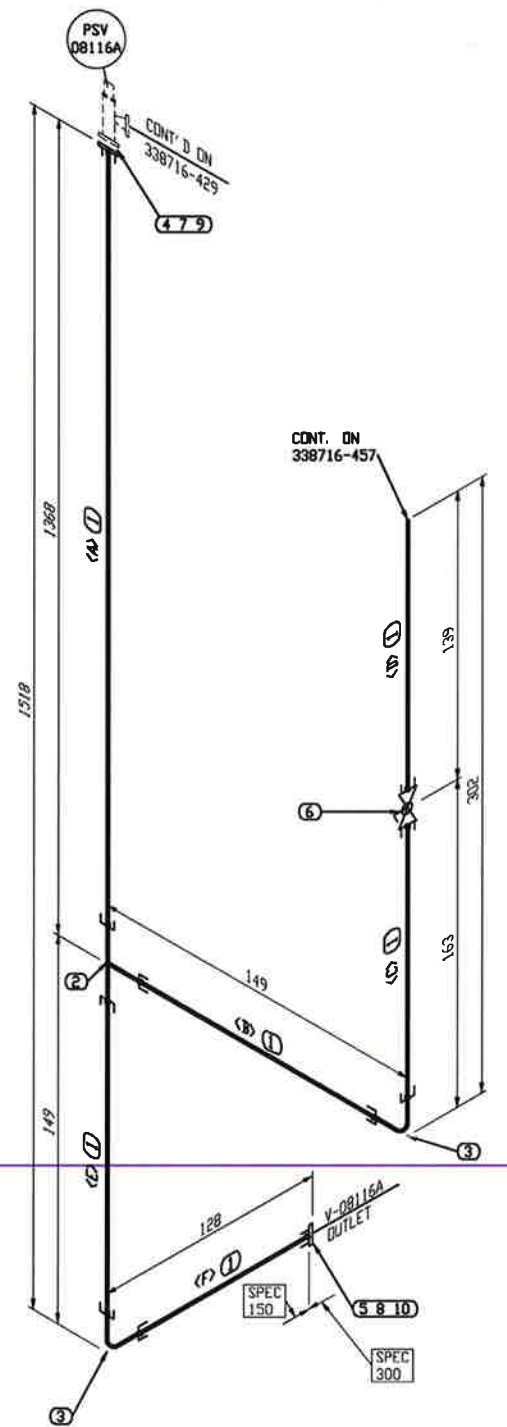
DWG #: 338716-456-Rev0

DATE: APR 06/15
 DATE: APR 09/15
 DATE: APR 09/15

APP BY: AA

PAGE: 1 OF 1 CAD: N/A

DESCRIPTION	DWN	CHK	APP	DATE
ISSUED FOR CONSTRUCTION				APR 09/15
V-08116A INLET SPOOL DETAIL				



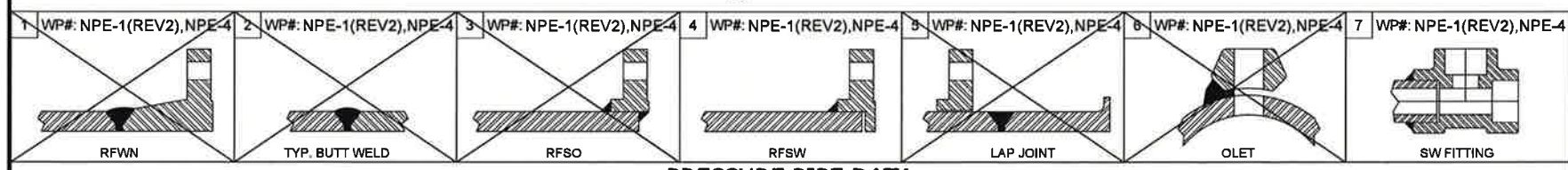
NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	1	PIPE, SMLS, SCH XS, ASTM A333-6	1833 MM	
FITTINGS				
2	1X1	TEE, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
3	1	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	2	
FLANGES				
4	1	FLG RFSW, 150LB, SCH XS, ASTM A350-LF2-CL. 1	1	
5	1	FLG RFSW, 300LB, SCH XS, ASTM A350-LF2-CL. 1	1	
VALVES / IN-LINE ITEMS				
6	1	BALL VALVE, SW, REF. 338716-100 ITEM #24	1	

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
7	1	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
8	1	GASKET, 300LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 304 SS INNER RING, CS OR SS OUTER RING	1	
BOLTS				
9	1X3 1/4	1/2" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	
10	1X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	1338	1
	101	1
<C>	102	1
<D>	102	1
<E>	102	1
<F>	88	1

ISSUED FOR CONSTRUCTION
15/04/15
DATE:YY/MM/DD
natpro
SIGNATURE



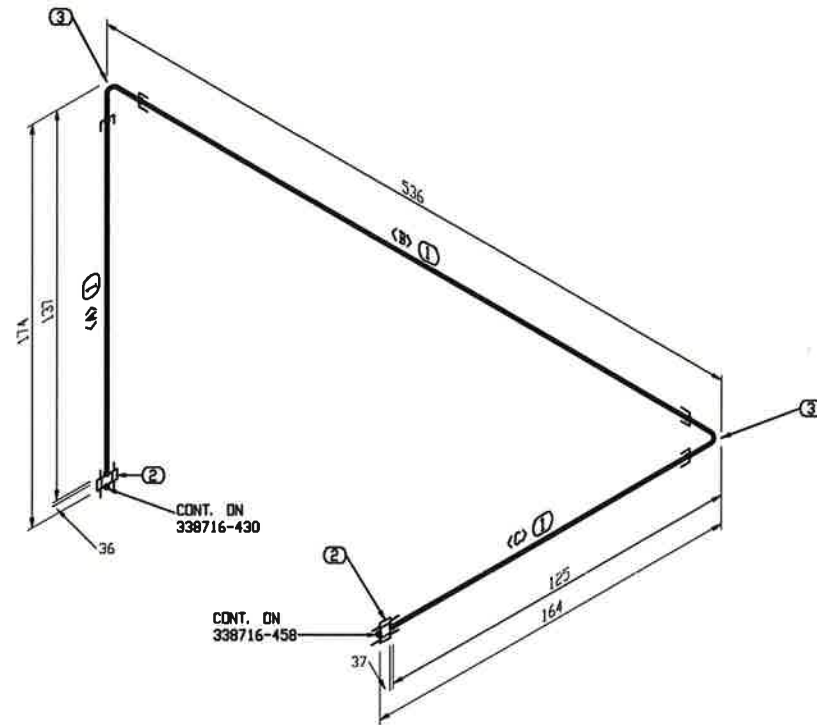
GENERAL NOTES
1. ALL DIMENSIONS ARE IN mm U.N.O.
2. FABRICATION TOLERANCE +/- 3mm U.N.O.
3. CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
4. ROOT GAP TO BE 1.6mm MAX.
5. NO FCAW ALLOWED BY SHELL.

PRESSURE PIPE DATA		
SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

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PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
SLS#: 338716 QUOTE: CGY2014-85 PDR: 4512-109-130
DWN: LK DATE: APR 06/15 DMD: 338716-430-Rev0
CHK: AA DATE: APR 09/15
APP: AA DATE: APR 09/15 PAGE: 1 OF 1 CAD: N/A

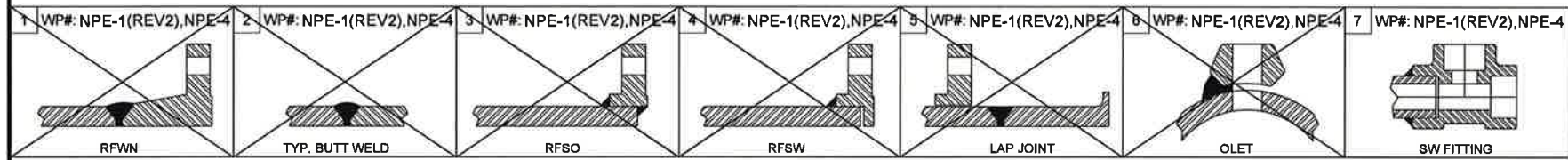
V-08116A OUTLET
SPOOL DETAIL



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	1	PIPE, SMLS, SCH XS, ASTM A333-6	701 MM	
FITTINGS				
2	1	UNION, SW, 3000LB, ASTM A350-LF2-CL. 1	2	
3	1	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	2	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	112	1
	488	1
<C>	101	1

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE:YY/MM/DD
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PRESSURE PIPE DATA

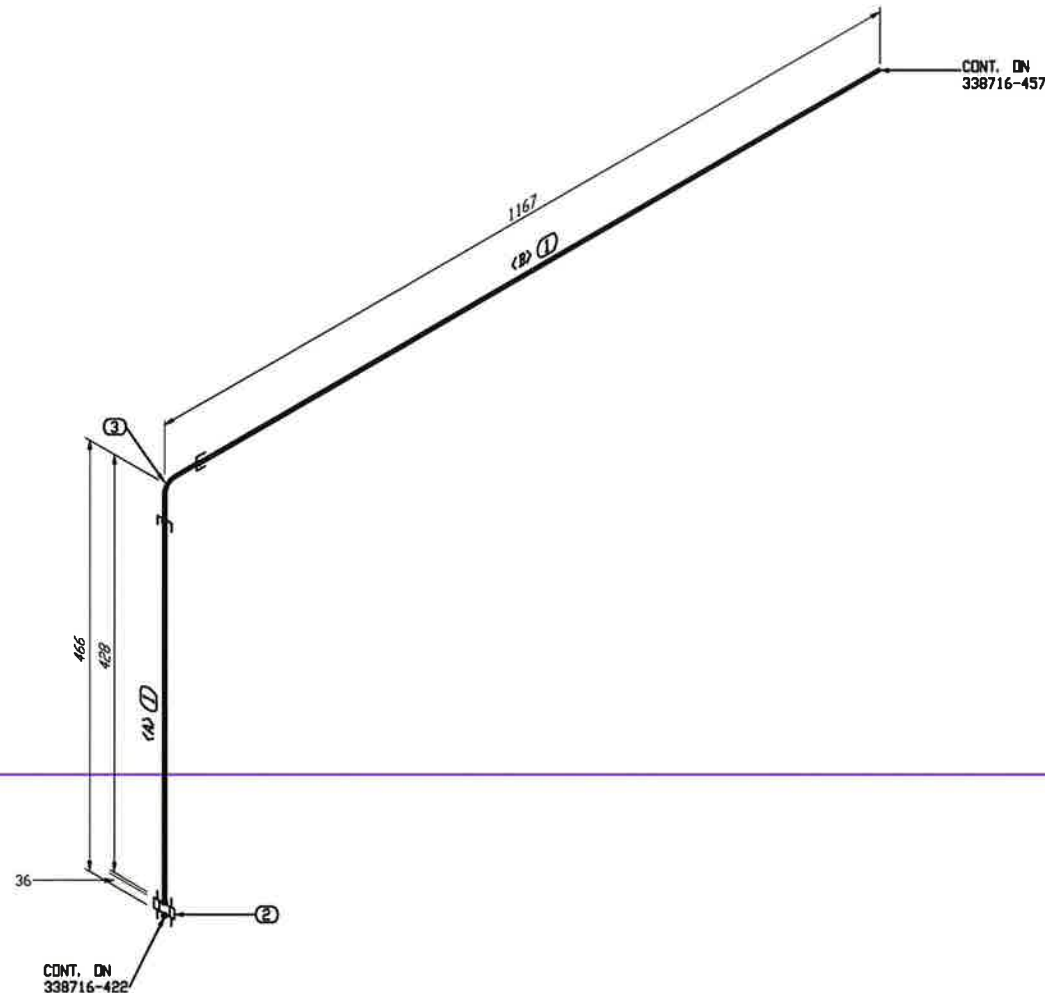
SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
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 - NO FCAW ALLOWED BY SHELL.

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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
 DWN: LK DATE: APR 06/15 DWG #: 338716-457-Rev0
 CHK: AA DATE: APR 09/15
 APP: AA DATE: APR 09/15 PAGE: 1 OF 1 CAD: N/A

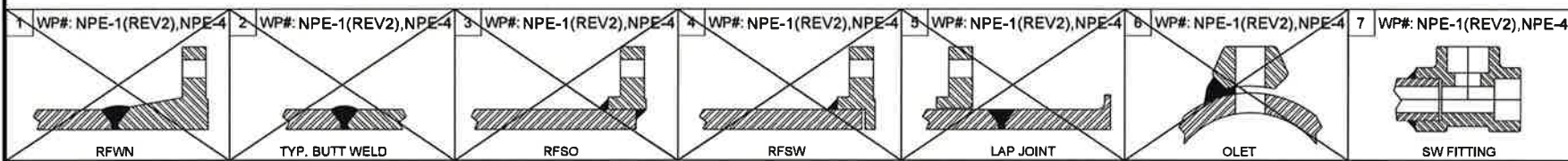
V-08116A OUTLET
 SPOOL DETAIL



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	1	PIPE, SMLS, SCH XS, ASTM A333-6	1547 MM	
FITTINGS				
2	1	UNION, SW, 3000LB, ASTM A350-LF2-CL. 1	1	
3	1	90 ELL, SW, 3000LB, ASTM A350-LF2-CL. 1	1	

CUT PIPE LENGTH		
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	404	1
	1143	1

ISSUED FOR CONSTRUCTION
 15/04/15
 DATE:YY/MM/DD
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- GENERAL NOTES**
- ALL DIMENSIONS ARE IN mm U.N.O.
 - FABRICATION TOLERANCE +/- 3mm U.N.O.
 - CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
 - ROOT GAP TO BE 1.6mm MAX.
 - NO FCAW ALLOWED BY SHELL.

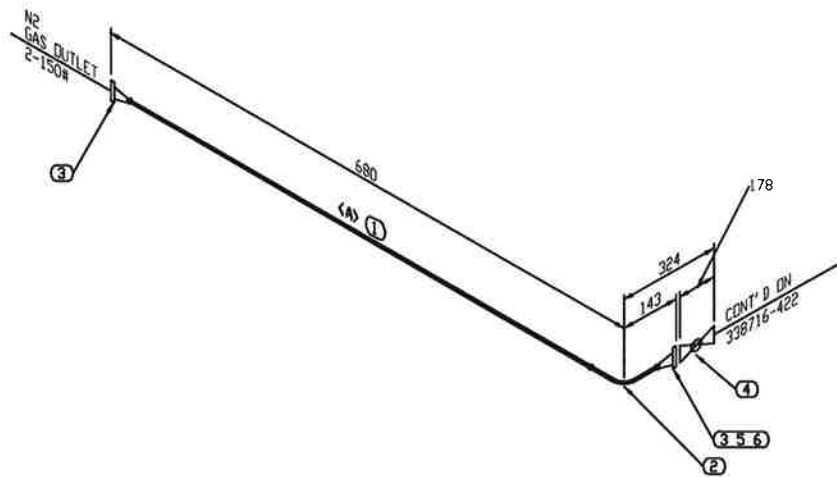
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PROJECT NAME: CARMON CREEK PROJECT
 CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
 LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PDR: 4512-109-130
 DWG#: 338716-458-Rev0
 DATE: APR 06/15
 DATE: APR 09/15
 DATE: APR 09/15
 PAGE: 1 OF 1
 CAD: N/A

PRESSURE PIPE DATA		
SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

DESCRIPTION	DWN	CHK	APP	DATE
ISSUED FOR CONSTRUCTION	LK	AA	AA	APR 09/15
V-08116A OUTLET SPOOL DETAIL				



BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
PIPE				
1	2	PIPE, SMLS, SCH XS, ASTM A333-6	534 MM	
FITTINGS				
2	2	90 ELL LR, SCH XS, ASTM A420-WPL-6	1	
FLANGES				
3	2	FLG RFWN, 150LB, SCH XS, ASTM A350-LF2-CL. 1	2	
VALVES / IN-LINE ITEMS				
4	2	BALL VALVE, FLG, REF. 338716-100 ITEM #20	1	

ERECTION MATERIALS

BILL OF MATERIAL				
MARK	SIZE	DESCRIPTION	QTY	HT#
GASKETS				
5	2	GASKET, 150LB, RF, 1/8" THK, 304SS SPIRAL WOUND, GRAPHITE FILLED, 316SS INNER RING, CS OUTER RING	1	
BOLTS				
6	2X3 1/4	5/8" STUD BOLTS W/NUTS, BOLT: A320-L7, W/2 NUTS: A194-2H	4	

CUT PIPE LENGTH

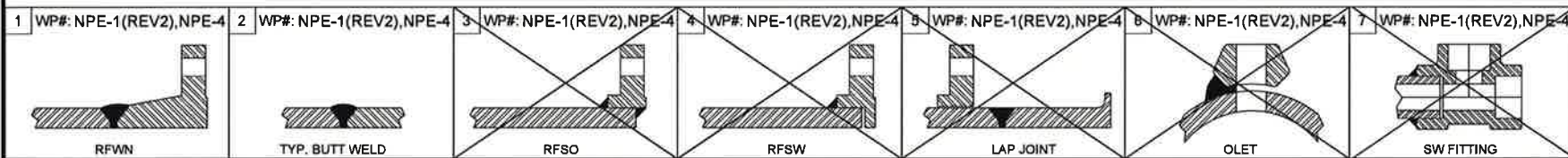
PIECE NUM	LENGTH (MM)	SIZE (INCH)
<A>	534	2

NOTE:
1. BALL VALVE HANDLE SHOP CUT TO FIT.

GENERAL NOTES

- ALL DIMENSIONS ARE IN mm U.N.O.
- FABRICATION TOLERANCE +/- 3mm U.N.O.
- CUT LENGTHS ARE FOR REFERENCE ONLY. FABRICATOR RESPONSIBLE FOR CORRECT CUT LENGTHS OF PIPE.
- ROOT GAP TO BE 1.6mm MAX.
- NO FCAW ALLOWED BY SHELL.

ISSUED FOR CONSTRUCTION
15/04/15
DATE:YY/MM/DD
natpro
SIGNATURE



PRESSURE PIPE DATA

SPECIFICATION: SHELL G21W CLASS 150	WELD PROCEDURE:	RADIOGRAPHY EXTENT %: 10% RT (BW)
DESIGN CODE Z662	TEST PRESSURE/TEMP./DURATION: 413 PSIG/AMB/60 MIN.	HARDNESS TESTING: NO
DESIGN PRESSURE: 260 PSIG @ 60°C	TEST MEDIUM: WATER	POST WELD HEAT TREATMENT YES / N.A.: NO
DESIGN TEMP. MIN. / MAX.: -45°C TO 60°C	MPI / LPI EXTENT %: NO	OTHER REQUIREMENTS: 100% VT
CORR. ALLOWANCE: 0.0mm	ULTRASONIC - OTHER NDE DESCRIPTION / EXTENT %: N/A	APPROXIMATE VOLUME, CU M:
SERVICE: SWEET GAS	SEVERE CYCLIC: (YES / NO) NO	

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	CHANGED NOTES	LK	AA	AA	APR 13/15
0	ISSUED FOR CONSTRUCTION	GW	ET	PM	MAR 05/15
A	ISSUED FOR APPROVAL	GW	ET	PM	JAN 28/15

GAS OUTLET SPOOL DETAIL

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PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CAMP FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
SLS#: 338716 QUOTE: CGY2014-85 POK: 4512-109-130
DWG #: 338716-423-Rev1
PAGE: 1 OF 1 CAD: N/A

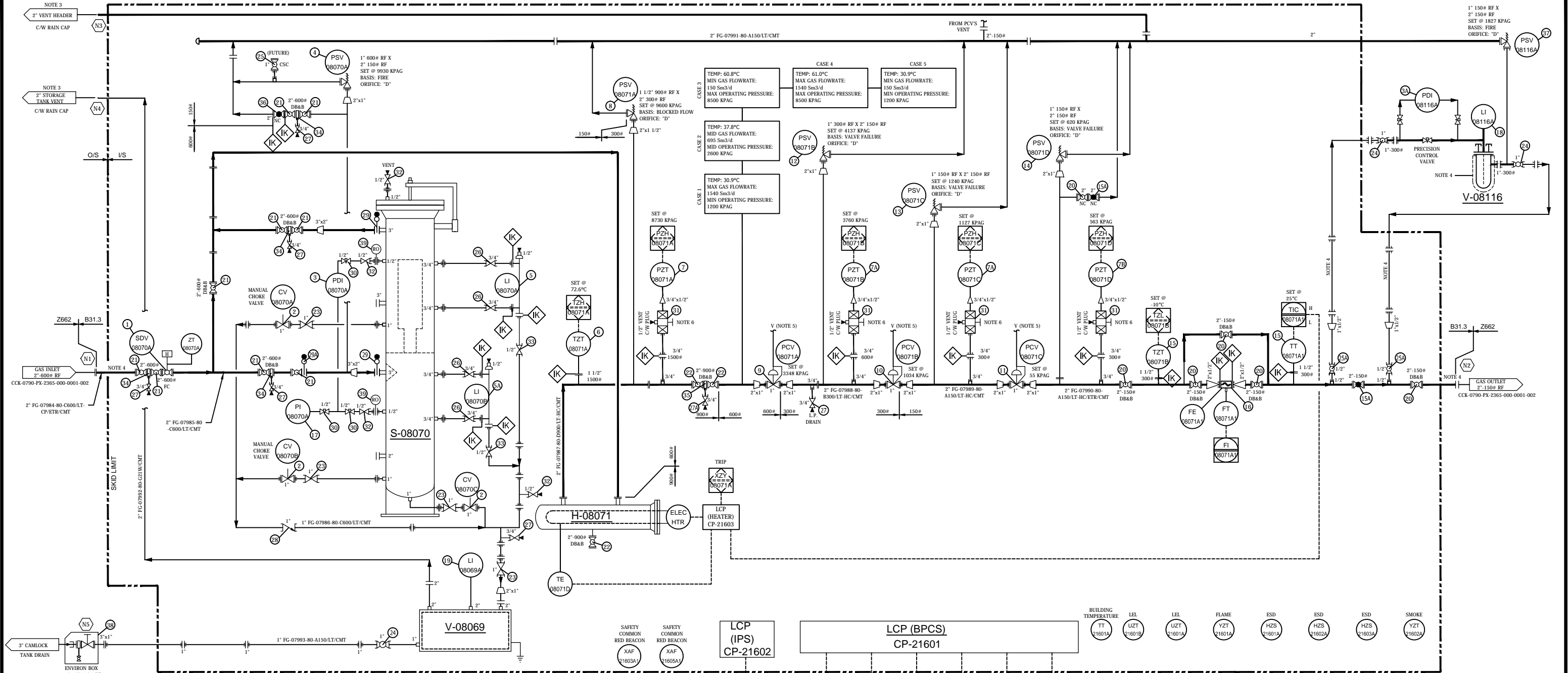
LINE DESIGNATION TABLE, DOC# 338716-LDT Rev0

Line System Description								Operating Conditions				Design Conditions Note 1.			Test & Inspection				
Line Number	Piping Size (inch)	WT (SCH)	Piping Class	Corrosion Allowance (mm)	Materials	Insulation Material/ Thickness(mm)	From Source	To Destination	Fluid & State	(Min./Max) Flow (Sm3/h)	(Min./Max) Pres. (kPag)	(Min./Max) Temp (°C)	Design Pressure (kPag)	(Min./Max) Temp (°C)	Piping Stress Analysis	Test Medium	Test Pressure @ Indoor. Temp. (kPag)	PWHT	NDE
2" FG-07984-80-C600/LT-CP/ETR/CMT	2	80	ASME 600# C600/LT	1	LOW TEMP.	Insulation and EHT by others	GAS INLET N1 (JACOBS P&ID CCK-0790- PX-2365-000-0001-002)	2" FG-07985-80-C600/LT/CMT	NATURAL GAS	150 / 1540	1200 / 8500	-5 / 40	9633 kPag @ 73 °C	-45 / 73	PASS	Water	15306	N/A	100% VISUAL 100% RT ON BW 10% MT ON SW
2" FG-07985-80-C600/LT/CMT	2 and 3	80 and 40	ASME 600# C600/LT	1	LOW TEMP.	n/a	2" FG-07984-80-C600/LT-CP/ETR/CMT	COALESCER FILTER S-08070	NATURAL GAS	150 / 1540	1200 / 8500	-5 / 40	9633 kPag @ 73 °C	-45 / 73	PASS	Water	15306	N/A	100% VISUAL 100% RT ON BW 10% MT ON SW
						n/a	COALESCER FILTER INLET LINE	HEATER H-08071	NATURAL GAS	150 / 1540	1200 / 8500	-5 / 40	9633 kPag @ 73 °C	-45 / 73	PASS	Water	15306	N/A	100% VISUAL 100% RT ON BW 10% MT ON SW
						n/a	COALESCER FILTER OUTLET LINE	HEATER H-08071	NATURAL GAS	150 / 1540	1200 / 8500	-5 / 40	9633 kPag @ 73 °C	-45 / 73	PASS	Water	15306	N/A	100% VISUAL 100% RT ON BW 10% MT ON SW
						n/a	2" FG-07987-80-D900/LT-HC/CM	PCV-08071A	NATURAL GAS	150 / 1540	1200 / 8500	-5 / 60.8	9633 kPag @ 73 °C	-45 / 73	PASS	Water	15306	N/A	100% VISUAL 100% RT ON BW 10% MT ON SW
	1 and 2	80	ASME 600# C600/LT	1	LOW TEMP.	n/a	COALESCER FILTER S-08070 INLET	PSV-08070A INLET	NATURAL GAS	150 / 1540	1200 / 8500	-5 / 40	9633 kPag @ 73 °C	-45 / 73	PASS	Water	15306	N/A	100% VISUAL 100% RT ON BW 10% MT ON SW
1" FG-07986-80-C600/LT/CMT	1 and under	80	ASME 600# C600/LT	1	LOW TEMP.	n/a	COALESCER FILTER S-08070	CONDENSATE STORAGE TANK V-08069	NATURAL GAS	150 / 1540	1200 / 8500	-5 / 40	9633 kPag @ 73 °C	-45 / 73	PASS	Water	15306	N/A	100% VISUAL 100% RT ON BW 10% MT ON SW
2" FG-07987-80-D900/LT-HC/CMT	2	80	ASME 900# D900/LT	1	LOW TEMP.	Mineral wool/ 37.5	HEATER H-08071	900#/600#-SPEC BREAK AFTER DB&B VALVE	NATURAL GAS	150 / 1540	1200 / 8500	-5 / 60.8	13100 kPag @ 204 °C	-45 / 204	PASS	Water	22960	N/A	100% VISUAL 100% RT ON BW 10% MT ON SW
						n/a	HEATER H-08071	PSV-08071A INLET	NATURAL GAS	150 / 1540	1200 / 8500	-5 / 60.8	13100 kPag @ 204 °C	-45 / 204	PASS	Water	22960	N/A	100% VISUAL 100% RT ON BW 10% MT ON SW
2" FG-07988-80-B300/LT-HC/CMT	2	80	ASME 300# B300/LT	1	LOW TEMP.	Mineral wool/ 37.5	PCV-08071A OUTLET	PCV-08071B INLET	NATURAL GAS	150 / 1540	1200 / 4137	30.9 / 40	4378 kPag @ 204 °C	-45 / 204	PASS	Water	7653	N/A	100% VISUAL 100% RT ON BW 10% MT ON SW
						n/a	PCV-08071A OUTLET	PSV-08071B INLET	NATURAL GAS	150 / 1540	1200 / 4137	30.9 / 40	4378 kPag @ 204 °C	-45 / 204	PASS	Water	7653	N/A	100% VISUAL 100% RT ON BW 10% MT ON SW
2" FG-07989-80-A150/LT-HC/CMT	2	80	ASME 150# A150/LT	1	LOW TEMP.	Mineral wool/ 37.5	PCV-08071B OUTLET	PCV-08071C INLET	NATURAL GAS	150 / 1540	1100 / 1240	30 / 40	1530 kPag @ 149 °C	-45 / 149	PASS	Water	2847	N/A	100% VISUAL 15% RT ON BW 15% MT ON SW
						n/a	PCV-08071B OUTLET	PSV-08071C INLET	NATURAL GAS	150 / 1540	1100 / 1240	30 / 40	1530 kPag @ 149 °C	-45 / 149	PASS	Water	2847	N/A	100% VISUAL 15% RT ON BW 15% MT ON SW
2" FG-07990-80-A150/LT-HC/ETR/CMT	2	80	ASME 150# A150/LT	1	LOW TEMP.	Mineral wool/ 37.5	PCV-08071C OUTLET	GAS OUTLET N2 (JACOBS P&ID CCK-0790-PX- 2365-000-0001-0002)	NATURAL GAS	150 / 1540	55 / 620	25/ 35	1530 kPag @ 149 °C	-45 / 149	PASS	Water	2847	N/A	100% VISUAL 15% RT ON BW 15% MT ON SW
						n/a	PCV-08071C OUTLET	PSV-08071D INLET	NATURAL GAS	150 / 1540	55 / 620	25/ 35	1530 kPag @ 149 °C	-45 / 149	PASS	Water	2847	N/A	100% VISUAL 15% RT ON BW 15% MT ON SW
	1 and under	80	ASME 150# A150/LT	1	LOW TEMP.	n/a	2" FG-07990-80-A150/LT-HC/ETR/CMT	ODORIZER INLET and OUTLET	NATURAL GAS	150 / 1540	55 / 620	-45/ 35	1530 kPag @ 149 °C	-45 / 149	PASS	Water	2847	N/A	100% VISUAL 15% RT ON BW 15% MT ON SW
						n/a	ODORIZER OUTLET	PSV-08116A INLET	NATURAL GAS	150 / 1540	55 / 620	-45/ 35	1530 kPag @ 149 °C	-45 / 149	PASS	Water	2847	N/A	100% VISUAL 15% RT ON BW 15% MT ON SW
2" FG-07991-80-A150/LT/CMT	2	80	ASME 150# A150/LT	1	LOW TEMP.	n/a	PSV 08070A/08071A/08071B/08071C/08071D /08116A OUTLET	ATMOSPHERE	NATURAL GAS	N/A	0	-45/ 35	1530 kPag @ 149 °C	-45 / 149	PASS	Water	2847	N/A	100% VISUAL 15% RT ON BW 15% MT ON SW
2" FG-07992-80-A150/LT/CMT	2	80	ASME 150# A150/LT	1	LOW TEMP.	n/a	TANK V-08069	ATMOSPHERE	NATURAL GAS	N/A	0	-45/ 35	1530 kPag @ 149 °C	-45 / 149	PASS	Water	2847	N/A	100% VISUAL 15% RT ON BW 15% MT ON SW
1" FG-07991-80-A150/LT/CMT	1	80	ASME 150# A150/LT	1	LOW TEMP.	n/a	TANK V-08069	ENVIRO BOX - N5	NATURAL GAS	N/A	0	-45/ 35	1530 kPag @ 149 °C	-45 / 149	PASS	Water	2847	N/A	100% VISUAL 15% RT ON BW 15% MT ON SW

Note:
1. Design condition refers to the Pipe class, A150/LT, B300/LT, C600/LT, D900/LT

SECTION 5.0
FINAL DATASHEETS

S-08070	H-08071	V-08069	V-08116
COALESCER FILTER	NATURAL GAS ELECTRIC HEATER	CONDENSATE STORAGE TANK	MERCAPTAN GAS ODORIZER
MAKE: JONELL	MAKE: EX HEAT	MAKE: STEELCRAFT	MAKE: TANSLEY ASSOCIATES
MODEL: JPMG-336-CE-R	RATED HEAT DUTY: 4.4 KW/600V/60HZ/3 PHASE	MODEL: 100 GAL DOUBLE WALL STEEL TANK	MODEL: 3-B
SIZE: 219mm x 2565mm S/S	VESSEL SIZE: 168mm OD x 1694mm LG	SIZE: 711mm OD x 1219mm LG	SIZE: 406mm OD x 762mm LG
DP/DT: 9930 KPAG -45/54°C	DP/DT: 9930 KPAG -45/93°C	DP/DT: ATMOSPHERIC	DP/DT: 2068 KPAG -45/66°C
C.A.: 3.05	CA: 1.6		C.A.: 0
	INSULATION: PERSONNEL PROTECTION ONLY		



CONN	SIZE	RATING	DESCRIPTION
N1	2"	600# RF	PACKAGE INLET
N2	2"	150# RF	PACKAGE OUTLET
N3	2"	-	VENT HEADER (VENT TO ATMOSPHERE)
N4	2"	-	TANK VENT (VENT TO ATMOSPHERE)
N5	3"	CAMLOCK	TANK DRAIN

- GENERAL NOTES:**
- DELETED.
 - NATPRO SCOPE OF SUPPLY.
 - (N3)(N4) TO BE ROUTED TO SAFE LOCATION. VENT TO ATMOSPHERE.
 - ELECTRIC HEAT TRACING & INSULATION AT LEAST 1M INSIDE THE BUILDING SHOULD BE PROVIDED BY OTHERS.
 - TO 2" VENT HEADER.
 - SS SPOOLS TO BE SS316/L C/W 3/4" XS SCH NIPPLES.
 - IK INDICATING ISOLATION KIT
 - PIPING HEAT CONSERVATION AFTER ELECTRICAL HEATER BY NPE.

REV	DESCRIPTION	DWN	CHK	APP	DATE
9	AS BUILT	NSP	AA	AA	NOV 20/15
8	REVISED AS PER CUSTOMER'S REQUIREMENT	NSP	AA	AA	SEPT 29/15
7	REVISED AS PER CUSTOMER'S REQUIREMENT	NSP	AA	AA	SEPT 1/15
6	REVISED TAGGING & ANSI RATING; ADDED GEN. NOTE 5	GG	ET	PM	DEC 18/14
5	REVISED AS PER CUSTOMER'S MARKUPS	GG	ET	PM	NOV 27/14
4	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	OCT 10/14
3	REVISED AS TITLE BLOCK/TAGGING & ADDED LINE NUMBERS	GG	ET	PM	OCT 02/14
2	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	SEP 17/14
1	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	SEP 08/14
0	ISSUED FOR APPROVAL	GG	ET	PM	JUL 04/14

CMT NG PRESSURE REDUCTION SKID PACKAGE P & ID

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PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
DWN BY: GG DATE: JUL 04/14 DWG #: 338716-100-Rev9
CHK BY: ET DATE: JUL 04/14
APP BY: COG DATE: JUL 04/14 PAGE: 1 OF 4 CAD: N/A REV: 9

TAG: C-08169
SUPPLY FAN
CONTINUOUS 3 ACH OPERATION
UN-CLASSIFIED
 AIR FLOW: 55 L/S
 POWER SUPPLY: 115V/1PH/60HZ
 FAN MOTOR: 1/4 HP, 6.8 A, 1140 RPM
 ACCESSORIES: BACKDRAFT DAMPER,
 90 DEGREE INTAKE COWL C/W
 BIRDSCREEN

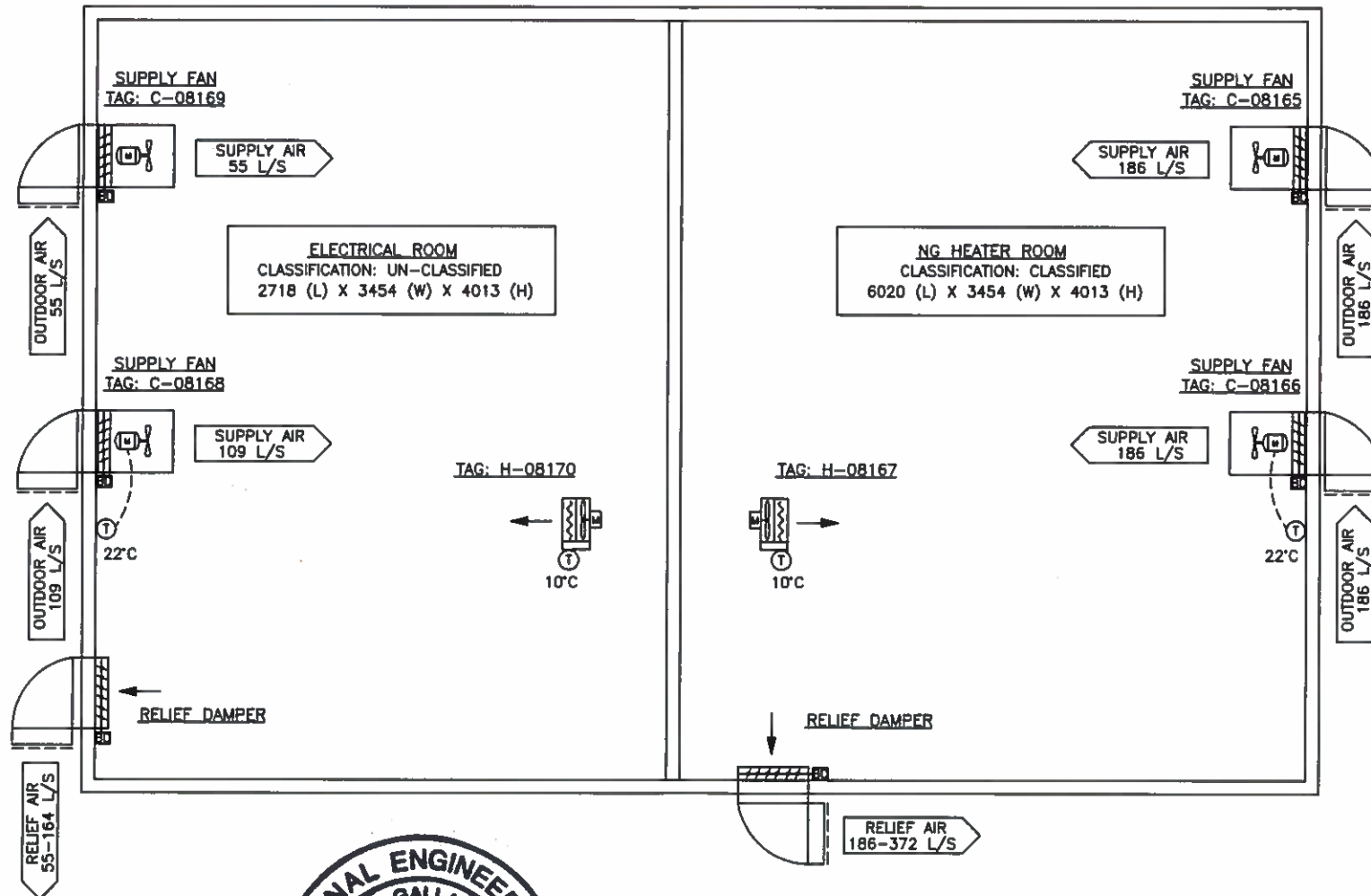
TAG: C-08168
COOLING SUPPLY FAN
UN-CLASSIFIED
 AIR FLOW: 109 L/S
 POWER SUPPLY: 115V/1PH/60HZ
 FAN MOTOR: 1/4 HP, 6.8 A, 1140 RPM
 ACCESSORIES: BACKDRAFT DAMPER,
 90 DEGREE INTAKE COWL C/W
 BIRDSCREEN, REMOTE THERMOSTAT

BAROMETRIC RELIEF DAMPER
 AIRFLOW: 55-164 L/S
 SIZE: 305 mm (12") (W) X 305 mm (12") (H)
 SETTING: BAROMETRIC 25 Pa. (0.10" W.C.)
 ACCESSORIES: 90 DEGREE DISCHARGE COWL
 C/W BIRDSCREEN

TAG: H-08170
UNIT HEATER
UN-CLASSIFIED
 HEATING CAPACITY: 10 kW
 HEATING: ELECTRIC
 AIR FLOW: 217 L/S (460 CFM)
 POWER SUPPLY: 575V/3PH/60HZ
 FAN MOTOR: 0.37 kW (1/3 HP)
 ACCESSORIES: REMOTE THERMOSTAT

TAG: C-08165
SUPPLY FAN
CONTINUOUS 6 ACH OPERATION
CLASSIFIED
 AIR FLOW: 186 L/S
 POWER SUPPLY: 115V/1PH/60HZ
 FAN MOTOR: 0.19 kW (1/4 HP)
 ACCESSORIES: BACKDRAFT DAMPER,
 90 DEGREE INTAKE COWL C/W
 BIRDSCREEN, AUTO OVERLOAD XP RATED
 CLASS 1, GROUP C&D, TEMP CODE T3B

TAG: C-08166
COOLING SUPPLY FAN
AND/OR LEL ALARM FAN, 6 ACH
CLASSIFIED
 AIR FLOW: 186 L/S
 POWER SUPPLY: 115V/1PH/60HZ
 FAN MOTOR: 0.19 kW (1/4 HP)
 ACCESSORIES: BACKDRAFT DAMPER,
 90 DEGREE INTAKE COWL C/W
 BIRDSCREEN, REMOTE THERMOSTAT,
 AUTO OVERLOAD XP RATED
 CLASS 1, GROUP C&D, TEMP CODE T3B



BAROMETRIC RELIEF DAMPER
 AIRFLOW: 186-372 L/S
 SIZE: 457 mm (18") (W) X 457 mm (18") (H)
 SETTING: BAROMETRIC 25 Pa. (0.10" W.C.)
 ACCESSORIES: 90 DEGREE DISCHARGE COWL
 C/W BIRDSCREEN

TAG: H-08167
UNIT HEATER
CLASSIFIED
 HEATING CAPACITY: 25 kW
 HEATING: ELECTRIC
 AIR FLOW: 1670 L/S (3600 CFM)
 POWER SUPPLY: 600V/3PH/60HZ
 FAN MOTOR: 0.373 kW (1/2 HP)
 ACCESSORIES: REMOTE CLASSIFIED
 THERMOSTAT



REV	DATE	BY	DESCRIPTION
2	17 NOV 2015	TV	RE-ISSUED FOR CONSTRUCTION
1	16 JULY 2015	TV	RE-ISSUED FOR CONSTRUCTION
0	31 MAY 2015	TV	ISSUED FOR CONSTRUCTION

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CLIENT:
natpro

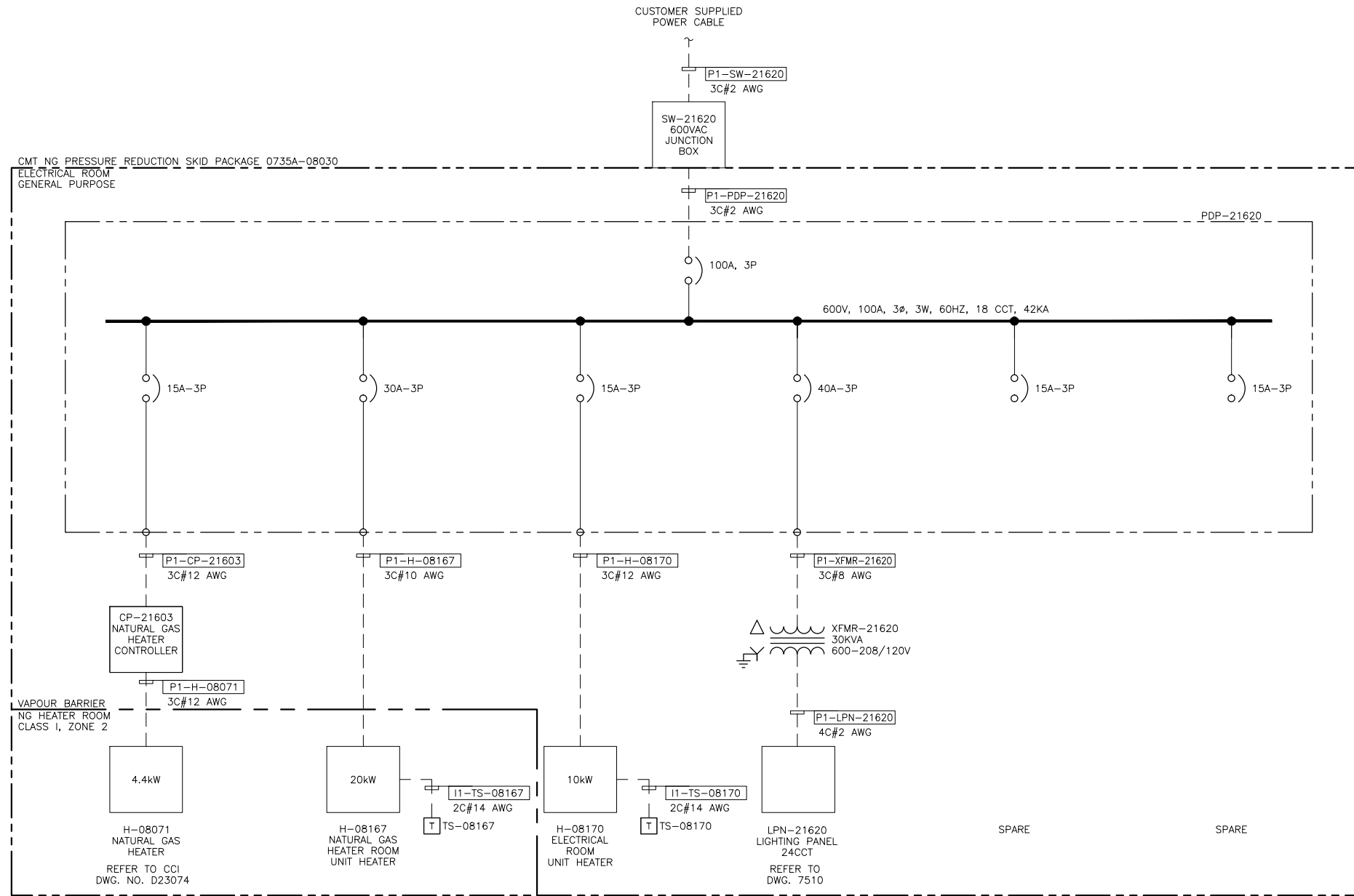
PROJECT NAME:
 SHELL CARMON CREEK PROJECT

DESIGNED BY: J.G.
 DRAWN BY: T.V.

TITLE:
 HVAC P & ID FOR BU-215
 NATURAL GAS PRESSURE REDUCTION SKID-CMT

CHECKED BY: J.G.
 SLS #

DATE: 17 NOVEMBER 2015
 SCALE: N.T.S.
 SHEET NO.: 0735A-08030-M-1
 PAGES: 2



LEGEND

- POWER OR LIGHTING TRANSFORMER
- CIRCUIT BREAKER
- DELTA CONNECTION
- WYE CONNECTION SOLID GROUNDED
- THERMOSTAT

REFERENCE DRAWINGS:

- DWG. 7400 - ELECTRICAL POWER LAYOUT & BOM
- DWG. 7402 - ELECTRICAL ROOM ELEVATIONS
- DWG. 7500 - CABLE SCHEDULE (1 OF 2)
- DWG. 7501 - CABLE SCHEDULE (2 OF 2)
- DWG. 7510 - 120/208 VAC DISTRIBUTION PANEL SCHEDULE
- DWG. 7900 - JUNCTION BOX LAYOUTS & BOM

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PROJECT NAME: **CARMON CREEK**
 CUSTOMER: **SHELL**
 LOCATION: **CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2**

TAG: **0735A-08030**
 SLS#: **338716** QUOTE: **CGY2014-85** PO#: **4512-109-130**

DWN BY: **JP** DATE: **JUL 23/14** DWG #: **214068-7100**
 CHK BY: **JS** DATE: **JUL 23/14**
 APP BY: **-** DATE: **-** PAGE: **1 OF 1** CAD: **N/A** REV: **1**

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	AS-BUILT	LS	JS	-	NOV 09/15
0	ISSUED FOR FIELD CONSTRUCTION	JP	JS	-	AUG 18/15

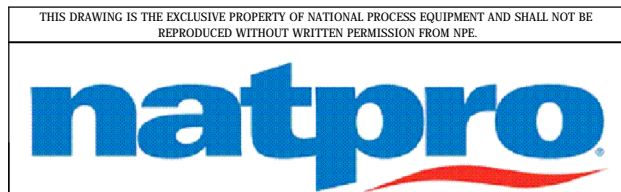
**CMT NG PRESSURE REDUCTION SKID PACKAGE
SINGLE LINE DIAGRAM**



**COLLEAUX
ENGINEERING
INC.**

BILL OF MATERIALS

ITEM	QTY	TYPE	DESCRIPTION	MFR.	CUST. TAG#
	1	COALESCER FILTER	MAKE: JONELL MODEL: JPMG-336-CE-R SIZE: 219 x 2565 S/S DP/DT: 9930 KPAG -45/54°C CRN: AB C.A.: 3.05	JONELL	S-08070
	1	NATURAL GAS ELECTRIC HEATER	MAKE: EX HEAT RATED HEAT DUTY: 4.4 KW/600V/60HZ/3 PHASE VESSEL SIZE: 168mm OD x 1694mm LG MAWP: 9930 KPAG -45/93°C CRN: AB CA: 1.6mm INSULATION: PERSONNEL PROTECTION ONLY	EX HEAT	H-08071
	1	CONDENSATE STORAGE TANK	MAKE: STEELCRAFT MODEL: 100 GAL DOUBLE WALL STEEL TANK SIZE: 711 OD x 1219 LG DP/DT: ATMOSPHERIC	STEELCRAFT	V-08069
	1	MERCAPTAN GAS ODORIZER	MAKE: TANSLEY ASSOCIATES MODEL: 3-B SIZE: 406 OD x 762 LG DP/DT: 700 KPAG -45/50°C C.A.: 0	TANSLEY ASSOCIATES	V-08116
1	1	EMERGENCY SHUT DOWN VALVE	JAG BALL VALVE, 2" CL600 RF FULL PORT, JAG FIG TB3-F20R06LH-S1, TRUNNION MOUNTED, SA350 LF2 BODY, LF2/CS ENP BALL & STEM, RPTFE SEATS, HNBR SEALS, CSA Z245-15; C/W ROTORK FIG# EH-060-045H/C2 SELF CONTAINED ELECTRO-HYDRAULIC ACTUATOR, FAIL CLOSED, 24VDC POWER SUPPLY, 24VDC OPEN/CLOSE CONTROL VOLTAGE, AMBIENT TEMPERATURE RATING -30C	JAG/ROTORK	SDV-08070A ZT-08070A
2	3	CHOKE VALVE	WILLIS MC10A INLINE CHOKE, 1" CL600 RF INLET X OUTLET, 1-0.125" TUNGSTEN CARBIDE DISC TRIM, STYLE C NACE MR01-75 SOUR LOW TEMP, MANUAL OPERATION, STANDARD DIMENSION, A= 11.05"	CAMERON	CV-08070A CV-08070B CV-08070C
3	1	DIFFERENTIAL PRESSURE INDICATOR	MIDWEST MODEL 120-SA-10-00-50 DIFFERENTIAL PRESSURE INDICATOR, 2 1/2" DIAL FACE, 0-50# RANGE DUAL SCALE, LIQUID FILLED, VITON SEALS, MAGNETIC MOVEMENT, 3%-2%-3% ACCURACY, 1/4" FNPT REAR CONNECTIONS, 6000 PSIG MAXIMUM WORKING PRESSURE	WGI	PDI-08070A
3A	1	DIFFERENTIAL PRESSURE INDICATOR	MIDWEST MODEL 120-SA-10-00-05 DIFFERENTIAL PRESSURE INDICATOR, 2 1/2" DIAL FACE, 0-5# RANGE DUAL SCALE, LIQUID FILLED, VITON SEALS, MAGNETIC MOVEMENT, 3%-2%-3% ACCURACY, 1/4" FNPT REAR CONNECTIONS, 6000 PSIG MAXIMUM WORKING PRESSURE	WGI	PDI-08116A
4	1	PRESSURE SAFETY VALVE	1" CL600 RF X 2" CL150 RF FARRIS RELIEF VALVE, SET @ 9930 KPAG, 60F, GAS, FARRIS TYPE 2600 PSV, MODEL# 26DA13-120/LC, "D" ORIFICE (0.110 SQ IN API), CONVENTIONAL DESIGN, TEMPERATURE: -50 DEG F TO 650 DEG F, SCREWED CAP CONSTRUCTION, LCC CS BODY & BONNET; 316 SS DISC & NOZZLE, CHROME ALLOY SPRING, COMPLIES TO NACE MR0175-2002 IN PRIMARY ZONE	FARRIS	PSV-08070A
5	2	MANETIC LEVEL GAUGE	61 FLOAT AND CHAMBER 45106 IN A 2.5" S10 WITH A MINIMUM SG OF 0.61 C MOUNTING STYLE STYLE C - CLOSED TOP ; FLANGED BOTTOM WITH SIDE PC, AB INSTRUMENT RATING 600# ASME B16.5 1 ACCESS FLANGE TYPE RF WELD NECK, E UNIT OF MEASURE ENGLISH (DEFAULT IN INCHES), 01400 MOUNTING DIMENSION 14, S CHAMBER MATERIAL 316/316L (STANDARD), E CONNECTION DESIGN 300# ASME B16.5, 2 CONNECTION SIZE 3/4" RF, AB CONNECTION RATING 600# ASME B16.5, 1 CONNECTION TYPE RF WELD NECK, 1 CONNECTION SCHEDULE S10, S CONNECTION MATERIAL 316/316L (STANDARD), D TOP GAGE DOME CAP, 8 TOP SIZE 1/2", F TOP TYPE COUPLING - FNPT WITH PLUG 3 TOP SCHEDULE 3, B BOTTOM GAGE BLIND FLANGE, 8 BOTTOM SIZE 1/2", A BOTTOM TYPE NPT TAP ONLY WITH PLUG, Z BOTTOM SCHEDULE DEFAULT (SAME SCHEDULE AS CHAMBER), F INDICATOR FLAG 01400 MEASURE RANGE 14.00, Z SCALE UNIT FEET AND INCHES MODEL: LG6 C-3/4 600#-0.610-38C-9931KPAG-356MM-(FS)(WN)	MAGTECH	LI-08070A LI-08070B
6	1	TEMPERATURE INDICATOR TRANSMITTER	ROSEMOUNT 3144P SMART TEMPERATURE TRANSMITTER MODEL# 3144PD1A1K6M5 D1: TRANSMITTER HOUSING TYPE/CONDUIT ENTRY: FIELD MOUNT HOUSING, ALUMINUM, 1/2-14 NPT A: COMMUNICATIONS PROTOCOL: 4-20 MA WITH DIGITAL SIGNAL BASED ON HART PROTOCOL 1: MEASUREMENT TYPE CONFIGURATION: SINGLE SENSOR INPUT K6: PRODUCT CERTIFICATIONS: CSA IS, FISCO DIVISION 2 AND EXPLOSION-PROOF COMBO M5: LCD DISPLAY ROSEMOUNT 0068 TEMPERATURE SENSOR MODEL# 0068N21C30A060F24E6R07 N: SENSOR LEAD WIRE TERMINATION: SENSOR ONLY WITH 6-INCH; TEFLON-INSULATED; 22-GAUGE LEAD WIRES 21: SENSOR TYPE: SPRING-LOADED STYLE C: EXTENSION TYPE MATERIAL: NIPPLE UNION SST 30: EXTENSION LENGTH: 3.0 " (STD) A: THERMOWELL MATERIAL: TYPE 316 SST 060: SENSOR IMMERSION LENGTH: 6.0 F24: FLANGE MOUNT 1 1/2-INCH; CLASS 1500 TAPERED,RAISED FACE E6: CSA EXPLOSION-PROOF APPROVAL R07: FULL PENETRATION WELD	ROSEMOUNT	TZT-08071A / TW-08071A



8	REVISED AS PER CUSTOMER'S REQUIREMENT	NSP	AA	AA	OCT 2/15	PROJECT NAME: CARMON CREEK PROJECT CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2 TAG: 0735A-08030 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130 DWN BY: GG DATE: JUL 04/14 DWG #: 338716-100-Rev8 CHK BY: ET DATE: JUL 04/14 APP BY: COG DATE: JUL 04/14 PAGE: 2 OF 4 CAD: N/A REV: 8
7	REVISED AS PER CUSTOMER'S MARKUPS	NSP	AA	AA	SEPT 1/15	
6	REVISED TAGGING & ANSI RATING; ADDED GEN. NOTE 5	GG	ET	PM	DEC 18/14	
5	REVISED AS PER CUSTOMER'S MARKUPS	GG	ET	PM	NOV 27/14	
4	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	OCT 10/14	
3	REVISED AS TITLE BLOCK/TAGGING & ADDED LINE NUMBERS	GG	ET	PM	OCT 02/14	
2	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	SEP 17/14	
REV	DESCRIPTION	DWN	CHK	APP	DATE	
CMT NG PRESSURE REDUCTION SKID PACKAGE BOM						

BILL OF MATERIALS					
ITEM	QTY	TYPE	DESCRIPTION	MFR.	CUST. TAG#
7	1	PRESSURE INDICATOR TRANSMITTER	MODEL# 2088G4S22A1M5K6P1Q4Q8 G: TRANSMITTER TYPE: GAGE, 4: PRESSURE RANGE: -14.7 TO 4,000 PSI, S: OUTPUT: 4-20 MA DC/DIGITAL HART PROTOCOL, 22: MATERIAL OF CONSTRUCTION: 316L SST / SILICONE FILL, A: PROCESS CONNECTION: 1/2-14 NPT FEMALE, 1: CONDUIT THREAD: 1/2-14 NPT M5: LCD DISPLAY, CONFIGURED FOR ENGINEERING UNITS, K6: CSA EXPLOSION-PROOF, DUST IGNITION-PROOF, INTRINSICALLY SAFE P1: HYDROSTATIC TESTING, Q4: CALIBRATION CERTIFICATE Q8: MATERIAL TRACEABILITY PER EN 10204 3.1.B	ROSEMOUNT	PZT-08071A
7A	2	PRESSURE INDICATOR TRANSMITTER	MODEL# 2088G3S22A1M5K6P1Q4Q8 G: TRANSMITTER TYPE: GAGE, 3: PRESSURE RANGE: -14.7 TO 800 PSI S: OUTPUT: 4-20 MA DC/DIGITAL HART PROTOCOL, 22: MATERIAL OF CONSTRUCTION: 316L SST / SILICONE FILL, A: PROCESS CONNECTION: 1/2-14 NPT FEMALE, 1: CONDUIT THREAD: 1/2-14 NPT, M5: LCD DISPLAY, CONFIGURED FOR ENGINEERING UNITS, K6: CSA EXPLOSION-PROOF, DUST IGNITION-PROOF, INTRINSICALLY SAFE, P1: HYDROSTATIC TESTING, Q4: CALIBRATION CERTIFICATE, Q8: MATERIAL TRACEABILITY PER EN 10204 3.1.B	ROSEMOUNT	PZT-08071B PZT-08071C
7B	1	PRESSURE INDICATOR TRANSMITTER	MODEL# 2088G2S22A1M5K6P1Q4Q8 G: TRANSMITTER TYPE: GAGE, 1: PRESSURE RANGE: -14.7 TO 150 PSI S: OUTPUT: 4-20 MA DC/DIGITAL HART PROTOCOL, 22: MATERIAL OF CONSTRUCTION: 316L SST / SILICONE FILL, A: PROCESS CONNECTION: 1/2-14 NPT FEMALE, 1: CONDUIT THREAD: 1/2-14 NPT, M5: LCD DISPLAY, CONFIGURED FOR ENGINEERING UNITS, K6: CSA EXPLOSION-PROOF, DUST IGNITION-PROOF, INTRINSICALLY SAFE, P1: HYDROSTATIC TESTING, Q4: CALIBRATION CERTIFICATE, Q8: MATERIAL TRACEABILITY PER EN 10204 3.1.B	ROSEMOUNT	PZT-08071D
8	1	PRESSURE SAFETY VALVE	1-1/2" CL900 RF X 2" CL300 RF FARRIS RELIEF VALVE SET @ 9600 KPAG, 60F, GAS, FARRIS TYPE 2600 PSV, MODEL# 26DA14-120/LC, "D" ORIFICE (0.110 SQ IN API), CONVENTIONAL DESIGN, TEMPERATURE: -50 DEG F TO 650 DEG F, SCREWED CAP CONSTRUCTION, LCC CS BODY & BONNET; 316 SS DISC & NOZZLE, CHROME ALLOY SPRING, COMPLIES TO NACE MR0175-2002 IN PRIMARY ZONE	FARRIS	PSV-08071A
9	1	PRESSURE REGULATOR VALVE	FISHER 627 PRESSURE REGULATOR, SET @ 3348 KPAG - 1" 600 RF 627H BODY MATERIAL: WCC STEEL - SPRING CASE MATERIAL: STEEL - 3/16" ORIFICE SST NYLON DISK - SPRING RANGE 240-500 PSIG - MAXIMUM INLET PRESSURE: 1500 PSIG - CRN, MTR, HYDROTEST, MANUFACTURE CERT, SET TEST REPORT	FISHER	PCV-08071A
10	1	PRESSURE REGULATOR VALVE	FISHER 627 PRESSURE REGULATOR, SET @ 1034 KPAG - 1" 300 RF 627 BODY MATERIAL: WCC STEEL - SPRING CASE MATERIAL: STEEL - 1/8" ORIFICE SST NYLON DISK - SPRING RANGE 70-150 PSIG - MAXIMUM INLET PRESSURE: 740 PSIG - CRN, MTR, HYDROTEST, MANUFACTURE CERT, SET TEST REPORT	FISHER	PCV-08071B
11	1	PRESSURE REGULATOR VALVE	FISHER 627 PRESSURE REGULATOR, SET @ 55 KPAG - 1" 150 RF 627 BODY MATERIAL: WCC STEEL - SPRING CASE MATERIAL: STEEL - 3/16" ORIFICE SST NYLON DISK - SPRING RANGE 5-20 PSIG - MAXIMUM INLET PRESSURE: 285 PSIG - CRN, MTR, HYDROTEST, MANUFACTURE CERT, SET TEST REPORT	FISHER	PCV-08071C
12	1	PRESSURE SAFETY VALVE	1" CL300 RF X 2" CL150 RF FARRIS RELIEF VALVE, SET @ 4137 KPAG, 60F, GAS, FARRIS TYPE 2600 PSV, MODEL# 26DA12-120/LC, "D" ORIFICE (0.110 SQ IN API), CONVENTIONAL DESIGN, TEMPERATURE: -50 DEG F TO 650 DEG F, SCREWED CAP CONSTRUCTION, LCC CS BODY & BONNET; 316 SS DISC & NOZZLE, CHROME ALLOY SPRING, COMPLIES TO NACE MR0175-2002 IN PRIMARY ZONE	FARRIS	PSV-08071B
13	1	PRESSURE SAFETY VALVE	1" 150 RF X 2" 150 RF FARRIS RELIEF VALVE, SET @ 1240 KPAG, 70C, GAS, FARRIS TYPE 2600 PSV, MODEL# 26DA10-120/LC, D ORIFICE (0.110 SQ IN API), CONVENTIONAL DESIGN, TEMPERATURE: -50 DEG F TO 650 DEG F, SCREWED CAP CONSTRUCTION, LCC CS BODY & BONNET; 316 SS DISC & NOZZLE, CHROME ALLOY SPRING, COMPLIES TO NACE MR0175-2002 IN PRIMARY ZONE	FARRIS	PSV-08071C
14	1	PRESSURE SAFETY VALVE	1" 150 RF X 2" 150 RF FARRIS RELIEF VALVE, SET @ 620 KPAG, 70C, GAS, FARRIS TYPE 2600 PSV, MODEL# 26DA10-120/LC, D ORIFICE (0.110 SQ IN API), CONVENTIONAL DESIGN, TEMPERATURE: -50 DEG F TO 650 DEG F, SCREWED CAP CONSTRUCTION, LCC CS BODY & BONNET; 316 SS DISC & NOZZLE, CHROME ALLOY SPRING, COMPLIES TO NACE MR0175-2002 IN PRIMARY ZONE	FARRIS	PSV-08071D
15	2	TEMPERATURE INDICATOR TRANSMITTER	D1: TRANSMITTER HOUSING TYPE/CONDUIT ENTRY: FIELD MOUNT HOUSING, ALUMINUM, 1/2-4 NPT, A: COMMUNICATIONS PROTOCOL: 4-20 MA WITH DIGITAL SIGNAL BASED ON HART PROTOCOL, 1: MEASUREMENT TYPE CONFIGURATION: SINGLE SENSOR INPUT K6: PRODUCT CERTIFICATIONS: CSA IS, FISCO DIVISION 2 AND EXPLOSION-PROOF COMBO, M5: LCD DISPLAY, Q4: CALIBRATION CERTIFICATE, ROSEMOUNT 0068 TEMPERATURE SENSOR MODEL# 0068N21C30A050F62E6Q4R01Q8R07R25, c/w 1-1/2"300# FLANGE CONNECTION 0068: THIN-FILM PLATINUM RTD SENSOR, N: SENSOR LEAD WIRE TERMINATION: SENSOR ONLY WITH 6-INCH; TEFLON-INSULATED; 22-GAUGE LEAD WIRES, 21: SENSOR TYPE: SPRING-LOADED STYLE C: EXTENSION TYPE MATERIAL: NIPPLE UNION SST, 30: EXTENSION LENGTH: 3.0" (STD), A: THERMOWELL MATERIAL: TYPE 316 SST O50: SENSOR IMMERSION LENGTH: 5.0 F62: FLANGE MOUNT 2-INCH; c/w 1-1/2"300# FLANGE CONNECTION (M). E6: CSA EXPLOSION-PROOF APPROVAL Q4:CALIBRATION CERTIFICATION. R01: EXTERNAL PRESSURE TEST. Q8: MTR R07: FULL PENETRATION WELD. R25: CRN	ROSEMOUNT	TZT-08071B/ TW-08071B TT-08071A1/ TW-08071A1
15A	2	GLOBE VALVE	2" CL150 RF GLOBE VALVE, A352-LF2 CL 1 BODY, A352-LF2 CL 1 BONNET, ASTM A276-410/ATL OVERLAY, SST STEM, API TRIM 12, HF SEAT RING, LO-TEMP NACE, NEWAY GL1RC12-NC	NEWAY	VO104-ELD

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8	REVISED AS PER CUSTOMER'S REQUIREMENT	NSP	AA	AA	OCT 2/15
7	REVISED AS PER CUSTOMER'S MARKUPS	NSP	AA	AA	SEPT 1/15
6	REVISED TAGGING & ANSI RATING; ADDED GEN. NOTE 5	GG	ET	PM	DEC 18/14
5	REVISED AS PER CUSTOMER'S MARKUPS	GG	ET	PM	NOV 27/14
4	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	OCT 10/14
3	REVISED AS TITLE BLOCK/TAGGING & ADDED LINE NUMBERS	GG	ET	PM	OCT 02/14
2	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	SEP 17/14
REV	DESCRIPTION	DWN	CHK	APP	DATE

PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

CMT NG PRESSURE REDUCTION
SKID PACKAGE
BOM

DWN BY: GG DATE: JUL 04/14 DWG #: 338716-100-Rev8
CHK BY: ET DATE: JUL 04/14
APP BY: COG DATE: JUL 04/14 PAGE: 3 OF 4 CAD: N/A REV: 8

BILL OF MATERIALS					
ITEM	QTY	TYPE	DESCRIPTION	MFR.	CUST. TAG#
16	1	FLOW INDICATING TRANSMITTER	83F15-EAAS6ANABBA+Z1, PROMASS 83F15, DN15 1/2", CORIOLIS MASS FLOWMETER, ASSIGN CURRENT OUTPUT MASS FLOW CURRENT SPAN 4-20 MA HART, US VALUE 4MA 0.000 LB/MIN, VALUE 20 MA 50.000 LB/MIN, TIME CONSTANT 1.000 S, FAILURE MODE MIN. CURRENT ASSIGN PULSE OUTPUT MASS FLOW, PULSE VALUE (PER PULSE) 0.20000 LB PULSE WIDTH 100.000 MS, OUTPUT SIGNAL PASSIVE - POSITIVE FAILSAFE MODE PULSE OUTPUT FALLBACK VALUE, E MEASURING TUBE MATERIAL: STAINL. STEEL, MAT. CERTIFICATE (CT+WP = CONTAINMENT + WETTED PARTS), AAS PROCESS CONNECTION: CL.150, 316L/1.4404, FLANGE ANSI B16.5, 6 ADDITIONAL TEST, CERTIFICATE: CRN APPROVAL + PRESSURE TEST (TUBE) + TYPE TEST CONTAINMENT) A CALIBRATION: 0.1%, 0.0005G/CC, N APPROVAL: XP FM CL I DIV.1/CSA CL I DIV.1, ABCD + ZONE 1, A HOUSING: COMPACT IP67 NEMA4X, ALUMINIUM, B CABLE ENTRY: THREAD NPT 1/2, B POWER SUPPLY; DISPLAY: 20-55VAC / 16-62VDC; WEA, 4-LINE + TOUCH CONTROL, WEA= LANGUAGE, DE+EN+FR+IT+ES+PT+NL, B ADJUSTMENT; SOFTWARE FEATURE: DEFAULT GAS; BASIC VERSION, A OUTPUT; INPUT: 4-20MA SIL HART + FREQUENCY, Z1 >>MARKING: TAGGING (TAG)	ENDRESS HAUSER	FE-08071A1/ FT-08071A1
17	1	PRESSURE INDICATOR	4.5" DIAL WIKA 233.34 PRESSURE INDICATOR, DUAL UNIT, LIQUID FILLED, 1/2" NPT BOTTOM CONNECTION, 0-10,000 KPAG RANGE, NACE, BLOW OUT BACK	WIKA	PI-08070A
18	1	LEVEL GAUGE	TANSLEY ASSOCIATES LEVEL GAUGE, MOUNTED WITH MERCAPTAN NATURAL GAS ODORIZER	TANSLEY ASSOCIATES	LI-08116A
19	1	LEVEL GAUGE	2" NPT KRUEGER AT-A-GLANCE GAUGE (MECHANICAL LIQUID LEVEL GAUGE)	KRUEGER	LI-08069A
20	6	BALL VALVE	2" 150# RF FULL PORT BALL VALVE, TRUNNION MOUNTED, DBB, A350 LF2 CL1 BODY, CARBON STEEL + 3MIL ENP BALL & STEM, HNBR/RTFE SEATS, JAG FIG TB3-F20R01LH-S1-01	JAG	VB114-ELD
21	9	BALL VALVE	2" CL600 RF FULL PORT BALL VALVE, TRUNNION MOUNTED, DBB, A350 LF2 CL1 BODY, CARBON STEEL + 3MIL ENP BALL & STEM, HNBR/RTFE SEATS, JAG FIG PTD3-F20R15LH-S39-01;	JAG	VB614-ELD
22	3	BALL VALVE	2" CL1500 RF FULL PORT BALL VALVE, TRUNNION MOUNTED, A350 LF2 CL1 BODY, CARBON STEEL + 3MIL ENP BALL & STEM, NYLON SEATS, CSA Z245-15, JAG FIG TB3-F20R15LH-S1-01	JAG	VB1524-ELD
23	4	GATE VALVE	1" SW X SW BOLTED BONNET GATE VALVE, CLASS 800, ASTM A350 LF2 CL1 BODY & BONNET MATERIAL, TRIM F316/HF (API TRIM #12), BONNEY FORGE MODEL HL-1L3S-SW, LO TEMP NACE	BONNEY FORGE	VG801-ELD
24	3	BALL VALVE	1" SW X SW FULL PORT BALL VALVE, NACE TO LO TEMP, HN-705-SW(M), LF2, F316L, 3 PC GOST APPROVAL, CL800, (2000 PSI)	BONNEY FORGE	VB2001-ELD
25	1	BALL VALVE	1" CL150 RF FULL PORT BALL VALVE, 2-PIECE BOLTED BODY, A352 LCC BODY, 316 SS BALL, 316 SS STEM, RPTFE SEAT, GRAPHITE PACKING, STARLINE 175-5GS-G, NACE LO TEMP	STARLINE	VB114-ELD
25A	2	BALL VALVE	1/2" SW X SW FULL PORT BALL VALVE, NACE TO LO TEMP, HN-703-SW, LF2, F316L, 3 PC GOST APPROVAL, CL800, (2000 PSI)	BONNEY FORGE	VB2000-ELD
26	4	GATE VALVE	3/4" SW X SW BOLTED BONNET GATE VALVE, CLASS 800, ASTM A350 LF2 CL1 BODY & BONNET MATERIAL, TRIM F316/HF (API TRIM #12), BONNEY FORGE MODEL HL-1L3S-SW, LO TEMP NACE	BONNEY FORGE	VG801-ELD
27	6	GATE VALVE	3/4" SW X NPT BOLTED BONNET GATE VALVE, CLASS 800, ASTM A350 LF2 CL1 BODY & BONNET MATERIAL, TRIM F316/HF (API TRIM #12), BONNEY FORGE MODEL HL-1L3S-SW-T, LO TEMP NACE	BONNEY FORGE	VG803-ELD
27A	1	GATE VALVE	3/4" SW X NPT BOLTED BONNET GATE VALVE, CLASS 1500, ASTM A350 LF2 CL1 BODY & BONNET MATERIAL, TRIM F316/HF (API TRIM #12), BONNEY FORGE MODEL HL-1L3S-SW-T, LO TEMP NACE	BONNEY FORGE	VG1503-ELD
28	1	CHECK VALVE	1" SW X SW PISTON CHECK VALVE, CLASS 800, ASTM A350 LF2 CL1 BODY/BONNET MATERIAL, TRIM F316/HF (API TRIM #12), BONNEY FORGE MODEL HL-4L3S-SW, LO TEMP NACE	BONNEY FORGE	VC841-ELD
29	2	SPECTACLE BLIND	3" CL600 RF SPECTACLE BLIND, SA-516-70N, (1/2" THK), B16.48	R10-TEK	
29A	1	SPECTACLE BLIND	2" CL600 RF SPECTACLE BLIND, SA-516-70N, (3/8" THK), B16.48	R10-TEK	
30	3	NEEDLE VALVE	1/2" MNPT X FNPT NEEDLE VALVE, HARD SEAT, SS BODY MATERIALS, SS BONNET, SS STEM, TEFLON PACKING, 6000 CWP, CENTURY CM2-1-M44T-DN-T	CENTURY	VN6019-ELD
31	4	MONOFLANGE 3-VALVE MANIFOLD	MODEL# PARKER HPM6LS3DBBB-MD4-14299EHXJ TYPE: HI-PRO MANIFOLD (10MM BORE) VALVE CONFIGURATIONS: 3-VALVE- DOUBLE BLOCK & BLEED (BALL-BALL-BALL) BODY MATERIAL: 316 STAINLESS STEEL INLET: 3/4" NB SOCKET WELD SCH XS EXTENDED 4" OUTLET: 3/4" NPT FEMALE WITH 5MM BORE ORIFICE RESTRICTION VENT: 1/2" FNPT FEMALE WITH 5MM BORE ORIFICE RESTRICTION PRESSURE: 6000 PSI VALVE PACKING: GRAPHITE SEATING: PTFE	PARKER	
32	4	GATE VALVE	1/2" SW X NPT BOLTED BONNET GATE VALVE, CLASS 800, ASTM A350 LF2 CL1 BODY & BONNET MATERIAL, TRIM F316/HF (API TRIM #12), BONNEY FORGE MODEL HL-1L3S-T-05 (M TO SW), LO TEMP NACE	BONNEY FORGE	VG803-ELD
33	2	GATE VALVE	1/2" SW BOLTED BONNET GATE VALVE, CLASS 800, ASTM A350 LF2 CL1 BODY & BONNET MATERIAL, TRIM F316/HF (API TRIM #12), BONNEY FORGE MODEL HL-1L3S-T, LO TEMP NACE	BONNEY FORGE	VG801-ELD
34	4	BLEED RING	2" BLEED RING, 600LB RF C/W 3/4" DRILL SW, 316LSS (1 1/2" THK)	R10-TEK	
35	1	BLEED RING	2" BLEED RING, 900LB RF C/W 3/4" DRILL SW, 316LSS (1 1/2" THK)	R10-TEK	
36	1	GLOBE VALVE	2" CL600 RF GLOBE VALVE, CF8M BODY, CF8M BONNET & DISC, 316 STEM, CF8M + STL. 6 SEAT RING, GRAPHITE+GRPAHITE WITH INCONEL PACKING, PK MODEL 02-601RF125H GRF	PK	
37	1	PRESSURE SAFETY VALVE	1" 150 RF X 2" 150 RF, FARRIS RELIEF VALVE, MODEL# 26DA10-120/LC, SET @ 1827 KPAG, D ORIFICE (0.110 SQ IN API), CONVENTIONAL DESIGN, TEMPERATURE: -50 DEG F TO 650 DEG F, SCREWED CAP CONSTRUCTION, LCC CS BODY & BONNET; 316 SS DISC & NOZZLE CHROME ALLOY, COMPLIES TO NACE MR0175-2002 IN PRIMARY ZONE MTR, CRN, HYDROTEST, SET TESTREPO	FARRIS	PSV-08116A
38	1	ENVIRO BOX	ENVIRO BOX, c/w 3" 150# GATE VALVE, 3" CAMLOCK, DUST CAP WITH CHAIN	STADCO INDUSTRIES	
39	2	ORIFACE PLATE	1/2" CLASS 600#, ORIFICE PLATE, c/w 5mm HOLE	RIO-TEK	

ADDITIONAL BILL OF MATERIAL					
	QTY	TYPE	DESCRIPTION	MFR.	CUST.TAG
	1	TEMPERATURE TRANSMITTER	SMART TEMPERATURE TRANSMITTER, MODEL# 3144PD1A1K6B5M5T1CNQ4HR7XAK1005 C/W TEMPERATURE SENSOR, MODEL# 0068N11N00N030E6X8Q4XA	ROSEMOUNT	TT-21601A
	2	GAS DETECTOR	INFRARED HYDROCARBON GAS DETECTOR, POINTWATCH ECLIPSE CERTIFIED, MODEL PIRECL/UD10	DET-TRONICS	UZT-21601A/B
	1	FLAME DETECTOR	MULTISPECTRUM IR FLAME DETECTOR, MODEL X3301A4N13W1	DET-TRONICS	YZT-21601A
	2	ESD BUTTON	ESD BUTTON, ASSEMBLED CONTROL STATION MODEL GHG43, C/W PUSH BUTTON SGT-55-1-2-06	CROUSE-HINDS	HZS-21601A/2A
	1	ESD BUTTON	ESD BUTTON, STANDARD MUSHROOM HEAD ACTUATOR, RED LENS COLOR, MODEL 800T-FX6D4	ALLEN BRADLEY	HZS-21603A
	1	SMOKE DETECTOR	4 WIRE PHOTOELECTRIC SYSTEM SMOKE DETECTOR, MODEL 8240PY, PART# 908-1208-002	GENTEX	YZT-21602A
	1	TEMPERATURE ELEMENT	RTD (DUPLX) 6mm DIA. 2000 mm LONG PT100 BSEN 60751 : 1996 CLASS B (MINERAL INSULATED) STAINLESS STEEL GRADE 3163 WIRE. TAILS 1MTR LONG.	EX-HEAT	TE-08071D
	1	HORN	LOUDSPEAKER, SELECTONE HAZARDOUS LOCATION AUDIBLE SIGNALLING DEVICE MODEL 302GCX	FEDERAL SIGNAL	XAF-21601A
	2	STROBE	FLASHING LED HAZARDOUS LOCATION WARNING LIGHT WITH XLT™, MODEL 191XL-S024R	FEDERAL SIGNAL	XAF-21603A1/A2
	2	STROBE	FLASHING LED HAZARDOUS LOCATION WARNING LIGHT WITH XLT™, MODEL 191XL-S024R	FEDERAL SIGNAL	XAF-21605A1/A2
	1	GAS ROOM HEATER	GE FORCED AIR HEATER REGULAR DUTY 10 KW, MODEL GE108CT	CALORITECH	H-08167
	1	ELECTRICAL ROOM HEATER	EXPLOSION-PROOF ELECTRIC AIR HEATER FOR HAZARDOUS LOCATIONS, 25 KW, MODEL XEU1-20-250-600360	HAZLOC	H-08170

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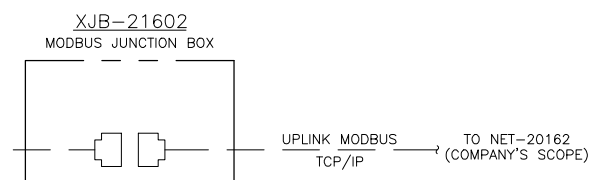
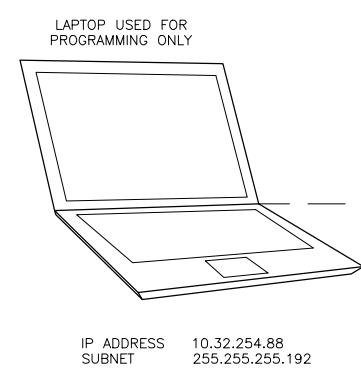
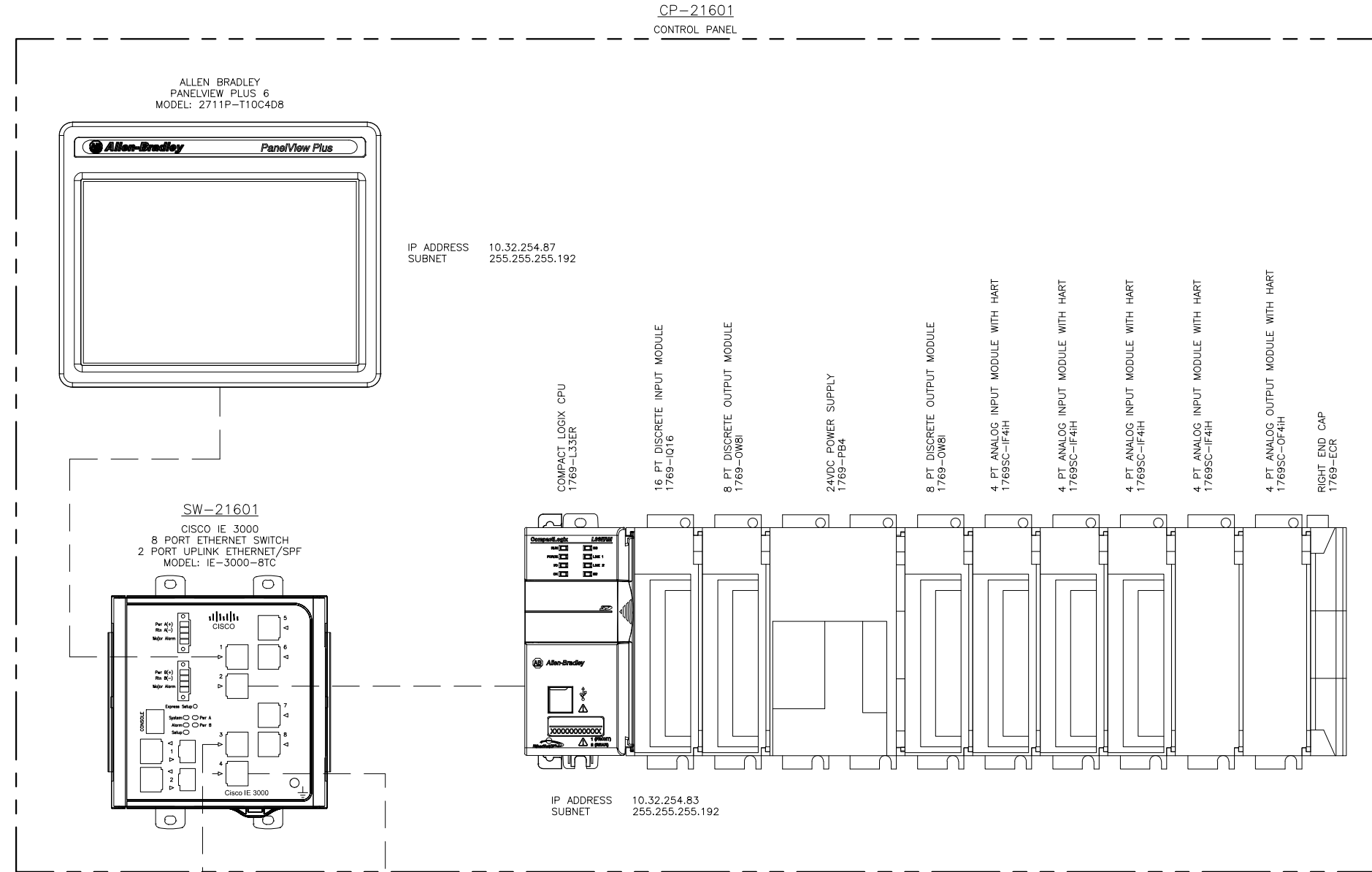


REV	DESCRIPTION	DWN	CHK	APP	DATE
8	REVISED AS PER CUSTOMER'S REQUIREMENT	NSP	AA	AA	OCT 2/15
7	REVISED AS PER CUSTOMER'S MARKUPS	NSP	AA	AA	SEPT 1/15
6	REVISED TAGGING & ANSI RATING; ADDED GEN. NOTE 5	GG	ET	PM	DEC 18/14
5	REVISED AS PER CUSTOMER'S MARKUPS	GG	ET	PM	NOV 27/14
4	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	OCT 10/14
3	REVISED AS TITLE BLOCK/TAGGING & ADDED LINE NUMBERS	GG	ET	PM	OCT 02/14
2	REVISED AS PER CUSTOMER'S COMMENTS	GG	ET	PM	SEP 17/14

PROJECT NAME:	CARMON CREEK PROJECT		
CUSTOMER:	SHELL CANADA c/o JACOBS ENGINEERING		
LOCATION:	CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2		
TAG:	0735A-08030		
SLS#:	338716	QUOTE:	CGY2014-85
PO#:	4512-109-130		
DWN BY:	GG	DATE:	JUL 04/14
CHK BY:	ET	DATE:	JUL 04/14
APP BY:	COG	DATE:	JUL 04/14
DWG #:	338716-100-Rev8		
PAGE:	4 OF 4	CAD:	N/A
REV:	8		

**CMT NG PRESSURE REDUCTION
SKID PACKAGE
BOM**

LEGEND
TCP/IP



- REFERENCE DRAWINGS:**
- DWG. 7300 - CP-21601 PLC PANEL DIMENSIONAL & DOOR LAYOUT
 - DWG. 7301 - CP-21601 PLC PANEL BACKPAN LAYOUT & BOM
 - DWG. 7305 - CP-21601 PLC PANEL POWER DISTRIBUTION
 - DWG. 7309 - CP-21601 PLC PANEL SYSTEM ARCHITECTURE
 - DWG. 7320 - CP-21601 PLC DISCRETE INPUT SCHEMATIC
 - DWG. 7330 - CP-21601 PLC DISCRETE OUTPUT SCHEMATIC
 - DWG. 7340 - CP-21601 PLC ANALOG INPUT SCHEMATIC (1 OF 2)
 - DWG. 7341 - CP-21601 PLC ANALOG INPUT SCHEMATIC (2 OF 2)
 - DWG. 7347 - CP-21601 PLC ANALOG OUTPUT SCHEMATIC

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PROJECT NAME: CARMON CREEK
CUSTOMER: SHELL
LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

DWN BY: JP	DATE: JUL 23/14	DWG #:	214068-7309
CHK BY: JS	DATE: JUL 23/14	PAGE: 1 OF 1	
APP BY: -	DATE: -	CAD: N/A	

REV	DESCRIPTION	DWN	CHK	APP	DATE
2	AS-BUILT	LS	JS	-	NOV 09/15
1	ISSUED FOR FIELD CONSTRUCTION	JP	JS	-	AUG 18/15
0	ISSUED FOR CONSTRUCTION	JB	JS	-	MAY 05/15

**CMT NG PRESSURE REDUCTION SKID PACKAGE
CP-21601 PLC PANEL SYSTEM ARCHITECTURE**

COLLEAUX ENGINEERING INC.



NATIONAL PROCESS EQUIPMENT

0735A-08030 CMT - NATURAL GAS PRESSURE REDUCTION SKID PACKAGE

UTILITIES SCHEDULE

CARMON CREEK

REV 1

Client: SHELL c/o JACOBS ENGINEERING

SLS # 338716

BUILDING #

DOC #:

Date: March 6, 2015

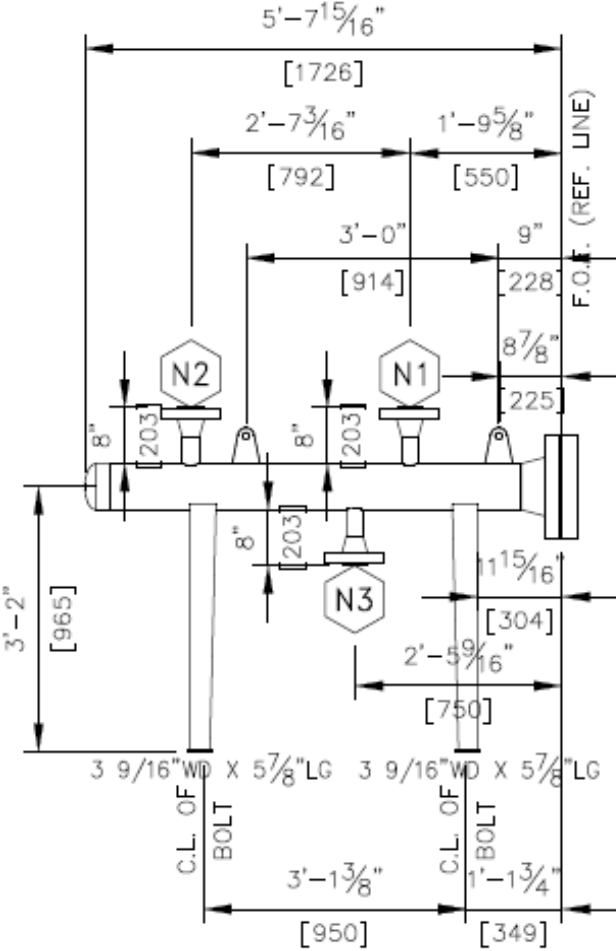
MAIN POWER		CHARACTERISTICS			
SERVICE DISCRIPTION	VOLTAGE	AMPERAGE	CIRCUITS	MAIN BREAKER	
MAIN DISTRIBUTION PANEL	600/3/60	100	18	100AMP 65KA	
CONNECTED LOADS					
SERVICE DISCRIPTION	VOLTAGE	TOLERANCE	HARMONICS	TOTAL CURRENT	REMARKS
NATURAL GAS HEATER 4.4KW	600/3/60	5% max. unbalance	5% max. THD	5	min. 575V at skid
UNIT HEATER 10KW	600/3/60	5% max. unbalance	5% max. THD	10	min. 575V at skid
UNIT HEATER 20KW	600/3/60	5% max. unbalance	5% max. THD	20	min. 575V at skid
BUILDING TRANSFORMER 30KVA 600-120/208 3PH	600/3/60	5% max. unbalance	5% max. THD	30	min. 575V at skid

APPROXIMATE TOTAL LOAD CURRENT

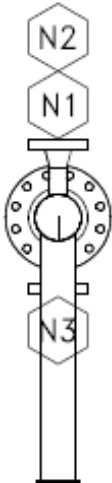
65

VESSEL DATA SHEET

NATURAL GAS ELECTRIC HEATER				
DESIGN DATA				
1	Rated Heat Duty	4.4KW/600V/60HZ/3PH		
2	Quantity of Vessels (Tag#)	One (Tag# H-08071)		
3	Design Code	2013 ASME SEC VIII, DIV 1		
4	Dimensions	168mm OD x 1726mm OAL		
5	Max. Operating Pressure	8500kpag (1233PSIG)		
6	Vessel Design Pressure	9930kpag (1440PSIG)		
7	Vessel Vacuum Rating	FV @ 93°C		
8	Vessel Design Temperature	93° C (200°F)		
9	MDMT Temperature	-45° C (-50°F)		
10	Corrosion Allowance	1.5mm (0.0625")		
11	PWHT/Volume	NO/0.03m3 (1.02 cu.ft)		
12	Materials of Construction	Shell: SA-333-6/Head:SA-420-WPL6/SA-350-LF2 Class 1		
13	Studs/Nuts/Gasket Type	SA-320-L7/SA-194-2H/1/8" thk Flexitallic		
14	Flanges/Nozzles-Necks	SA-350-LF2 Class 1/SA-333-6		
15	Radiography	UW-11(a) , RT-1 (Full)		
16	Hydrotest	12,909kpag (1872PSIG)		
17	CRN	W8598.2		
18	Empty Weight/Full Weight	1045kg(2299lbs)/1274kg(2803lbs)		
19	Sweet Natural Gas	YES		
External Attachments Description				
a	Name Plate/Bracket	SS/SA-516-70N		
b	Davit Arm	N/A		
c	Lifting Lugs	SA-516-70N		
d	Insulation	SS mesh guard only for personnel protection		
e	Saddle	SA-516-70N		
f	Skirt	N/A		
g	Base Plate	SA-516-70N		
Nozzle Schedule				
MK.	Qty.	Size	Rating/Type	Service
N1	1	60 (2")	900# RFWN	GAS INLET
N2	1	60 (2")	900# RFWN	GAS OUTLET
N3	1	60 (2")	900# RFWN	DRAIN



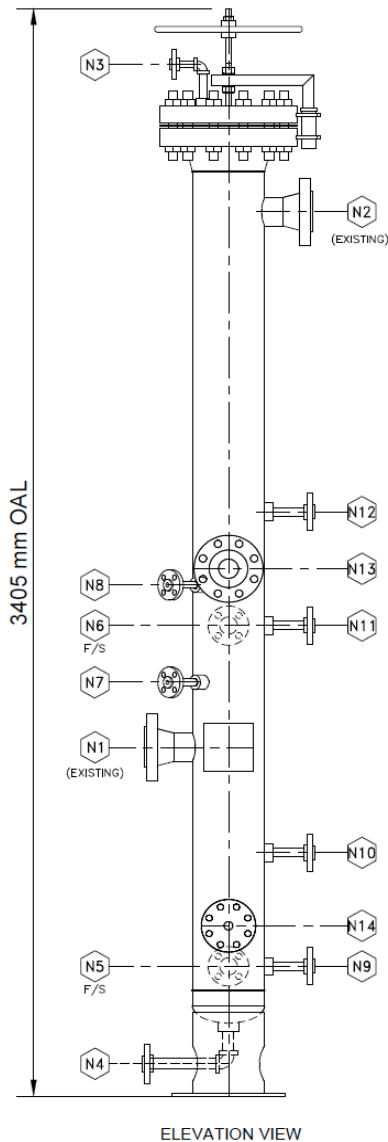
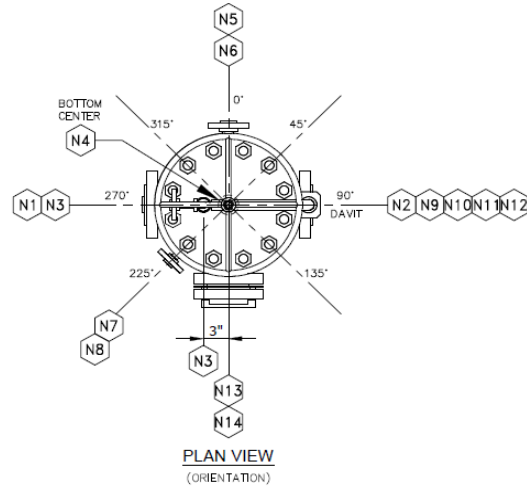
ELEVATION VIEW



RIGHT SIDE VIEW

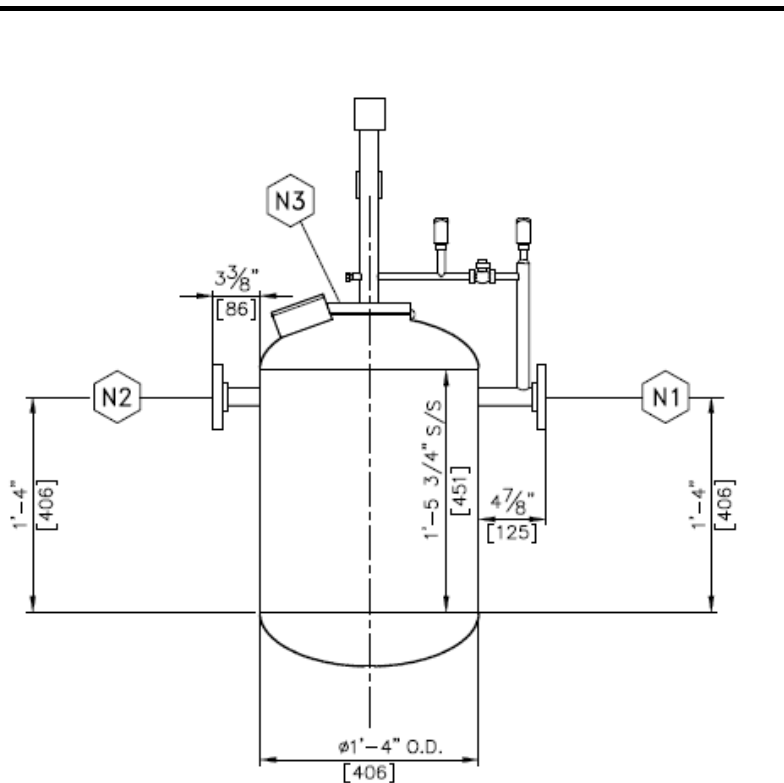
VESSEL DATA SHEET

COALESCER FILTER (STOCK VESSEL)				
DESIGN DATA Rev 0				
1	Make- Model	Jonell-JVC-3-8-1440-1-336-STD c/w JPMG-336-CF-R Filter Element		
2	Quantity of Vessels (Tag#)	One (Tag# S-08070)		
3	Design Code	2013 Ed. ASME SEC VIII, DIV 1		
4	Dimensions	219mm OD x 3405mm OAL		
5	Max. Operating Pressure	8500kpag (1233PSIG)		
6	Vessel Design Pressure	9930kpag (1440PSIG)		
7	Vessel Vacuum Rating	N/A		
8	Vessel Design Temperature	54° C (130°F)		
9	MDMT Temperature	-45° C (-50°F)		
10	Corrosion Allowance	3.05mm (0.12")		
11	PWHT/Volume	NO/0.08m3 (2.96cu.ft)		
12	Materials of Construction	Shell-SA-106-B/Head-SA- 234-WPB/SA-105N		
13	Studs/Nuts/Gasket Type	SA-193-B7M/SA-194-2HM/1/8" thk Flex		
14	Flanges/Nozzles-Necks/Coupling/SW-Elbow	SA-350-LF2 Class 1/SA-333-6/SA-105N/SA-350-LF2 Class 1		
15	Radiography	UW-11(a) , RT-1 (Full)		
16	Hydrotest	12,907kpag (1872PSIG)		
17	CRN	T5967.213		
18	Empty Weight/Full Weight	409kg(900lbs)/493kg(1084lbs)		
19	Sweet Natural Gas	YES		
20	External Attachments Description			
a	Name Plate	SS/CS		
b	Davit Arm	Yes		
c	Lifting Lugs	N/A		
d	Insulation	N/A		
e	Saddle	N/A		
f	Skirt	SA-106-B		
g	Base Plate	SA-516-70N		
21	Nozzle Schedule			
MK.	Qty.	Size	Rating/Type	Service
N1	1	89 (3")	600# RFWN	GAS INLET
N2	1	89 (3")	600# RFWN	GAS OUTLET
N3	1	21 (½")	600# RFSW	VENT
N4	1	33 (1")	600# RFSW	DRAIN
N5	1	33 (1")	600# RFSW	LIQUID OUT (LOWER)
N6	1	33 (1")	600# RFSW	LIQUID OUT (UPPER)
N7	1	21 (½")	600# RFSW	DPI
N8	1	21 (½")	600# RFSW	DPI
N9	1	27 (¾")	600# RFSW	LG (LOWER)
N10	1	27 (¾")	600# RFSW	LG (LOWER)
N11	1	27 (¾")	600# RFSW	LG (UPPER)
N12	1	27 (¾")	600# RFSW	LG (UPPER)
N13	1	60 (2")	600# RFWN	LLC UPPER C/W BLIND
N14	1	60 (2")	600# RFWN	LLC LOWER C/W BLIND

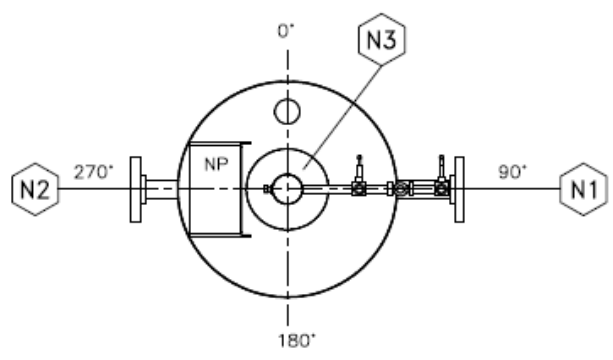


VESSEL DATA SHEET

MERCAPTAN GAS ODORIZER (STOCK VESSEL)				
DESIGN DATA REV 0				
1	Make- Model	KingTool-Model 3B		
2	Quantity of Vessels (Tag#)	One (Tag# V-08116)		
3	Design Code	2013 Ed. ASME SEC VIII DIV 1		
4	Dimensions	406mm OD x 451mm S/S		
5	Max. Operating Pressure	50kpag (7.25PSIG)		
6	Vessel Design Pressure	2068kpag (300PSIG)		
7	Vessel Vacuum Rating	N/A		
8	Vessel Design Temperature	66° C (150°F)		
9	MDMT Temperature	-45° C (-49°F)		
10	Corrosion Allowance	0mm (0")		
11	PWHT/Volume	No/0.07m ³ (2.66cu.ft)		
12	Materials of Construction	Shell: SA-106B SMLS Head: SA- 516-70N		
13	Studs/Nuts/Gasket Type	N/A		
14	Flanges Nozzles-Necks	SA-350-LF2 Class 1 SA-106 B SMLS/SA-516-70		
15	Radiography	UW-11(a), RT-1 (Full)		
16	Hydrotest	3,103kpag (450PSIG)		
17	CRN	L-3956.52		
18	Empty Weight/Full Weight	118kg(260lbs)/194kg(426bs)		
19	Sweet Natural Gas	YES		
20	External Attachments Description			
a	Name Plate	SS/CS		
b	Davit Arm	N/A		
c	Lifting Lugs	N/A		
d	Insulation/Heat Trace	By others in the field		
e	Saddle	N/A		
f	Skirt	N/A		
g	Base Plate	N/A		
21	Nozzle Schedule			
MK.	Qty.	Size	Rating/Type	Service
N1	1	(33) 1"	300# RFTHRD	GAS INLET
N2	1	(33) 1"	300# RFTHRD	GAS OUTLET
N3	1	168 (6")	N/A	HANDHOLE c/w CAP BOLTS



ELEVATION VIEW



PLAN VIEW
(ORIENTATION)

MATERIAL OF CONSTRUCTION										BILL OF MATERIALS															
Primary Tank Material: C.S.					Secondary Tank Material: C.S.					ITEM NO.	QTY	DESCRIPTION	DWG. NO.												
Head Thickness	Shell Thickness	Bottom Thickness	Roof Thickness	Other	Head Thickness	Shell Thickness	Bottom Thickness	Roof Thickness	Other																
2.5mm	2.5mm	N/A	N/A	N/A	2.5mm	2.5mm	N/A	N/A	N/A	1P	2	PRIMARY TANK HEAD													
										1S	2	SECONDARY TANK HEAD													
										2P	1	PRIMARY SHELL													
										2S	1	SECONDARY SHELL													
										3															
										4	1	LIFT LUG: PHOENIX SMALL #2-900-LUG													
										5	3	WELDIN: 2" NPT													
										6															
										7	1	WELDIN: 3" NPT													
										7a	1	VTFE30000XA	1												
										8	1	VIND40000XC-	1												
										9	1	BRKT ULC LABEL													
										9.1	1	LABEL: ULC-S601-07													
										10	1	PCUPH300010	1												
										10.1	1	SPLUG000100	1												
										11	1	PIPE: 1-1/2" SCH.40 x 30" LG. w/ T.O.E													
										11.1	1	PIPE CAP: 1-1/2" NPT													
										12															
										13	2	SADDLE: SKID TANK, 28" DIA													
										14															
										Replace 1-1/2" Weldin #6 with 2" #5, Revise E-Vent RG Apr 14/14 Revise Containment E-Vent HK Mar 13/13 Revise Containment E-Vent RG May 16/12															
										REFERENCE: C.S.T.I. CAN/ULC-S601 TANK CONSTRUCTION MANUAL										REFERENCE: C.S.T.I. CAN/ULC-S601 TANK CONSTRUCTION MANUAL					
										Name of Manufacturer: SteelCraft Inc.										PRIMARY TANK JOINTS			TANK CONNECTIONS		
										Year of Manufacture: MARKING / DECALS										Shell / Sidewall Fig. 1 - S1.5			Primary Secondary		
Tank Capacity: 455 Ltrs.										All Tanks: YES Head Fig. 2 - H2.5			Weldin Fig. 6 - 6.1a N/A												
Maximum Operating Pressure: 7 kPa										Rectangular Tanks: NO Roof N/A			Coupling Fig. 6 - 6.2 Fig. 10 - 10.2												
Maximum Test Pressure: 35 kPa										Utility Tanks: YES Bottom N/A			Flanged Fig. 6 - 6.5 N/A												
Maximum Operating Vacuum: 300 Pa										Double Wall Tanks: NO Corner N/A			Manway N/A N/A												
Req. Cap. of Emergency Venting: 33.8 cu.m./min										Contained Tanks: YES SECONDARY WALL JOINTS			Interstitial Connections Figure 12												
Standard Number: CAN/ULC-S601-07										Other: NO Shell / Sidewall Lap			Lifting / Tailing Lug Connections Fig. 14, IIIa												
Approx. Weight: 305 lbs. Serial No.:										Head / Shell Fig. 11 - D.2			Bulkhead Construction N/A												
Interior Finish: As Welded										Bottom N/A			Bracing for Unflanged Flat Heads N/A												
Exterior Finish: Apply One Coat Primer, Finish Coat (T.B.D.)										Spacer N/A			Production Test in accordance with Page 6												
										DESCRIPTION: 455 Ltr. A/G Utility Tank - Contained, 100%			CUSTOMER: SteelCraft Inc.												
										PROJECT:			ITEM NO.: TH5G000455X07E DRN.: RG Dec 02/10 SCALE: 1:14												
										JOB NO.:			DWG. NO.: TH5G000455X07E												

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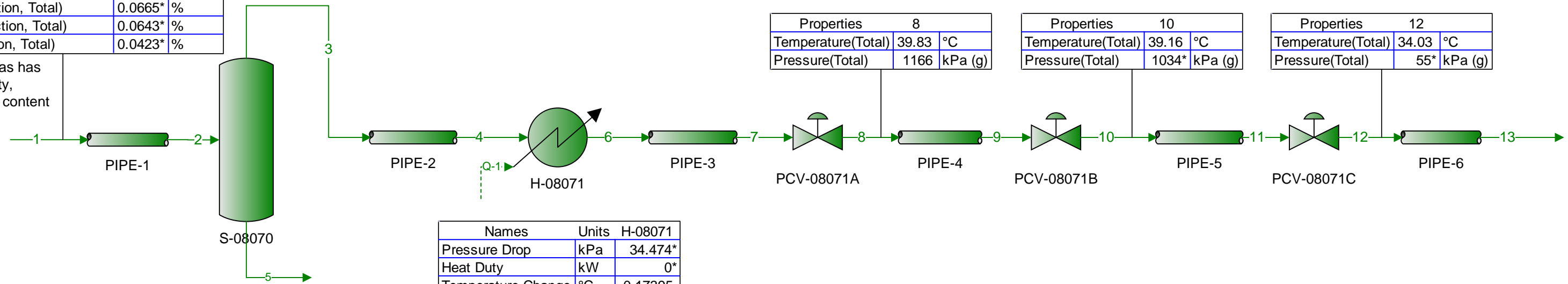
STEELCRAFT
Clemmer Division

3

CMT – Maximum Temperature Case 1 – Minimum Inlet Pressure and Maximum Flow Rate

Properties		1
Temperature(Total)		40* °C
Pressure(Total)		1200* kPa (g)
Std Vapor Volumetric Flow(Total)		1540* SCMD
Molecular Weight(Total)		17.58 lb/lbmol
Mass Flow(Total)		47.62 kg/h
Composition		1
He(Mole Fraction, Total)		0.0641* %
N2(Mole Fraction, Total)		0.9642* %
CO2(Mole Fraction, Total)		0.3853* %
C1(Mole Fraction, Total)		92.213* %
C2(Mole Fraction, Total)		4.2389* %
C3(Mole Fraction, Total)		1.4261* %
i-C4(Mole Fraction, Total)		0.2028* %
n-C4(Mole Fraction, Total)		0.3328* %
i-C5(Mole Fraction, Total)		0.0665* %
n-C5(Mole Fraction, Total)		0.0643* %
C6(Mole Fraction, Total)		0.0423* %

Assume feed gas has sales gas quality, maximum H2O content is 3lbs/MMSCF



Stream Table

Names	Units	1	2	3	4	6	7	8	9	10	11	12	13
Temperature	°C	40*	40	40	40	39.83	39.83	39.83	39.83	39.16	39.16	34.03	34.03
Pressure	kPa (g)	1200*	1200	1200	1200	1166	1166	1166	1166	1034*	1034	55*	54.95
Molecular Weight	lb/lbmol	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58
Std Vapor Volumetric Flow	SCMD	1540*	1540	1540	1540	1540	1540	1540	1540	1540	1540	1540	1540
Mass Flow	kg/h	47.619	47.619	47.619	47.619	47.619	47.619	47.619	47.619	47.619	47.619	47.619	47.619

Names	Units	H-08071
Pressure Drop	kPa	34.474*
Heat Duty	kW	0*
Temperature Change	°C	-0.17395

Properties		8
Temperature(Total)		39.83 °C
Pressure(Total)		1166 kPa (g)

Properties		10
Temperature(Total)		39.16 °C
Pressure(Total)		1034* kPa (g)

Properties		12
Temperature(Total)		34.03 °C
Pressure(Total)		55* kPa (g)

2in, SCH.80, Piping Properties

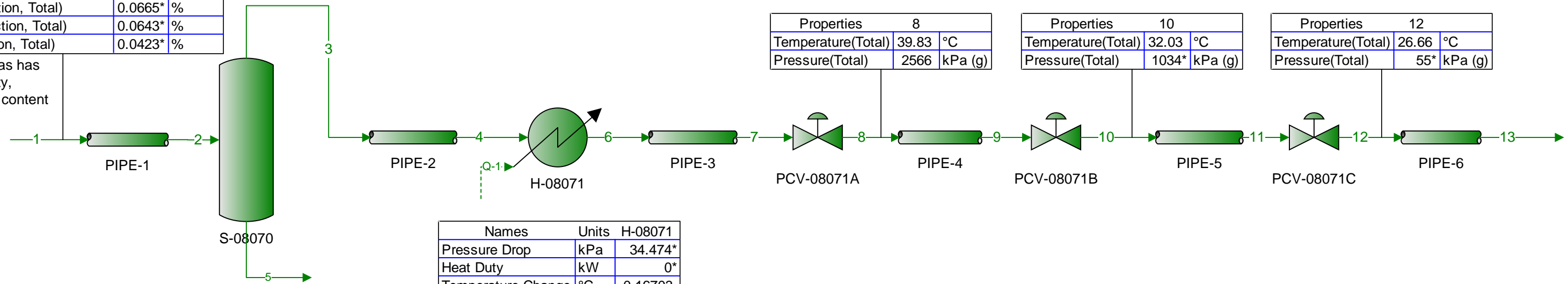
Pipe 1 Gas Velocity	0.234#	m/s
Pipe 2 Gas Velocity	0.769#	m/s
Pipe 3 Gas Velocity	0.79#	m/s
Pipe 4 Gas Velocity	0.79#	m/s
Pipe 5 Gas Velocity	0.882#	m/s
Pipe 6 Gas Velocity	6.43#	m/s

Names	Units	PIPE-1	PIPE-2	PIPE-3	PIPE-4	PIPE-5	PIPE-6
Pipe Length	m	4.572	4.572	4.572	4.572	4.572	4.572
Total Pressure Drop	kPa	0.00643	0.00643	0.0066	0.0066	0.00736	0.0535

CMT – Maximum Temperature Case 2 – Medium Inlet Pressure and Medium Flow Rate

Properties		1	
Temperature(Total)	40*	°C	
Pressure(Total)	2600*	kPa (g)	
Std Vapor Volumetric Flow(Total)	695*	SCMD	
Molecular Weight(Total)	17.58	lb/lbmol	
Mass Flow(Total)	21.49	kg/h	
Composition		1	
He(Mole Fraction, Total)	0.0641*	%	
N2(Mole Fraction, Total)	0.9642*	%	
CO2(Mole Fraction, Total)	0.3853*	%	
C1(Mole Fraction, Total)	92.213*	%	
C2(Mole Fraction, Total)	4.2389*	%	
C3(Mole Fraction, Total)	1.4261*	%	
i-C4(Mole Fraction, Total)	0.2028*	%	
n-C4(Mole Fraction, Total)	0.3328*	%	
i-C5(Mole Fraction, Total)	0.0665*	%	
n-C5(Mole Fraction, Total)	0.0643*	%	
C6(Mole Fraction, Total)	0.0423*	%	

Assume feed gas has sales gas quality, maximum H2O content is 3lbs/MMSCF



Stream Table

Names	Units	1	2	3	4	6	7	8	9	10	11	12	13
Temperature	°C	40*	40	40	40	39.83	39.83	39.83	39.83	32.03	32.03	26.66	26.66
Pressure	kPa (g)	2600*	2600	2600	2600	2566	2566	2566	2566	1034*	1034	55*	54.99
Molecular Weight	lb/lbmol	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58
Std Vapor Volumetric Flow	SCMD	695*	695	695	695	695	695	695	695	695	695	695	695
Mass Flow	kg/h	21.49	21.49	21.49	21.49	21.49	21.49	21.49	21.49	21.49	21.49	21.49	21.49

Properties		8	
Temperature(Total)	39.83	°C	
Pressure(Total)	2566	kPa (g)	

Properties		10	
Temperature(Total)	32.03	°C	
Pressure(Total)	1034*	kPa (g)	

Properties		12	
Temperature(Total)	26.66	°C	
Pressure(Total)	55*	kPa (g)	

Names	Units	H-08071
Pressure Drop	kPa	34.474*
Heat Duty	kW	0*
Temperature Change	°C	-0.16703

2in, SCH.80, Piping Properties

Pipe 1 Gas Velocity_x1	0.0496#	m/s
Pipe 2 Gas Velocity_x1	0.163#	m/s
Pipe 3 Gas Velocity_x1	0.165#	m/s
Pipe 4 Gas Velocity_x1	0.165#	m/s
Pipe 5 Gas Velocity_x1	0.388#	m/s
Pipe 6 Gas Velocity_x1	2.83#	m/s

Names	Units	PIPE-1	PIPE-2	PIPE-3	PIPE-4	PIPE-5	PIPE-6
Pipe Length	m	4.572	4.572	4.572	4.572	4.572	4.572
Total Pressure Drop	kPa	0.000721	0.000721	0.00073	0.00073	0.0017	0.0123

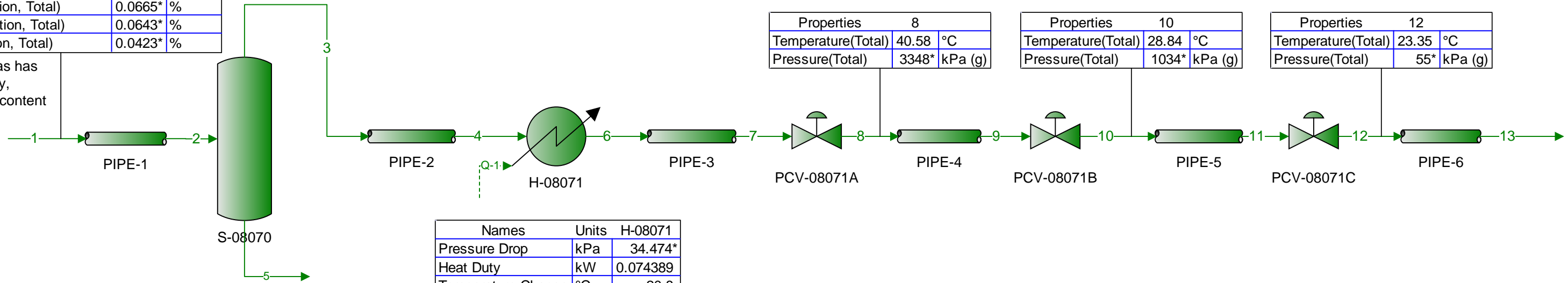


Swift Engineering Inc.

CMT – Maximum Temperature Case 3 – Maximum Inlet Pressure and Minimum Flow Rate

Properties		1	
Temperature(Total)	40*	°C	
Pressure(Total)	8500*	kPa (g)	
Std Vapor Volumetric Flow(Total)	150*	SCMD	
Molecular Weight(Total)	17.58	lb/lbmol	
Mass Flow(Total)	4.638	kg/h	
Composition		1	
He(Mole Fraction, Total)	0.0641*	%	
N2(Mole Fraction, Total)	0.9642*	%	
CO2(Mole Fraction, Total)	0.3853*	%	
C1(Mole Fraction, Total)	92.213*	%	
C2(Mole Fraction, Total)	4.2389*	%	
C3(Mole Fraction, Total)	1.4261*	%	
i-C4(Mole Fraction, Total)	0.2028*	%	
n-C4(Mole Fraction, Total)	0.3328*	%	
i-C5(Mole Fraction, Total)	0.0665*	%	
n-C5(Mole Fraction, Total)	0.0643*	%	
C6(Mole Fraction, Total)	0.0423*	%	

Assume feed gas has sales gas quality, maximum H2O content is 3lbs/MMSCF



Stream Table

Names	Units	1	2	3	4	6	7	8	9	10	11	12	13
Temperature	°C	40*	40	40	40	60.8*	60.8	40.58	40.58	28.84	28.84	23.35	23.35
Pressure	kPa (g)	8500*	8500	8500	8500	8466	8466	3348*	3348	1034*	1034	55*	55
Molecular Weight	lb/lbmol	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58
Std Vapor Volumetric Flow	SCMD	150*	150	150	150	150	150	150	150	150	150	150	150
Mass Flow	kg/h	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382

Names	Units	H-08071
Pressure Drop	kPa	34.474*
Heat Duty	kW	0.074389
Temperature Change	°C	20.8

2in, SCH.80, Piping Properties

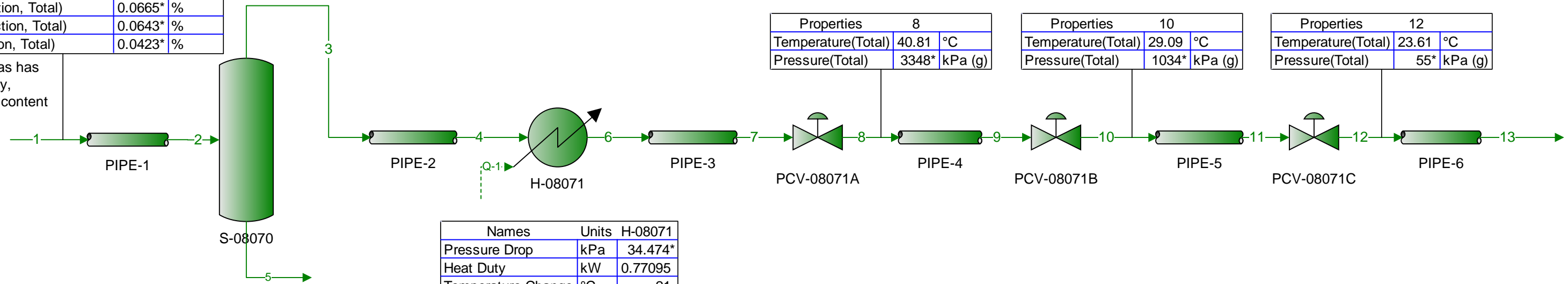
Pipe 1 Gas Velocity_x2	0.00305#	m/s
Pipe 2 Gas Velocity_x2	0.00999#	m/s
Pipe 3 Gas Velocity_x2	0.0111#	m/s
Pipe 4 Gas Velocity_x2	0.0272#	m/s
Pipe 5 Gas Velocity_x2	0.0828#	m/s
Pipe 6 Gas Velocity_x2	0.604#	m/s

Names	Units	PIPE-1	PIPE-2	PIPE-3	PIPE-4	PIPE-5	PIPE-6
Pipe Length	m	4.572	4.572	4.572	4.572	4.572	4.572
Total Pressure Drop	kPa	1.48e-005	1.48e-005	1.67e-005	3.88e-005	0.000116	0.000839

CMT – Maximum Temperature Case 4 – Maximum Inlet Pressure and Maximum Flow Rate

Properties		1
Temperature(Total)		40* °C
Pressure(Total)		8500* kPa (g)
Std Vapor Volumetric Flow(Total)		1540* SCMD
Molecular Weight(Total)		17.58 lb/lbmol
Mass Flow(Total)		47.62 kg/h
Composition		1
He(Mole Fraction, Total)		0.0641* %
N2(Mole Fraction, Total)		0.9642* %
CO2(Mole Fraction, Total)		0.3853* %
C1(Mole Fraction, Total)		92.213* %
C2(Mole Fraction, Total)		4.2389* %
C3(Mole Fraction, Total)		1.4261* %
i-C4(Mole Fraction, Total)		0.2028* %
n-C4(Mole Fraction, Total)		0.3328* %
i-C5(Mole Fraction, Total)		0.0665* %
n-C5(Mole Fraction, Total)		0.0643* %
C6(Mole Fraction, Total)		0.0423* %

Assume feed gas has sales gas quality, maximum H2O content is 3lbs/MMSCF



Stream Table

Names	Units	1	2	3	4	6	7	8	9	10	11	12	13
Temperature	°C	40*	40	40	40	61*	61	40.81	40.81	29.09	29.09	23.61	23.6
Pressure	kPa (g)	8500*	8500	8500	8500	8466	8466	3348*	3348	1034*	1034	55*	54.95
Molecular Weight	lb/lbmol	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58
Std Vapor Volumetric Flow	SCMD	1540*	1540	1540	1540	1540	1540	1540	1540	1540	1540	1540	1540
Mass Flow	kg/h	47.619	47.619	47.619	47.619	47.619	47.619	47.619	47.619	47.619	47.619	47.619	47.619

Properties		8
Temperature(Total)		40.81 °C
Pressure(Total)		3348* kPa (g)

Properties		10
Temperature(Total)		29.09 °C
Pressure(Total)		1034* kPa (g)

Properties		12
Temperature(Total)		23.61 °C
Pressure(Total)		55* kPa (g)

Names	Units	H-08071
Pressure Drop	kPa	34.474*
Heat Duty	kW	0.77095
Temperature Change	°C	21

2in, SCH.80, Piping Properties

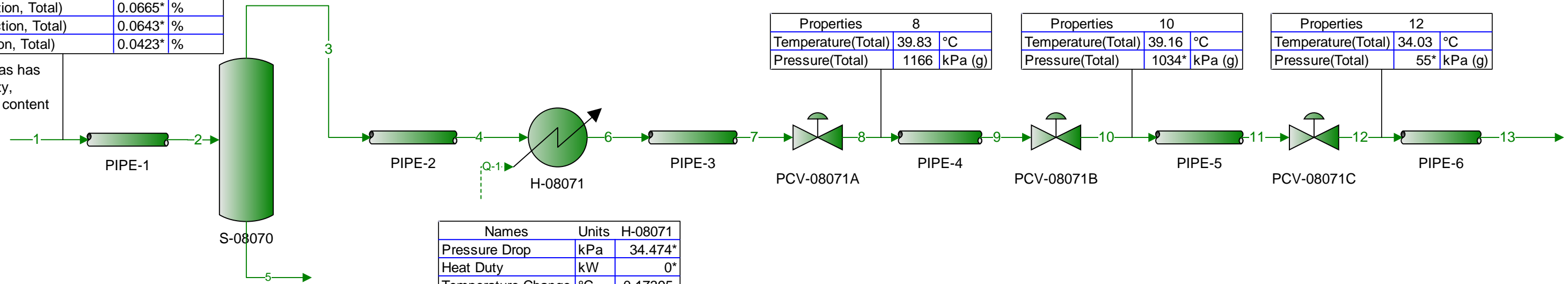
Pipe 1 Gas Velocity_x3	0.0313#	m/s
Pipe 2 Gas Velocity_x3	0.103#	m/s
Pipe 3 Gas Velocity_x3	0.114#	m/s
Pipe 4 Gas Velocity_x3	0.279#	m/s
Pipe 5 Gas Velocity_x3	0.851#	m/s
Pipe 6 Gas Velocity_x3	6.21#	m/s

Names	Units	PIPE-1	PIPE-2	PIPE-3	PIPE-4	PIPE-5	PIPE-6
Pipe Length	m	4.572	4.572	4.572	4.572	4.572	4.572
Total Pressure Drop	kPa	0.000882	0.000882	0.000989	0.00235	0.00707	0.0514

CMT – Maximum Temperature Case 5 – Minimum Inlet Pressure and Minimum Flow Rate

Properties		1
Temperature(Total)		40* °C
Pressure(Total)		1200* kPa (g)
Std Vapor Volumetric Flow(Total)		150* SCMD
Molecular Weight(Total)		17.58 lb/lbmol
Mass Flow(Total)		4.638 kg/h
Composition		1
He(Mole Fraction, Total)		0.0641* %
N2(Mole Fraction, Total)		0.9642* %
CO2(Mole Fraction, Total)		0.3853* %
C1(Mole Fraction, Total)		92.213* %
C2(Mole Fraction, Total)		4.2389* %
C3(Mole Fraction, Total)		1.4261* %
i-C4(Mole Fraction, Total)		0.2028* %
n-C4(Mole Fraction, Total)		0.3328* %
i-C5(Mole Fraction, Total)		0.0665* %
n-C5(Mole Fraction, Total)		0.0643* %
C6(Mole Fraction, Total)		0.0423* %

Assume feed gas has sales gas quality, maximum H2O content is 3lbs/MMSCF



Stream Table

Names	Units	1	2	3	4	6	7	8	9	10	11	12	13
Temperature	°C	40*	40	40	40	39.83	39.83	39.83	39.83	39.16	39.16	34.03	34.03
Pressure	kPa (g)	1200*	1200	1200	1200	1166	1166	1166	1166	1034*	1034	55*	55
Molecular Weight	lb/lbmol	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58
Std Vapor Volumetric Flow	SCMD	150*	150	150	150	150	150	150	150	150	150	150	150
Mass Flow	kg/h	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382

Names	Units	H-08071
Pressure Drop	kPa	34.474*
Heat Duty	kW	0*
Temperature Change	°C	-0.17395

Properties		8
Temperature(Total)		39.83 °C
Pressure(Total)		1166 kPa (g)

Properties		10
Temperature(Total)		39.16 °C
Pressure(Total)		1034* kPa (g)

Properties		12
Temperature(Total)		34.03 °C
Pressure(Total)		55* kPa (g)

2in, SCH.80, Piping Properties

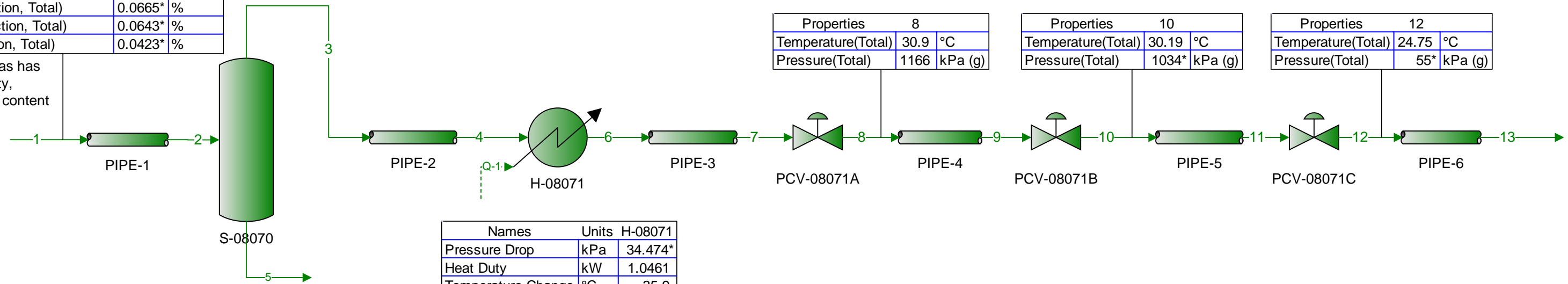
Pipe 1 Gas Velocity_x4	0.0228#	m/s
Pipe 2 Gas Velocity_x4	0.0749#	m/s
Pipe 3 Gas Velocity_x4	0.077#	m/s
Pipe 4 Gas Velocity_x4	0.077#	m/s
Pipe 5 Gas Velocity_x4	0.0859#	m/s
Pipe 6 Gas Velocity_x4	0.626#	m/s

Names	Units	PIPE-1	PIPE-2	PIPE-3	PIPE-4	PIPE-5	PIPE-6
Pipe Length	m	4.572	4.572	4.572	4.572	4.572	4.572
Total Pressure Drop	kPa	0.000106	0.000106	0.000109	0.000109	0.000121	0.000877

CMT – Minimum Temperature Case 1 – Minimum Inlet Pressure and Maximum Flow Rate

Properties		1	
Temperature(Total)	-5*	°C	
Pressure(Total)	1200*	kPa (g)	
Std Vapor Volumetric Flow(Total)	1540*	SCMD	
Molecular Weight(Total)	17.58	lb/lbmol	
Mass Flow(Total)	47.62	kg/h	
Composition		1	
He(Mole Fraction, Total)	0.0641*	%	
N2(Mole Fraction, Total)	0.9642*	%	
CO2(Mole Fraction, Total)	0.3853*	%	
C1(Mole Fraction, Total)	92.213*	%	
C2(Mole Fraction, Total)	4.2389*	%	
C3(Mole Fraction, Total)	1.4261*	%	
i-C4(Mole Fraction, Total)	0.2028*	%	
n-C4(Mole Fraction, Total)	0.3328*	%	
i-C5(Mole Fraction, Total)	0.0665*	%	
n-C5(Mole Fraction, Total)	0.0643*	%	
C6(Mole Fraction, Total)	0.0423*	%	

Assume feed gas has sales gas quality, maximum H2O content is 3lbs/MMSCF



Stream Table

Names	Units	1	2	3	4	6	7	8	9	10	11	12	13
Temperature	°C	-5*	-5	-5	-5	30.9*	30.9	30.9	30.9	30.19	30.19	24.75	24.75
Pressure	kPa (g)	1200*	1200	1200	1200	1166	1166	1166	1166	1034*	1034	55*	54.95
Molecular Weight	lb/lbmol	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58
Std Vapor Volumetric Flow	SCMD	1540*	1540	1540	1540	1540	1540	1540	1540	1540	1540	1540	1540
Mass Flow	kg/h	47.619	47.619	47.619	47.619	47.619	47.619	47.619	47.619	47.619	47.619	47.619	47.619

Properties		8	
Temperature(Total)	30.9	°C	
Pressure(Total)	1166	kPa (g)	

Properties		10	
Temperature(Total)	30.19	°C	
Pressure(Total)	1034*	kPa (g)	

Properties		12	
Temperature(Total)	24.75	°C	
Pressure(Total)	55*	kPa (g)	

Names	Units	H-08071
Pressure Drop	kPa	34.474*
Heat Duty	kW	1.0461
Temperature Change	°C	35.9

2in, SCH.80, Piping Properties

Pipe 1 Gas Velocity_x5	0.197#	m/s
Pipe 2 Gas Velocity_x5	0.646#	m/s
Pipe 3 Gas Velocity_x5	0.765#	m/s
Pipe 4 Gas Velocity_x5	0.765#	m/s
Pipe 5 Gas Velocity_x5	0.854#	m/s
Pipe 6 Gas Velocity_x5	6.23#	m/s

Names	Units	PIPE-1	PIPE-2	PIPE-3	PIPE-4	PIPE-5	PIPE-6
Pipe Length	m	4.572	4.572	4.572	4.572	4.572	4.572
Total Pressure Drop	kPa	0.00528	0.00528	0.00637	0.00637	0.0071	0.0516

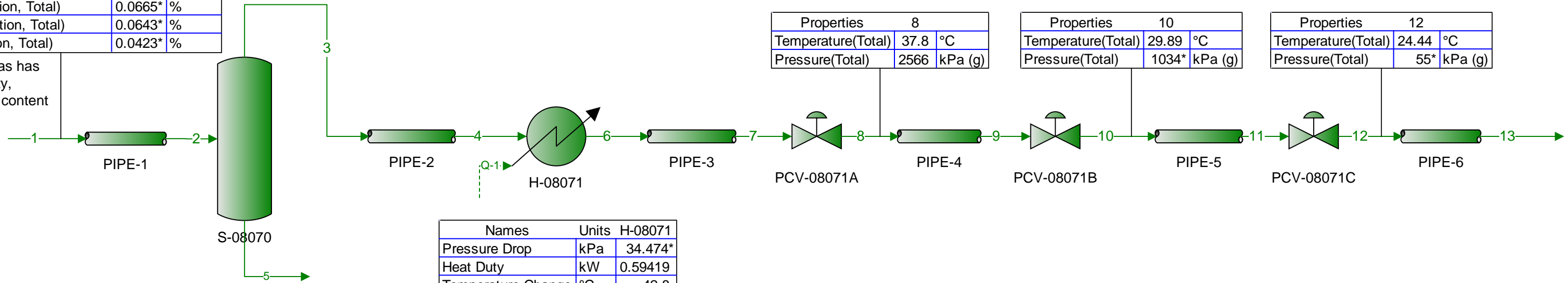


Swift Engineering Inc.

CMT – Minimum Temperature Case 2 – Medium Inlet Pressure and Medium Flow Rate

Properties		1
Temperature(Total)		-5* °C
Pressure(Total)		2600* kPa (g)
Std Vapor Volumetric Flow(Total)		695* SCMD
Molecular Weight(Total)		17.58 lb/lbmol
Mass Flow(Total)		21.49 kg/h
Composition		1
He(Mole Fraction, Total)		0.0641* %
N2(Mole Fraction, Total)		0.9642* %
CO2(Mole Fraction, Total)		0.3853* %
C1(Mole Fraction, Total)		92.213* %
C2(Mole Fraction, Total)		4.2389* %
C3(Mole Fraction, Total)		1.4261* %
i-C4(Mole Fraction, Total)		0.2028* %
n-C4(Mole Fraction, Total)		0.3328* %
i-C5(Mole Fraction, Total)		0.0665* %
n-C5(Mole Fraction, Total)		0.0643* %
C6(Mole Fraction, Total)		0.0423* %

Assume feed gas has sales gas quality, maximum H2O content is 3lbs/MMSCF



Stream Table

Names	Units	1	2	3	4	6	7	8	9	10	11	12	13
Temperature	°C	-5*	-5	-5	-5	37.8*	37.8	37.8	37.8	29.89	29.89	24.44	24.44
Pressure	kPa (g)	2600*	2600	2600	2600	2566	2566	2566	2566	1034*	1034	55*	54.99
Molecular Weight	lb/lbmol	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58
Std Vapor Volumetric Flow	SCMD	695*	695	695	695	695	695	695	695	695	695	695	695
Mass Flow	kg/h	21.49	21.49	21.49	21.49	21.49	21.49	21.49	21.49	21.49	21.49	21.49	21.49

Names	Units	H-08071
Pressure Drop	kPa	34.474*
Heat Duty	kW	0.59419
Temperature Change	°C	42.8

Properties		8
Temperature(Total)		37.8 °C
Pressure(Total)		2566 kPa (g)

Properties		10
Temperature(Total)		29.89 °C
Pressure(Total)		1034* kPa (g)

Properties		12
Temperature(Total)		24.44 °C
Pressure(Total)		55* kPa (g)

2in, SCH.80, Piping Properties

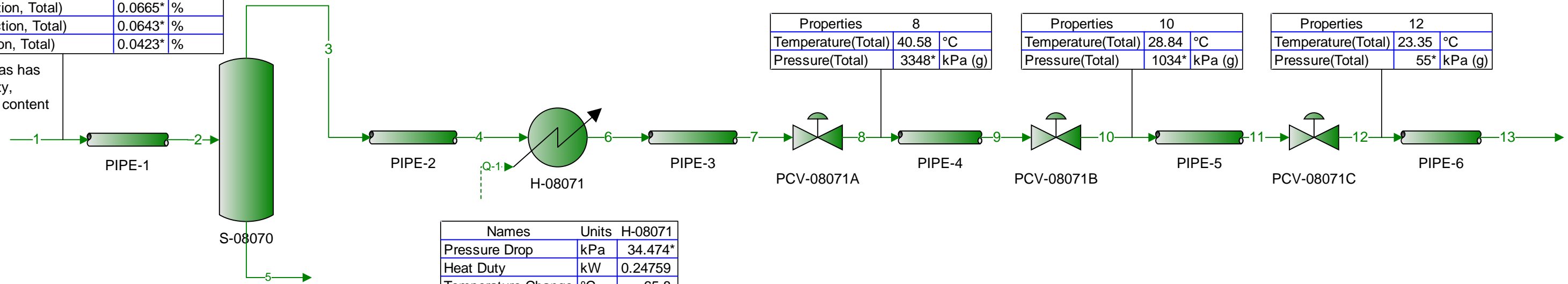
Pipe 1 Gas Velocity_x6	0.0406#	m/s
Pipe 2 Gas Velocity_x6	0.133#	m/s
Pipe 3 Gas Velocity_x6	0.163#	m/s
Pipe 4 Gas Velocity_x6	0.163#	m/s
Pipe 5 Gas Velocity_x6	0.385#	m/s
Pipe 6 Gas Velocity_x6	2.81#	m/s

Names	Units	PIPE-1	PIPE-2	PIPE-3	PIPE-4	PIPE-5	PIPE-6
Pipe Length	m	4.572	4.572	4.572	4.572	4.572	4.572
Total Pressure Drop	kPa	0.000576	0.000576	0.000723	0.000723	0.00169	0.0122

CMT – Minimum Temperature Case 3 – Maximum Inlet Pressure and Minimum Flow Rate

Properties		1
Temperature(Total)		-5* °C
Pressure(Total)		8500* kPa (g)
Std Vapor Volumetric Flow(Total)		150* SCMD
Molecular Weight(Total)		17.58 lb/lbmol
Mass Flow(Total)		4.638 kg/h
Composition		1
He(Mole Fraction, Total)		0.0641* %
N2(Mole Fraction, Total)		0.9642* %
CO2(Mole Fraction, Total)		0.3853* %
C1(Mole Fraction, Total)		92.213* %
C2(Mole Fraction, Total)		4.2389* %
C3(Mole Fraction, Total)		1.4261* %
i-C4(Mole Fraction, Total)		0.2028* %
n-C4(Mole Fraction, Total)		0.3328* %
i-C5(Mole Fraction, Total)		0.0665* %
n-C5(Mole Fraction, Total)		0.0643* %
C6(Mole Fraction, Total)		0.0423* %

Assume feed gas has sales gas quality, maximum H2O content is 3lbs/MMSCF



Stream Table

Names	Units	1	2	3	4	6	7	8	9	10	11	12	13
Temperature	°C	-5*	-5	-5	-5	60.8*	60.8	40.58	40.58	28.84	28.84	23.35	23.35
Pressure	kPa (g)	8500*	8500	8500	8500	8466	8466	3348*	3348	1034*	1034	55*	55
Molecular Weight	lb/lbmol	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58
Std Vapor Volumetric Flow	SCMD	150*	150	150	150	150	150	150	150	150	150	150	150
Mass Flow	kg/h	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382

Names	Units	H-08071
Pressure Drop	kPa	34.474*
Heat Duty	kW	0.24759
Temperature Change	°C	65.8

Properties		8
Temperature(Total)		40.58 °C
Pressure(Total)		3348* kPa (g)

Properties		10
Temperature(Total)		28.84 °C
Pressure(Total)		1034* kPa (g)

Properties		12
Temperature(Total)		23.35 °C
Pressure(Total)		55* kPa (g)

2in, SCH.80, Piping Properties

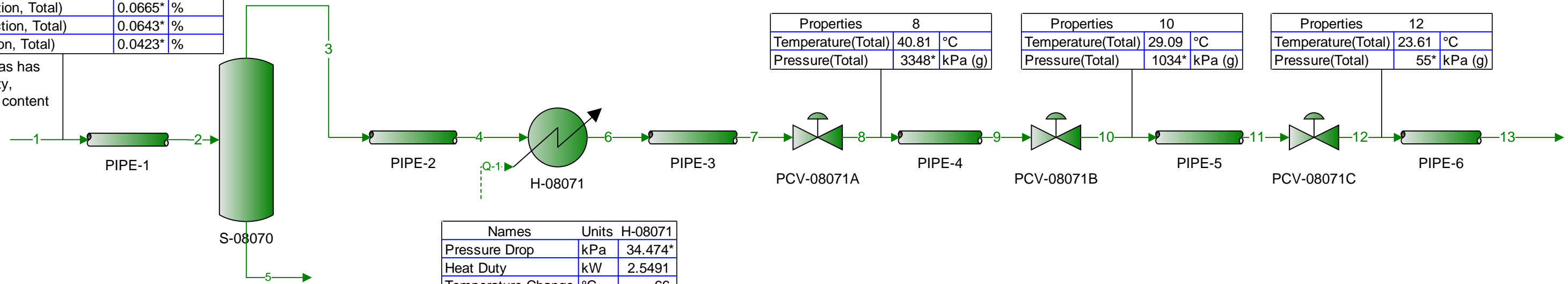
Pipe 1 Gas Velocity_x7	0.00223#	m/s
Pipe 2 Gas Velocity_x7	0.0073#	m/s
Pipe 3 Gas Velocity_x7	0.0111#	m/s
Pipe 4 Gas Velocity_x7	0.0272#	m/s
Pipe 5 Gas Velocity_x7	0.0828#	m/s
Pipe 6 Gas Velocity_x7	0.604#	m/s

Names	Units	PIPE-1	PIPE-2	PIPE-3	PIPE-4	PIPE-5	PIPE-6
Pipe Length	m	4.572	4.572	4.572	4.572	4.572	4.572
Total Pressure Drop	kPa	1.08e-005	1.08e-005	1.67e-005	3.88e-005	0.000116	0.000839

CMT – Minimum Temperature Case 4 – Maximum Inlet Pressure and Maximum Flow Rate

Properties		1
Temperature(Total)		-5* °C
Pressure(Total)		8500* kPa (g)
Std Vapor Volumetric Flow(Total)		1540* SCMD
Molecular Weight(Total)		17.58 lb/lbmol
Mass Flow(Total)		47.62 kg/h
Composition		1
He(Mole Fraction, Total)		0.0641* %
N2(Mole Fraction, Total)		0.9642* %
CO2(Mole Fraction, Total)		0.3853* %
C1(Mole Fraction, Total)		92.213* %
C2(Mole Fraction, Total)		4.2389* %
C3(Mole Fraction, Total)		1.4261* %
i-C4(Mole Fraction, Total)		0.2028* %
n-C4(Mole Fraction, Total)		0.3328* %
i-C5(Mole Fraction, Total)		0.0665* %
n-C5(Mole Fraction, Total)		0.0643* %
C6(Mole Fraction, Total)		0.0423* %

Assume feed gas has sales gas quality, maximum H2O content is 3lbs/MMSCF



Stream Table

Names	Units	1	2	3	4	6	7	8	9	10	11	12	13
Temperature	°C	-5*	-5	-5	-5	61*	61	40.81	40.81	29.09	29.09	23.61	23.6
Pressure	kPa (g)	8500*	8500	8500	8500	8466	8466	3348*	3348	1034*	1034	55*	54.95
Molecular Weight	lb/lbmol	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58
Std Vapor Volumetric Flow	SCMD	1540*	1540	1540	1540	1540	1540	1540	1540	1540	1540	1540	1540
Mass Flow	kg/h	47.619	47.619	47.619	47.619	47.619	47.619	47.619	47.619	47.619	47.619	47.619	47.619

Names	Units	H-08071
Pressure Drop	kPa	34.474*
Heat Duty	kW	2.5491
Temperature Change	°C	66

Properties		8
Temperature(Total)		40.81 °C
Pressure(Total)		3348* kPa (g)

Properties		10
Temperature(Total)		29.09 °C
Pressure(Total)		1034* kPa (g)

Properties		12
Temperature(Total)		23.61 °C
Pressure(Total)		55* kPa (g)

2in, SCH.80, Piping Properties

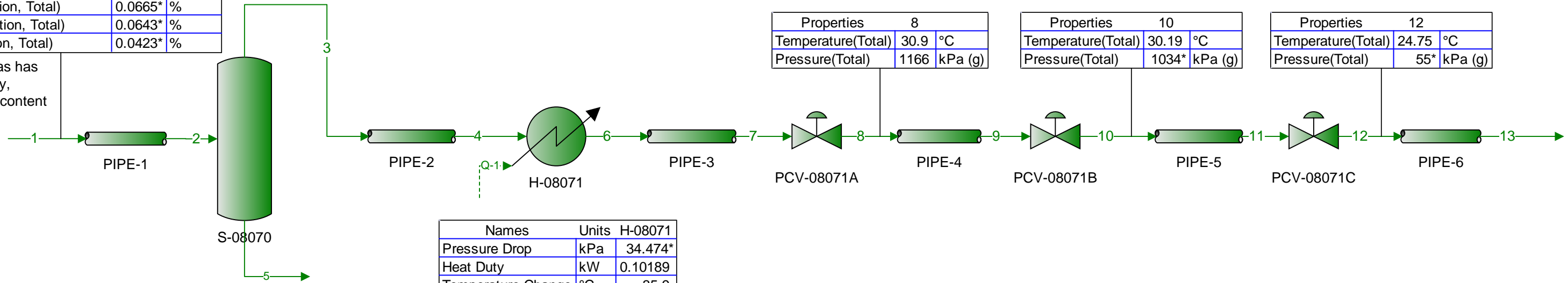
Pipe 1 Gas Velocity_x8	0.0229#	m/s
Pipe 2 Gas Velocity_x8	0.075#	m/s
Pipe 3 Gas Velocity_x8	0.114#	m/s
Pipe 4 Gas Velocity_x8	0.279#	m/s
Pipe 5 Gas Velocity_x8	0.851#	m/s
Pipe 6 Gas Velocity_x8	6.21#	m/s

Names	Units	PIPE-1	PIPE-2	PIPE-3	PIPE-4	PIPE-5	PIPE-6
Pipe Length	m	4.572	4.572	4.572	4.572	4.572	4.572
Total Pressure Drop	kPa	0.000643	0.000643	0.000989	0.00235	0.00707	0.0514

CMT – Minimum Temperature Case 5 – Minimum Inlet Pressure and Minimum Flow Rate

Properties		1
Temperature(Total)		-5* °C
Pressure(Total)		1200* kPa (g)
Std Vapor Volumetric Flow(Total)		150* SCMD
Molecular Weight(Total)		17.58 lb/lbmol
Mass Flow(Total)		4.638 kg/h
Composition		1
He(Mole Fraction, Total)		0.0641* %
N2(Mole Fraction, Total)		0.9642* %
CO2(Mole Fraction, Total)		0.3853* %
C1(Mole Fraction, Total)		92.213* %
C2(Mole Fraction, Total)		4.2389* %
C3(Mole Fraction, Total)		1.4261* %
i-C4(Mole Fraction, Total)		0.2028* %
n-C4(Mole Fraction, Total)		0.3328* %
i-C5(Mole Fraction, Total)		0.0665* %
n-C5(Mole Fraction, Total)		0.0643* %
C6(Mole Fraction, Total)		0.0423* %

Assume feed gas has sales gas quality, maximum H2O content is 3lbs/MMSCF



Stream Table

Names	Units	1	2	3	4	6	7	8	9	10	11	12	13
Temperature	°C	-5*	-5	-5	-5	30.9*	30.9	30.9	30.9	30.19	30.19	24.75	24.75
Pressure	kPa (g)	1200*	1200	1200	1200	1166	1166	1166	1166	1034*	1034	55*	55
Molecular Weight	lb/lbmol	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58	17.58
Std Vapor Volumetric Flow	SCMD	150*	150	150	150	150	150	150	150	150	150	150	150
Mass Flow	kg/h	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382	4.6382

Names	Units	H-08071
Pressure Drop	kPa	34.474*
Heat Duty	kW	0.10189
Temperature Change	°C	35.9

Properties		8
Temperature(Total)		30.9 °C
Pressure(Total)		1166 kPa (g)

Properties		10
Temperature(Total)		30.19 °C
Pressure(Total)		1034* kPa (g)

Properties		12
Temperature(Total)		24.75 °C
Pressure(Total)		55* kPa (g)

2in, SCH.80, Piping Properties

Pipe 1 Gas Velocity_x9	0.0192#	m/s
Pipe 2 Gas Velocity_x9	0.0629#	m/s
Pipe 3 Gas Velocity_x9	0.0746#	m/s
Pipe 4 Gas Velocity_x9	0.0746#	m/s
Pipe 5 Gas Velocity_x9	0.0832#	m/s
Pipe 6 Gas Velocity_x9	0.607#	m/s

Names	Units	PIPE-1	PIPE-2	PIPE-3	PIPE-4	PIPE-5	PIPE-6
Pipe Length	m	4.572	4.572	4.572	4.572	4.572	4.572
Total Pressure Drop	kPa	8.57e-005	8.57e-005	0.000105	0.000105	0.000117	0.000844

PROCESS SAFETY CAUSE & EFFECT DIAGRAM



SIEP, PROJECTS & TECHNOLOGY

FACILITY IDENTIFICATION :
CARMON CREEK PROJECT

Document No.: CCK-4512109130-0735-C14-00001-000 Page 1 of 2

SYSTEM: CMT NG PRESSURE REDUCTION SKID

REV	DESCRIPTION	DATE	DES	CHK	APPD
2	Issued for Construction	2015-11-06	SR	AR	PM
1	Issued for Review	2015-09-28	ZE	AR	PM

LEGEND
 X = Action I = Interlock T# = Time Delay by # seconds
 P = Permissive F = First Out

INITIATING DEVICE (CAUSE)

REV	DESCRIPTION	TAG NO.	NOTES
SHUTDOWN:			
1	EMERGENCY SHUTDOWN PUSHBUTTON	HZS-21601A	
2	EMERGENCY SHUTDOWN PUSHBUTTON	HZS-21602A	
3	EMERGENCY SHUTDOWN PUSHBUTTON	HZS-21603A	
4	EMERGENCY SHUTDOWN PUSHBUTTON	HZS-21603A	
5			
6			
7			
8			
PLC OUTPUTS			
9	GLOBAL RESET	XY-21602A4	
10	SILENCE HORN	XY-21602A2	
11	TEST ALARMS (BEACONS AND HORN)	XY-21602A1	2
12			
13			
14			
IPS SHUTDOWNS			
15	NATURAL GAS HEATER OUTLET TEMPERATURE HIGH TRIP	TZH-08071A	
16	GAS OUTLET TEMPERATURE LOW TRIP	TZL-08071B	
17	HEATER PRESSURE HIGH TRIP	PZH-08071A	
18	1st STAGE PRESSURE HIGH TRIP	PZH-08071B	
19	2nd STAGE PRESSURE HIGH TRIP	PZH-08071C	
20	3rd STAGE PRESSURE HIGH TRIP	PZH-08071D	
21	H-08071A HEATER TRIP COMMAND	XZY-08071A	
22			
23			
PLC TRANSMITTERS			
24			
25			
26			
27	BUILDING TEMPERATURE LOW ALARM	TAL-21601A	1
28	GAS OUTLET TEMPERATURE HIGH ALARM	TAH-08071A1	1
29	GAS OUTLET TEMPERATURE LOW ALARM	TAL-08071A1	1
30			
CP-21601 PLC INPUTS			
31			
32	UPS-21601 AC FAILURE	XI-21601C1	
33	UPS-21601 DC LOW	XI-21601D1	
34	CP-21601 COMMON ALARM	XI-B-21601A1	
35	CP-21602 COMMON ALARM	XI-S-21602A1	
36	CP-21604 HVAC COMMON ALARM	XI-21601A1	
37	CP-21603 HEATER COMMON ALARM	XI-21603A1	
38	LOSS OF POWER TO BEACONS AND HORN	XI-21602D1	
39			
DCS			
40			
41	TRIP COMMAND	XY-08071A1	
42			
43			
44			
45			
46			
47			
48			
49			
50			
51			
52			
53			
54			

ACTION (EFFECT)		DESCRIPTION	NOTES	REV
TRIP	HEATER PANEL TRIP FROM IPS			
CLOSE	GAS INLET SHUTDOWN VALVE			
ACTIVE	NG HEATER ROOM INTERIOR ALARM STROBE (RED)		2.7	
ACTIVE	NG HEATER ROOM EXTERIOR ALARM STROBE (RED)		2.7	
ACTIVE	ELECTRICAL ROOM INTERIOR ALARM STROBE (RED)		2.7	
ACTIVE	ELECTRICAL ROOM EXTERIOR ALARM STROBE (RED)		2.7	
ACTIVE	BUILD ALARM HORN		2	
ALARM	LCP COMMON ALARM TO NET-20162			
ALARM	TRIP ALARM TO NET-20162			
ALARM	HVAC COMMON ALARM TO NET-20162			
ALARM	BUILDING TEMP ALARM TO NET-20162			
ACTIVE	DISPLAY ALARM BANNER ON HMI		1	
TRIP	HEATER TEMPERATURE CONTROLLER		3.4	

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1.0 SCOPE

The following facilities fall within the scope of this document:

- CMT Natural gas pressure reduction skid.

Default control logic and HMI details defined by the control template are not covered by this document.

2.0 REFERENCE DOCUMENTS

Description	Document
P&IDs	CCK-4512109130-0735-C01-00001-001
Instrument Index	CCK-4512109130-0735-E08-00001-000
Process Cause and Effect Diagram	CCK-4512109130-0735-C14-00001-000
Fire and Gas Cause and Effect Diagram	CCK-4512109130-0735-C14-00002-000
Instrumentation Range, Alarm and Trip Setpoint (RATS) list	CCK-4512109130-0735-C99-00001-000
Start-Up Procedure	CCK-4512109130-0735-J06-00001-000

3.0 CMT NATURAL GAS PRESSURE REDUCTION SKID PACKAGE

3.1. Process Description

This process uses a series of pressure control valves(Regulator) to reduce the fuel gas pressure from the inlet pressure (1200-8500 KPag) down to the required outlet pressure (~55 kPag) and odorize the gas while maintaining a set outlet gas temperature(25°C). The inlet fuel gas first enters the coalescer filter (S-08070)to knock-out any residual liquids in the gas. It is then pre- heated by an electric heater (H-08071) to ensure the gas stays above the hydrocarbon dew point when it's pressure is decreased . Next, the gas enters three pressure Regulator valves in series which throttle the gas, bringing the pressure down to the desired outlet pressure. a portion of the gas is redirected through the mercaptan odorizer (V-08116),using a throttling valve, where it passively absorbs mercaptan. The odorized gas is then recombined with the non-odorized gas prior to leaving the skid.

3.2. Control Objective

There are 5 cases varying bases on inlet gas pressure, temperature, and flow rate. Refer to the P&ID for particular case temperature, flow rate and pressure details.

3.3. Normal Operation

3.3.1. *SDV-08070A Gas Inlet Shutdown Valve*

Under normal operating conditions this valve should be open. Any shutdown condition will cause this valve to close until the condition has been cleared and the valve is reset.

A shutdown condition can be caused by:

- Trip of TZH-08071A, TZL-08071B, PZH-08071D or XZY-08071A
- Emergency shutdown push buttons HZS-21601A or HZS-21602A or HZS-21603A
- Trip generated by UZT-21601A/B (LEL Trip 2oo2)
- YZT-21601A (Flame detector)

This is indicated in the process and fire and gas cause and effects diagrams.

This valve can also be closed from the Basic Process Control System (BPCS). This valve will be locked into "Auto" position so the safeguard cannot be overridden by switching it into manual.

3.3.2. *TZT-08071A – Heater H-08071 gas outlet temperature trip*

The purpose of this trip is to protect the downstream piping from being operated outside of its design conditions.

The trip is set at 72.6 °C (20% higher than the maximum operating temperature of 60.5°C)

For more detailed alarming and shutdown information refer to the Process Cause and Effect diagram.

3.3.3. *PZT-08071A – Gas Pressure Transmitter Upstream of PCV-086071A*

Pressure indication read by local control panel (CP-21601). The high pressure alarm is set at 8730 kPag. For alarming and shutdown information refer to the process shutdown key.

3.3.4. *PCV-08071A - 1st Stage pressure reduction Regulator valve*

3.3.5. *PZT-08071B- Gas pressure transmitter downstream of pressure reduction control valve PCV-08071A*

The measured pressure from PZT-08071B will be read back at the local control panel. The high pressure alarm on PZH-08071B is set at 3760 kPag.

For alarming and shutdown information refer to the Process Cause and Effect diagram.

3.3.6. *PCV-08071B – 2nd Stage pressure reduction Regulator valve*

3.3.7. *PZT-08071C- Gas pressure transmitter downstream of pressure reduction control valve PCV-080071B*

The measured pressure from PZT-08071C will be read back at the local control panel. The high pressure alarm on PZH-08071C is set at 1127 kPag.

For alarming and shutdown information refer to the Process Cause and Effect diagram.

3.3.8. PCV-08071C – 3rd Stage pressure reduction Regulator valve.

3.3.9. TT-08071A1 – Gas outlet temperature transmitter

Temperature measured by TT-08071A1 will be read by the PLC in the local control panel and used as the process variable to the temperature control loop TIC-08071A1. The set point for TIC-08071A1 will be manually set by operations (set point to be 25°C). The high temperature alarm is set at 60°C and the low temperature alarm is set at 18°C. The output control variable from the control loop TIC-08071A1 will be a 4-20mA signal from the PLC in CP-21601 to the SCR (Safety Control Relay) in the heater local control panel (CP-21603). The SCR then uses this 4-20mA signal to control the heater element from 0-100%.

The heater local control panel has built in trips to protect the heater unit, and will send a general fault alarm to the PLC in local control panel CP-21601. The PLC groups the local control panel fault alarms from CP-21601, CP-21602 and CP-21603 into 1 LCP (Local Control Panel) common alarm (XI-08071A1) which is sent to XJB-21601. The heater built in trips consist of 4 temperature trips, High Sheath Limit #1, High Sheath Limit #2, High Flange Limit #1, High Flange Limit #2 (measured by 4 separate RTD's), a ground fault trip, and a panel overheat trip (controlled by a thermostat). All of the heater local shutdowns will need to be manually reset at the heater local control panel.

3.3.10. TZT-08071B- Gas outlet low temperature trip

The purpose of this trip is to ensure natural gas exiting CMT unit above the dew point temperature which could be as high as minus 15°C.

The trip setpoint is set at -10°C on TZL-08071B

For more detailed alarming and shutdown information refer to the Process Cause and Effect diagram

3.3.11. PZT-08071D – High Outlet Pressure Trip

The purpose of this trip is to ensure the pressure remains within the design limits and PSV-08071D does not open and cause the gas to vent to atmosphere.

The trip setpoint is set at 563 kPag

For more detailed alarming and shutdown information refer to Process Cause and Effect diagram.

3.3.12. FI-08071A1 – Outlet Flow Meter

The measured flow from this transmitter (in Sm³/d) will be read back to the local control panel. A flow totalizer is available in the HMI.

3.4. Abnormal Operation

3.4.1. Start-up

On Start-up, SDV-08071A will open, allowing the flow of fuel gas into the skid through the pressure Regulator valves, until the target set-point 55 Kpag is reached.

For more details information on the Start-up see the Start-up Procedure.

3.4.2. Shutdown

On emergency shutdown the ESD valve closes and then the Regulator valves will automatically modulate.

The emergency shutdown pushbuttons are as follows:

- HZS-21601A, which is located outside the Natural Gas Heater Room (near the double doors)
- HZS-21602A, which is outside the Electrical Room (near the door)
- HZS-21603A, which is located inside the Electrical Room on IPS Panel CP-21602

If any of the three emergency shutdown pushbuttons is activated it will cause the following to occur:

- The heater (H-08071) to shutdown via trip of XZY-08071A from IPS
- SDV-08070A to close and stop the flow of fuel gas into the skid
- Horn XAF-21601A to activate
- Trip alarm (XI-08071B1) to activate
- Alarm on HMI to trigger

3.4.3. Loss of Power

Emergency lighting comes on. UPS power will continue uninterrupted providing 24 VDC to the SIL Panel (CP-21602) and LCP (CP-21601). Solenoid for the SDV is kept energized during loss of power. The skid will continue delivering natural gas until the low temperature trip (TZT-08071B) causes the skid to shutdown(See Process Cause and Effects Diagram for more information) due to the heater no longer providing heat.

3.4.4. Discrete Alarms

3.4.4.1. Discrete Process Alarms

- UPS-21601 AC Failure (XI-21601C1)
 - o Cause: generated from the UPS-21601 panel and wired to control panel (CP-21601) as a discrete input
 - o Effect: will generate an LCP common alarm on CP-21601 (XI-08071A1) and an alarm on the HMI
- UPS-21601 DC Low (XI-21601D1)
 - o Cause: generated from the UPS-21601 panel and wired to control panel (CP-21601) as a discrete input

- Effect: will generate an LCP common alarm on CP-21601 (XI-08071A1) and an alarm on the HMI
- CP-21601 Common Alarm (XI-B-21601A1)
 - Cause: generated from the series connection of the Ethernet switch alarm contact and the cabinet thermostat 2 alarm contact. If either of the contacts is de-energized, it will cause this alarm to trigger.
 - Effect: will generate an LCP common alarm on CP-21601 (XI-08071A1) and an alarm on the HMI
- CP-21602 Common Alarm (XI-S-21602A1)
 - Cause: Generated from the series connection of fault alarms contacts of all six (6) safety trip modules so any trip module fault will generate this alarm.
 - Effect: will generate an LCP common alarm on CP-21601 (XI-08071A1) and an alarm on the HMI
- CP-21604 HVAC Common Alarm (XI-21601A1)
 - Cause: generated from the series connection of overload contacts of all four building supply fan motors for HVAC (MS-08165/6/8/9). If any of the motors generate overload alarm, this common alarm will be generated.
 - Effect: will generate an HVAC common alarm on CP-21601 (XI-21601A1) and an alarm on the HMI
- CP-21603 Heater Common Alarm (XI-21603A1)
 - Cause: generated from inside the heater control panel
 - Effect: will generate an LCP common alarm on CP-21601 (XI-08071A1) and an alarm on the HMI

3.4.4.2. Discrete Fire & Gas Alarms

- LEL Gas Detector Alarms (UZT-21601A, UZT-21601B)
 - Cause: alarm at LEL > 10% and at LEL > 40%. ○
 - Effect:
 - LEL 10%: trigger LCP (local control panel) Common Alarm on CP-21601 and alarm on the HMI
 - LEL 40%: trigger Building LEL Gas Common Alarm on CP-21601 and alarm on the HMI. Readings from both detectors feed into LEL gas detector A/B trip. See below if both LEL detectors read >40%.
- LEL Gas Detector Trip (UZT-21601A/B)
 - Cause: 2oo2 LEL >40% from UZT-21601A/B. The voting logic 2oo2 will switch to 1oo1 voting if one detector is in fault (cannot detect or deactivated for maintenance)
 - Effect:
 - Heater (H-08071) shutdown via XZY-08071A trip from IPS
 - Close gas inlet shutdown valve SDV-08070A to prevent fuel gas from entering the skid
 - Activate the trip alarm (XI-08071B1) on CP-21601

- Activate horn (XAF-21601A) and beacons (XAF-21603A1/A2 and XAF-21605A1/A2)
 - Activate/Start the NG heater supply room fan (C-08166)
 - Trigger an alarm on the HMI
 - Flame Detector (YZT-21601A)
 - Cause: Flame detector detects flame
 - Effect:
 - Heater (H-08071) shutdown via XZY-08071A trip from IPS
 - Close gas inlet shutdown valve SDV-08070A to prevent fuel gas from entering the skid
 - Activate the trip alarm (XI-08071B1) on CP21601
- Activate the building flame common alarm (XI-21602B1) on CP21601
- Activate horn (XAF-21601A) and beacons (XAF-21603A1/A2 and XAF-21605A1/A2)
 - Trip all four supply fans C-08165, C-08166, C-08169, C-08168
 - Trigger an alarm on the HMI
- Smoke Detector (YZT-21602A)
 - Cause: Smoke detector detects smoke
 - Effect:
 - Activate the building flame common alarm (XI-21602B1) on CP-21601
 - Activate horn (XAF-21601A) and beacons (XAF-21603A1/A2 and XAF-21605A1/A2)
 - Trigger an alarm on the HMI

Note: Beacons and horn power is monitored by PLC through signal XI-21602D1. See Process Cause and Effects Diagram for more information.

3.4.5. Other

There is a “TEST PUSHBUTTON” located on the HMI that when held will activate the horns and all beacons to test their functionality. The HMI has a “SILENCE HORN” button that when pushed will silence the horn. There is also a “GLOBAL RESET” button on the HMI that when pressed will return the skid to normal operation after a trip (See Process Cause and Effects Diagram for more information).

There is no bypass for the SIL equipment. All other control instruments have a 4 hour bypass available in the PLC.

4.0 NATURAL GAS PRESSURE REDUCTION BUILDING HEATING AND VENTILATION

The building’s HVAC system consists of 2 heaters, 4 fans and 2 dampers (1 heater, two fans and 1 damper in each of the rooms).

The temperature for the heaters can be manually adjusted using a local thermostat (TS-

08170 for the electrical room and TS-08171 for the process room). There is a building temperature alarm XI-21601B1 based on the ambient room temperature transmitter TT-21601A. In the case of a building temperature alarm it will be up to operations to adjust the local thermostat on the heater to either increase or decrease the building temperature.

The following logic is implemented for supply fans.

- (a) C-08165 (NG heater room supply fan) and C-08168 (Electrical room supply fan) always keep running except they trip in case of fire detection by flame detector YZT-21601A.
- (b) Depending on the selection of H-O-A switch pertaining to C-08169 (Electrical room supply fan),
 - a. If “Hand” mode is selected, C-08169 always keeps running except it trips in case of fire detection by flame detector YZT-21601A.
 - b. If “Auto” mode is selected, C-08169 on-off is controlled by Thermostat TS-08170. However, in case of fire detection by flame detector YZT-21601A, it trips.
- (c) Depending on the selection of H-O-A switch pertaining to C-08166 (NG heater room supply fan),
 - a. If “Hand” mode is selected, C-08166 always keeps running except it trips in case of fire detection by flame detector YZT-21601A.
 - b. If “Auto” mode is selected, C-08166 on-off is controlled either of the following:
 - i. by Thermostat TS-08166. However, in case of fire detection by flame detector YZT-21601A, it trips.
 - ii. C-08166 starts when both LEL detectors UZT-21601A and UZT-21601B detect LEL >40%. However, in case of fire detection by flame detector YZT-21601A, it trips.

HVAC common alarm (XI- 21601A1) is triggered by the overload of one of 4 fans. All fan motors overload contacts are connected in series therefore if any one generates an alarm, the HVAC common alarm will trigger..


For more detailed heating and ventilation related alarms and control refer to Process and Fire & Gas Cause and Effect diagrams.

APPENDIX 1. CONTROL LOOPS SUMMARY

CONTROLLER TAG	SERVICE DESCRIPTION	CONTROL ACTION	SETPOINT (SP)	PERMITTED MODES	AI TAG NAME	PV SCALE	ENG UNITS	AO TAG NAME	AO ACTION
TIC-08071A1	NATURAL GAS	REVERSE	25	AUTO/MAN	TT-08071A1		°C	H-08071	TRIP

DOCUMENT FRONT SHEET

PURCHASERS NAME	National Process Equipment
PURCHASE ORDER NO	PUR630251
EXHEAT REFERENCE	041168
SDR DOCUMENT NO	041168.01.03
CLIENT DOCUMENT NO	
DOCUMENT TITLE	Heater Wiring Diagram

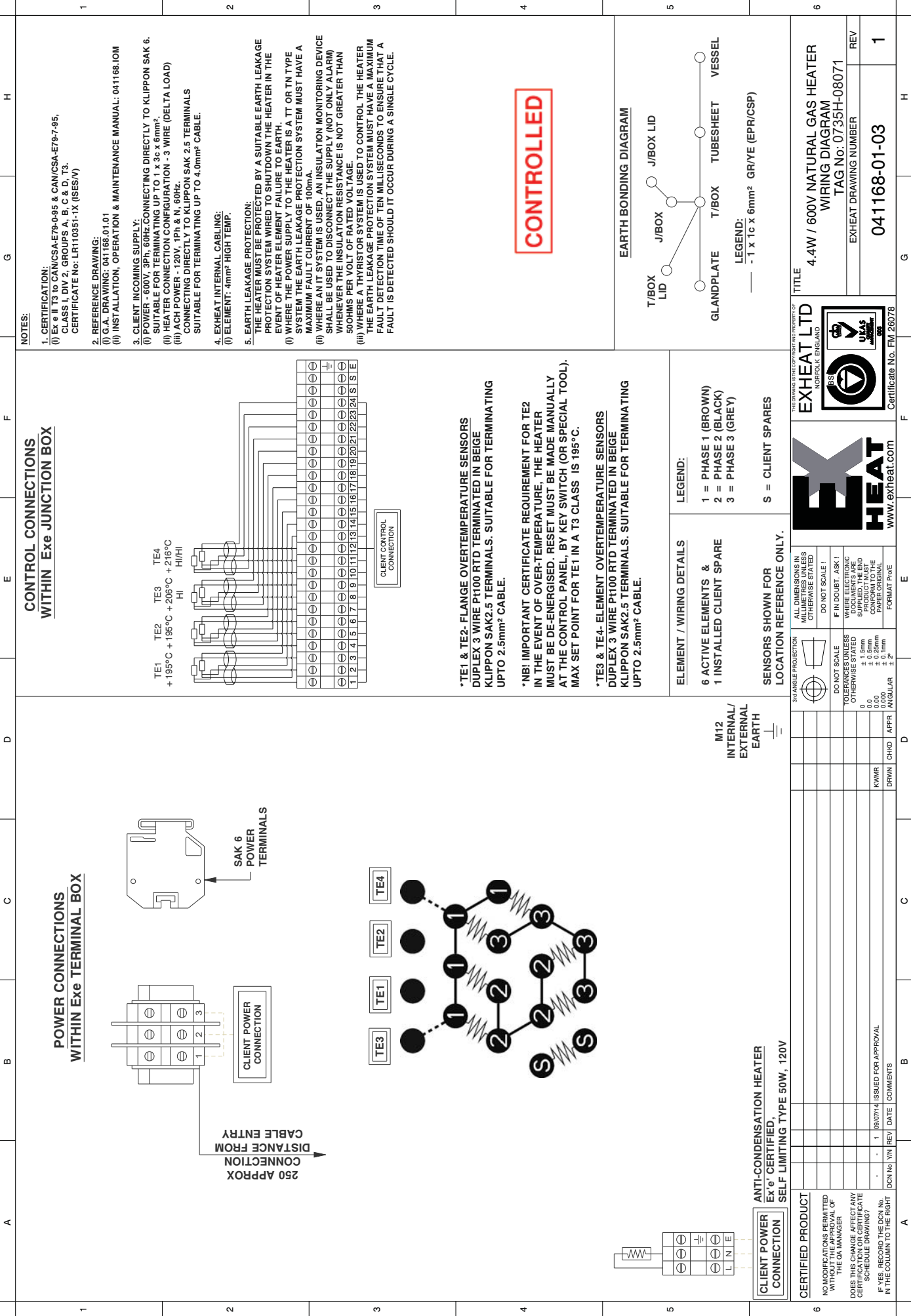
Doc Num	Revision	Issue	Date	Initials	Supplier's Approval Signature	Approval By
C01	1	1	14/08/2014	RDav		28/08/2014

Shell Carmon Creek Field Facilities & Infrastructure Project CMT Natural Gas Pressure Reduction Skid Package

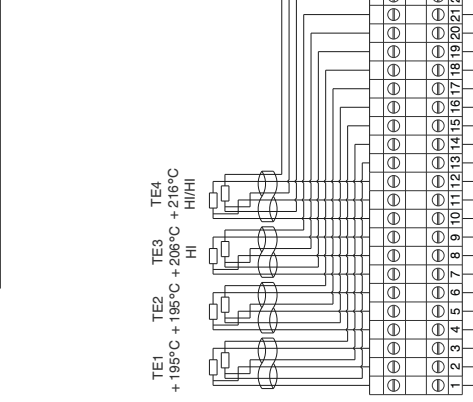
<u>To be filled by the reviewer of this document prior to its return</u>			
Tick Box	Code	Status	Description
<input type="checkbox"/>	E1	Approved	Approval given, no comments, final issue.
<input type="checkbox"/>	E2	Approved to Proceed	Approval given for work to proceed with document to be submitted as Final Issue providing comments are incorporated
<input type="checkbox"/>	E3	Not Approved	Document rejected and must be re-submitted with incorporation of comments. Work may NOT proceed
<input type="checkbox"/>	E4	Information Only	No comments made or approval given, for information purposes only.
<input type="checkbox"/>	E5	As-Built	Approval given for work to proceed provided comments incorporated in As-Built revision.

PAGES (Including this one)
2
COMMENTS

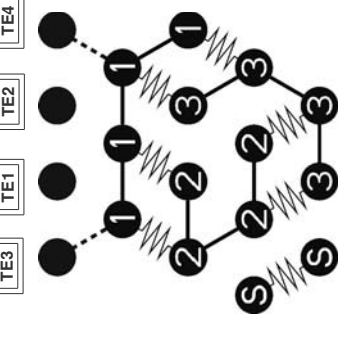
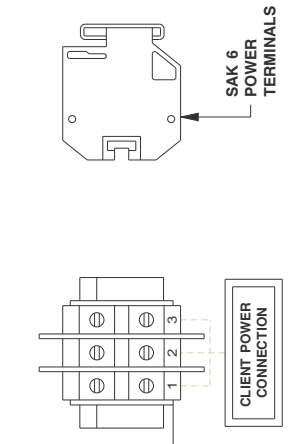
Please be aware that EXHeat will not be held responsible for late approval of documents and will not be held liable for any liquidated damages as a consequence.
Late approval of documents by the client may impact on the contractual delivery date.



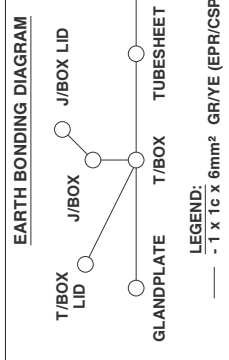
CONTROL CONNECTIONS
WITHIN Exe JUNCTION BOX



POWER CONNECTIONS
WITHIN Exe TERMINAL BOX



CONTROLLED



NOTES:

- CERTIFICATION:
 (i) Ex e II T3 to CA/II/CSA-E79-0-95 & CAN/CSA-E79-7-95,
 CLASS I, DIV 2, GROUPS A, B, C & D, T3,
 CERTIFICATE No: LR110351-1X (ISES/V).
 (ii) G.A. DRAWING: 041168.01.01
 (iii) INSTALLATION, OPERATION & MAINTENANCE MANUAL: 041168.IOM
- CLIENT INCOMING SUPPLY:
 (i) POWER - 600V, 3Ph, 60HZ, CONNECTING DIRECTLY TO KLIPPON SAK 6.
 SUITABLE FOR TERMINATING UP TO 1 x 3c x 6mm².
 (ii) HEATER CONNECTION CONFIGURATION - 3 WIRE (DELTA LOAD)
 (iii) A CH POWER - 120V, 1Ph & N, 60HZ.
 CONNECTING DIRECTLY TO KLIPPON SAK 2.5 TERMINALS
 SUITABLE FOR TERMINATING UP TO 4.0mm² CABLE.
- EXHEAT INTERNAL CABLING:
 (i) ELEMENT: 4mm² HIGH TEMP.
- EARTH LEAKAGE PROTECTION:
 THE HEATER MUST BE PROTECTED BY A SUITABLE EARTH LEAKAGE
 PROTECTION SYSTEM WIRED TO SHUTDOWN THE HEATER IN THE
 EVENT OF HEATER ELEMENT FAILURE TO EARTH.
 (i) WHERE THE POWER SUPPLY TO THE HEATER IS A TT OR TN TYPE
 SYSTEM THE EARTH LEAKAGE PROTECTION SYSTEM MUST HAVE A
 RESIDUAL CURRENT DEVICE (RCD) INSTALLED.
 (ii) WHERE AN IT SYSTEM IS USED, AN INSULATION MONITORING DEVICE
 SHALL BE USED TO DISCONNECT THE SUPPLY (NOT ONLY ALARM)
 WHENEVER THE INSULATION RESISTANCE IS NOT GREATER THAN
 50OHMS PER VOLT OF RATED VOLTAGE.
 (iii) WHERE A THERYSTOR SYSTEM IS USED TO CONTROL THE HEATER
 THE EARTH LEAKAGE PROTECTION SYSTEM MUST HAVE A MAXIMUM
 FAULT DETECTION TIME OF TEN MILLISECONDS TO ENSURE THAT A
 FAULT IS DETECTED SHOULD IT OCCUR DURING A SINGLE CYCLE.

- *TE1 & TE2- FLANGE OVERTEMPERATURE SENSORS
 DUPLEX 3 WIRE PT100 RTD TERMINATED IN BEIGE
 KLIPPON SAK2.5 TERMINALS. SUITABLE FOR TERMINATING
 UP TO 2.5mm² CABLE.
- *NB! IMPORTANT CERTIFICATE REQUIREMENT FOR TE2
 IN THE EVENT OF OVER-TEMPERATURE, THE HEATER
 MUST BE DE-ENERGISED. RESET MUST BE MADE MANUALLY
 AT THE CONTROL PANEL, BY KEY SWITCH (OR SPECIAL TOOL).
 MAX SET POINT FOR TE1 IN A T3 CLASS IS 195°C.
- *TE3 & TE4- ELEMENT OVERTEMPERATURE SENSORS
 DUPLEX 3 WIRE PT100 RTD TERMINATED IN BEIGE
 KLIPPON SAK2.5 TERMINALS. SUITABLE FOR TERMINATING
 UP TO 2.5mm² CABLE.

- ELEMENT / WIRING DETAILS**
- 6 ACTIVE ELEMENTS &
 1 INSTALLED CLIENT SPARE
- LEGEND:**
- 1 = PHASE 1 (BROWN)
 - 2 = PHASE 2 (BLACK)
 - 3 = PHASE 3 (GREY)
 - S = CLIENT SPARES
- SENSORS SHOWN FOR
 LOCATION REFERENCE ONLY.**

3/8" ANGLE PROJECTION	
	ALL DIMENSIONS IN THIS DRAWING UNLESS OTHERWISE STATED
	DO NOT SCALE 1
	F IN DOUBT, ASK 1
	WIRE ELECTRONIC TOLERANCES UNLESS OTHERWISE STATED
	± 1.5mm
	± 0.5mm
	± 0.1mm
	± 0.1mm
	± 2°
	ANGULAR

EXHEAT LTD
 THE HEATERS OF THE WORLD
 NORFOLK, ENGLAND

EXHEAT HEAT
 www.exheat.com

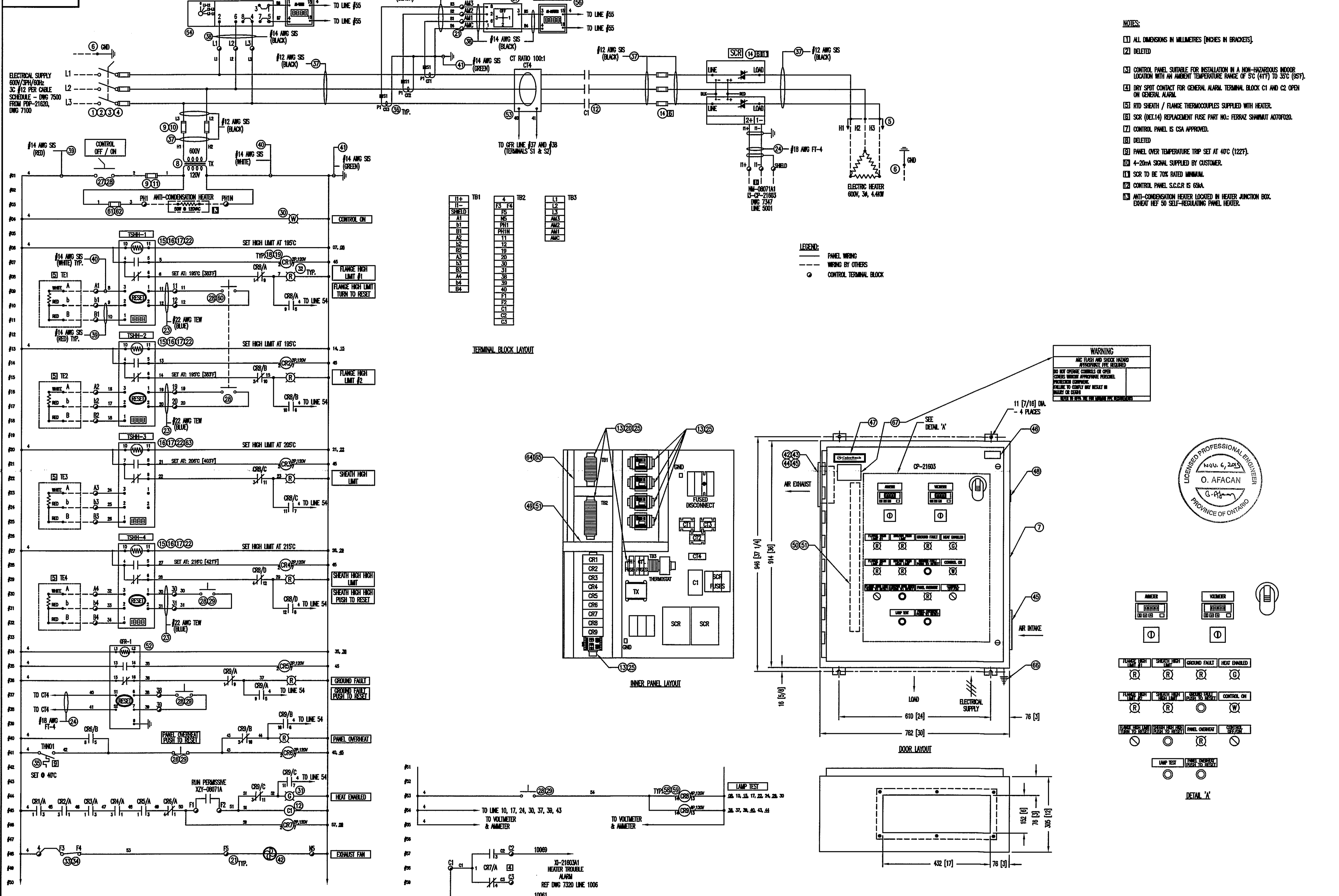
TITLE
 4.4W / 600V NATURAL GAS HEATER
 WIRING DIAGRAM
 TAG No: 0735H-08071

REV	EXHEAT DRAWING NUMBER
1	041168-01-03

Certificate No. FM 26078

6	CERTIFIED PRODUCT NO MODIFICATIONS PERMITTED WITHOUT THE APPROVAL OF THE QA MANAGER DOES THIS CHANGE AFFECT ANY CERTIFICATION OR CERTIFICATE SCHEDULE DRAWING? IF YES, RECORD THE DCN No. IN THE COLUMN TO THE RIGHT	DRWN	KVM/R	APPR	DATE	COMMENTS
-	1	19/07/14				ISSUED FOR APPROVAL

NO. D23075



- NOTES:**
- ALL DIMENSIONS IN MILLIMETRES (INCHES IN BRACKETS).
 - DELETED
 - CONTROL PANEL SUITABLE FOR INSTALLATION IN A NON-HAZARDOUS INDOOR LOCATION WITH AN AMBIENT TEMPERATURE RANGE OF 5°C (41°F) TO 35°C (95°F).
 - DRY SPOT CONTACT FOR GENERAL ALARM TERMINAL BLOCK C1 AND C2 OPEN ON GENERAL ALARM.
 - RTD SHEATH / FLANGE THERMOCOUPLES SUPPLIED WITH HEATER.
 - SCR (DEI.14) REPLACEMENT FUSE PART NO.: FERRAZ SHAWMUT A07R020.
 - CONTROL PANEL IS CSA APPROVED.
 - DELETED
 - PANEL OVER TEMPERATURE TRIP SET AT 40°C (102°F).
 - 4-20mA SIGNAL SUPPLIED BY CUSTOMER.
 - SCR TO BE 70% RATED MINIMUM.
 - CONTROL PANEL S.C.C.R IS 65KA.
 - ANTI-CONDENSATION HEATER LOCATED IN HEATER JUNCTION BOX. EXHAUST HEF 50 SELF-REGULATING PANEL HEATER.

NO.	REVISION	DATE	PAR/REV
1	REVISED PER CUSTOMER COMMENTS. ANTI-CONDENSATION HEATER POWER CONNECTION & TEST SWITCH FOR FLANGE LIMIT RESET ADDED.	SEPT. 8/14	A.G./D.D.
2	REVISED AS BUILT. INNER PANEL LAYOUT REVISED. LETS 19, 21 & 20 GIVES MORE L, M & T. LETS 64 & 65 ADDED. LETS 35, 39 & 40 PART NOS WERE 1-TIME, 2-TIME & 3-TIME.	NOV. 12/14	S.M./A.C.
3	ADDED WIRING SCHEDULE, AND UPDATED WIRING	NOV. 3/15	H.S.P./A.R.

67	ARC FLASH LABEL	BRADY #102307	1	
68	SERVIT POST (EXTERNAL BOND)	BURNBY KC-26	1	
65	WIRE DUCT COVER 1	99010	1FT	
64	WIRE DUCT 1 x 4	91040	1FT	
63	LIMIT CONTROLLER (0-400°C)	SA100L02-IM-PH-01/Y	1	
62	ANTI-CONDENSATION HEATER FUSE	TM 0.6	1	
61	ANTI-CONDENSATION HEATER FUSE HOLDER	USM1	1	
60	2 POSITION SPRING RETURN KEY SWITCH	Z25AGS	1	
59	RELAY BASE 14 PIN	ZP114	2	
58	CONTROL RELAY 4PDT	RP000A120L	2	
57	AMMETER SELECTOR SWITCH	OMAG1PB	1	
56	AMMETER 0-20A	LMG04VED00X	1	
55	VOLTMETER 0-60V	LMG04VED00X	1	
54	VOLTMETER SELECTOR SWITCH	OMAG3B	1	
53	CURRENT TRANSFORMER	ECT-26	1	
52	GROUND FAULT RELAY, 120VAC 50Hz/60Hz	SE-701-00	1	
51	WIRE DUCT COVER 1 1/2	99015	14FT	
50	WIRE DUCT 1 1/2 x 2	91520	2FT	
49	WIRE DUCT 1 1/2 x 4	91540	12FT	
48	NAMEPLATE, CSA	C10090-14	1	
47	NAMEPLATE, LOGO	A10180-01	1	
46	CAUTION LABEL	A71225-01	1	
45	LOADERS	T-EP4	2	
44	FAN MOUNTING BRACKET	99FL1968	2	
43	FINGER GUARD	L277	1	
42	EXHAUST FAN PACKAGE 115VAC, 50/60Hz 233CFM	W25130-0M15-01	1	
41	WIRE, #14 AWG SS, GREEN	SS14G	20FT	
40	WIRE, #14 AWG SS, WHITE	SS14W	70FT	
39	WIRE, #14 AWG SS, RED	SS14R	210FT	
38	WIRE, #14 AWG SS, BLACK	SS14B	10FT	
37	WIRE, #12 AWG SS, BLACK	SS12B	10FT	
36	CURRENT TRANSFORMER 20:5A	RCT151205A	3	
35	THERMOSTAT NORMALLY OPEN	011475-00	1	
34	END BLOCK	A14015-31	1	
33	TERMINAL BLOCK SWITCH	A14015-30	1	
32	PILOT LIGHT ASSEMBLY, RED 120V LED	X254M4	6	
31	PILOT LIGHT ASSEMBLY, GREEN 120V LED	X254M3	1	
30	PILOT LIGHT ASSEMBLY, WHITE 120V LED	X254M1	1	
29	PUSH BUTTON, RED	Z428L4	4	
28	CONDUCT BLOCK I.D.	Z428L101	6	
27	2 POSITION SELECTOR SWITCH	Z428R2	1	
26	CONDUCT BLOCK I.C.	Z428L102	1	
25	MOUNTING RAIL	A14015-32	4FT	
24	WIRE, #18 FT-4 SHIELDED	#18 AWG FT-4	5FT	
23	WIRE #22 AWG TEM BLUE	TEM22BL	5FT	
22	3-POST HOUSING	XIP-3	4	
21	TERMINAL BLOCK, CONTROL	A14015-01	41	
20	END PLATE	A14015-11	4	
19	RELAY BASE, 8 PIN	ZP08	7	
18	RELAY DPDT, 120VAC	RP2P002 120AC	7	
17	CONNECTOR PIN	35-0218-00	8	
16	SOCKET	ATC1800A1	4	
15	LIMIT CONTROLLER (0-400°C)	SA100L02-IM-4PH-01/Y	3	
14	SCR 600V, 3A, 50/60Hz, 15A, 4-20mA INPUT	ZP2-575-15-FX-C	1	
13	END STOP	A14015-19	17	
12	CONDUCTOR 35A 120VAC	41NBS30F	1	
11	FUSE SECONDARY, CONTROL 4A	TM 4	1	
10	PRIMARY FUSE 1.6 A	AT01.6	2	
9	FUSE HOLDER, CONTROL 30A	USM3	1	
8	TRANSFORMER 600V/120V 350VA 60Hz	EXA350-39	1	
7	ENCLOSURE E3M/C/NEHA 12	TSK10275-01	1	
6	GROUND LUG	KLU-35	B10243-01	2
5	SPLITTER, 175A	B11085-01	1	
4	DISCONNECT HANDLE	OB683G	1	
3	POWER FUSE, CLASS J 6A	AM6	3	
2	DISCONNECT SHUNT	OPSP0225	1	
1	FUSED DISCONNECT 30A c/w DOOR INTERLOCK	OS30AJ12	1	
REF	DESCRIPTION	PART NO.	QTY	

BILL OF MATERIAL / LISTE DE MATERIEL

TITLE: CONTROL PANEL 600/3/60 4.4KW

NO. D23075

REV. 2

REF: NATIONAL PROCESS EQUIPMENT INC. P.O. NO. PURES0305

S.D.: WORKBOOK

SCALE: NTS

DATE: JULY 23/14

APPROVED: JULY 23/14

DATE: JULY 23/14

DET.: G

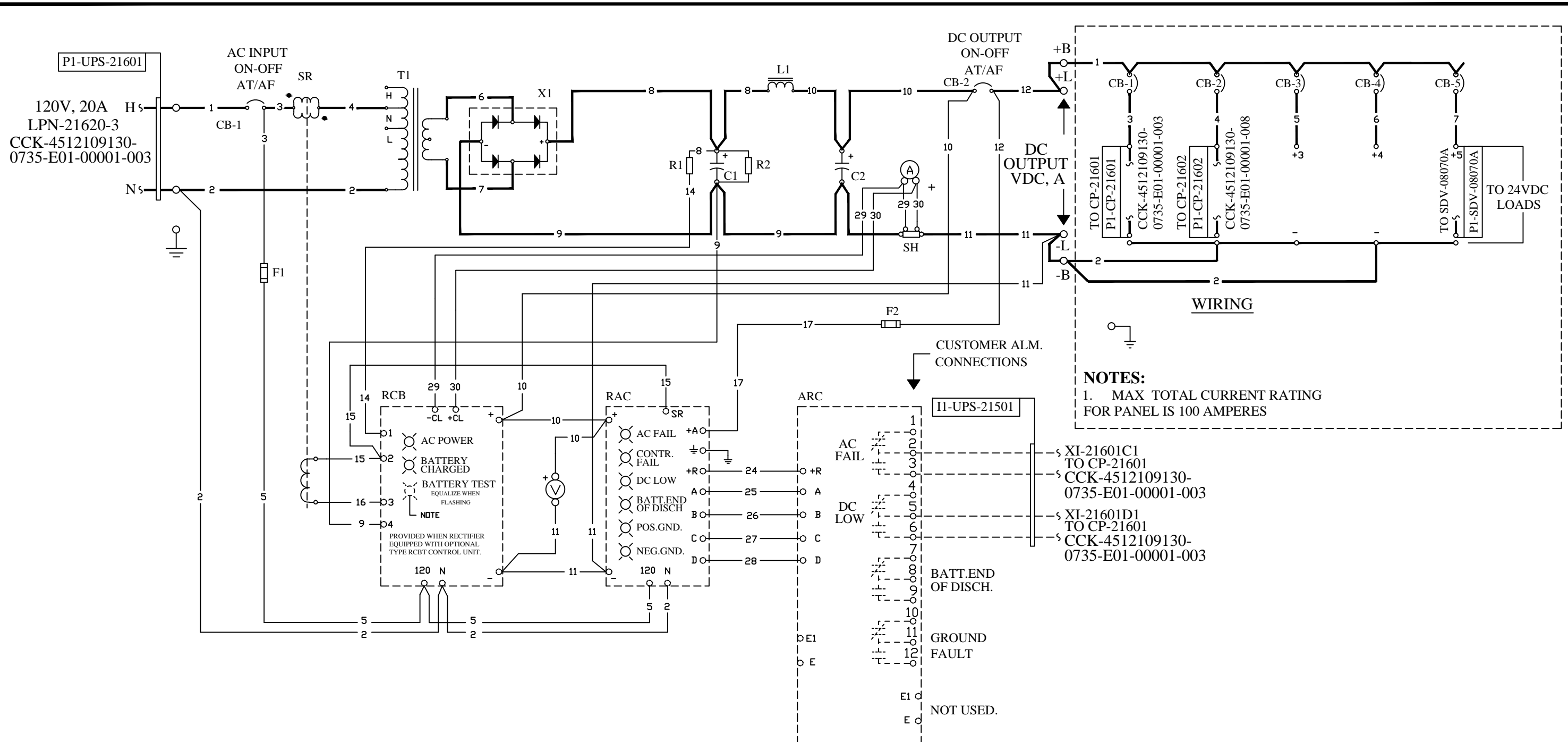
TOLERANCE UNLESS NOTED OTHERWISE

*	ANGULAR	*	1/4	*	6
	DECIMAL		FRACT.		METRIC

CCI Thermal Technologies Inc. Heating and Filtration Solutions

ITEM NO.	CATALOG NO.	VOLTS	PH	Hz	AMPS	APPROXIMATE WEIGHT KG (LB)	ORDER VERIFICATION NO.
01	CP23075-01	600	3	60	6	100 (220)	T071405-1

LEGAL NOTICE: CCI Thermal Technologies Inc. accepts no responsibility for the safety and reliability of any products which have been used in conjunction with other equipment, unless specifically stated otherwise on the product label. THE USER AND THEIR REPRESENTATIVE AGENTS OR EMPLOYEES ARE SOLELY RESPONSIBLE FOR THE SAFETY AND RELIABILITY OF ANY PRODUCTS WHICH ARE USED IN CONJUNCTION WITH OTHER EQUIPMENT, UNLESS IT IS SPECIFICALLY STATED OTHERWISE ON THE PRODUCT LABEL. THE USER AND THEIR REPRESENTATIVE AGENTS OR EMPLOYEES ARE SOLELY RESPONSIBLE FOR THE SAFETY AND RELIABILITY OF ANY PRODUCTS WHICH ARE USED IN CONJUNCTION WITH OTHER EQUIPMENT, UNLESS IT IS SPECIFICALLY STATED OTHERWISE ON THE PRODUCT LABEL.



NOTES:
 1. MAX TOTAL CURRENT RATING FOR PANEL IS 100 AMPERES

ALARM CONTACT RATINGS:
 0.5A @ 120VAC, 0.2 @ 125VDC, 1.0A @ 24VDC
 RESISTIVE, FOR ALARM PURPOSES ONLY

- NOTES:**
1. SHUNT SH USED ON UNITS RATED ABOVE 40A OUTPUT
 2. ALL ALARM CONTACTS ARE SHOWN IN THE SHELF STATE.
 3. CONTACTS REMAIN ENERGIZED IN "NORMAL STATE". CONTACTS WILL DE ENERGIZE IN "ALARM STATE".

2	UPDATED AS PER MARKUPS	NSP	AR	AR	NOV 27/15
1	AS BUILT	NSP	AR	AR	NOV 12/15
0	ISSUED FOR CONSTRUCTION	NSP	AR	PM	OCT 26/15
REV	DESCRIPTION	DWN	CHK	APP	DATE

SCHEMATIC DIAGRAM FOR CCE(T) UPS-21601 SUPERTROL RECTIFIER

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PROJECT NAME: CARMON CREEK PROJECT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1&2
 CUSTOMER: SHELL CANADA
 LOCATION: CARMON CREEK, AB, CANADA

TAG: 0835A-08028
 SLS#: 338716 QUOTE: CGY2014-85 PD#: 4512-109-130

DWN BY: NSP DATE: OCT 26/15 DVG #:
 CHK BY: AR DATE: -
 APP BY: PM DATE: -

338716-700

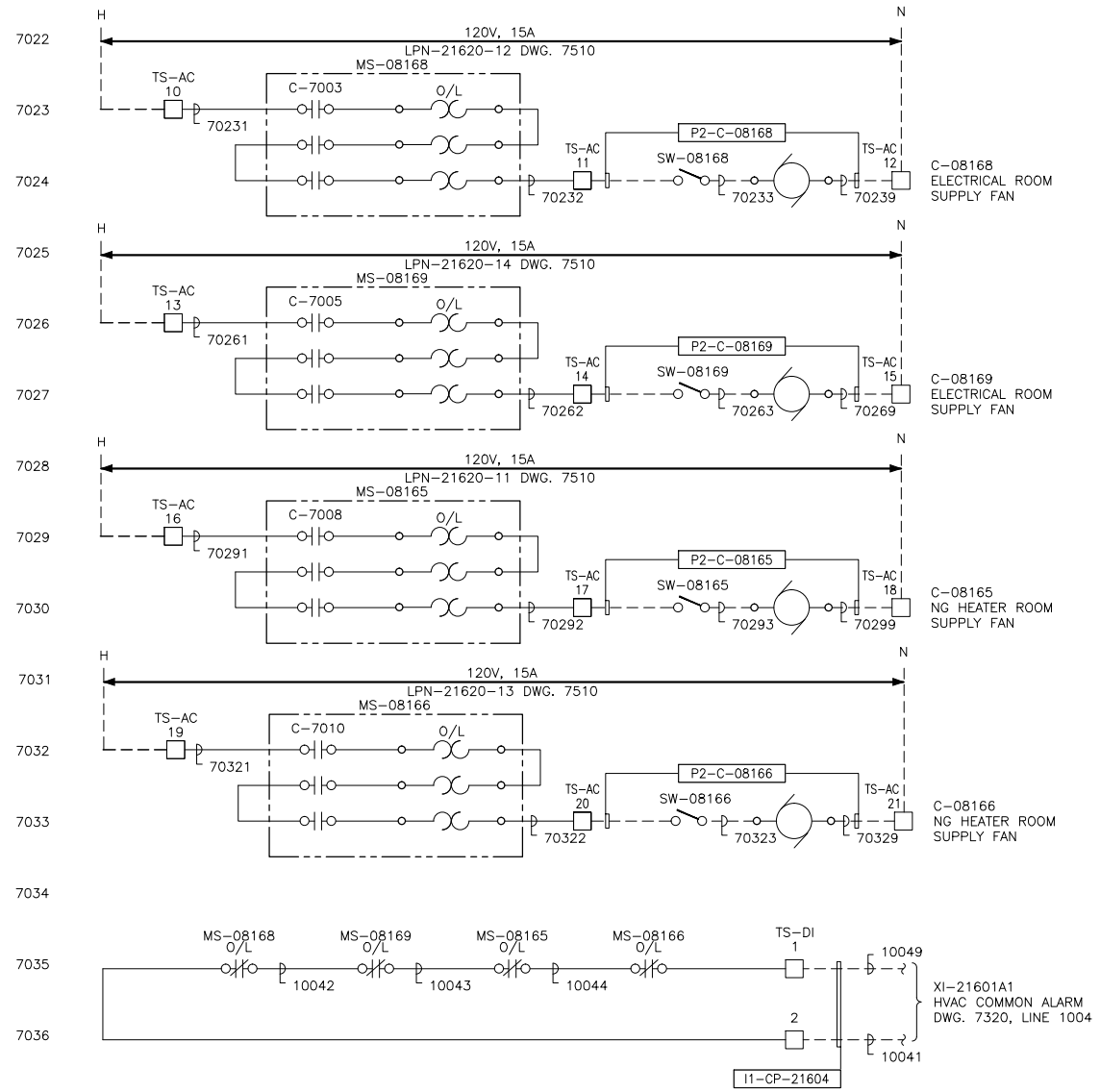
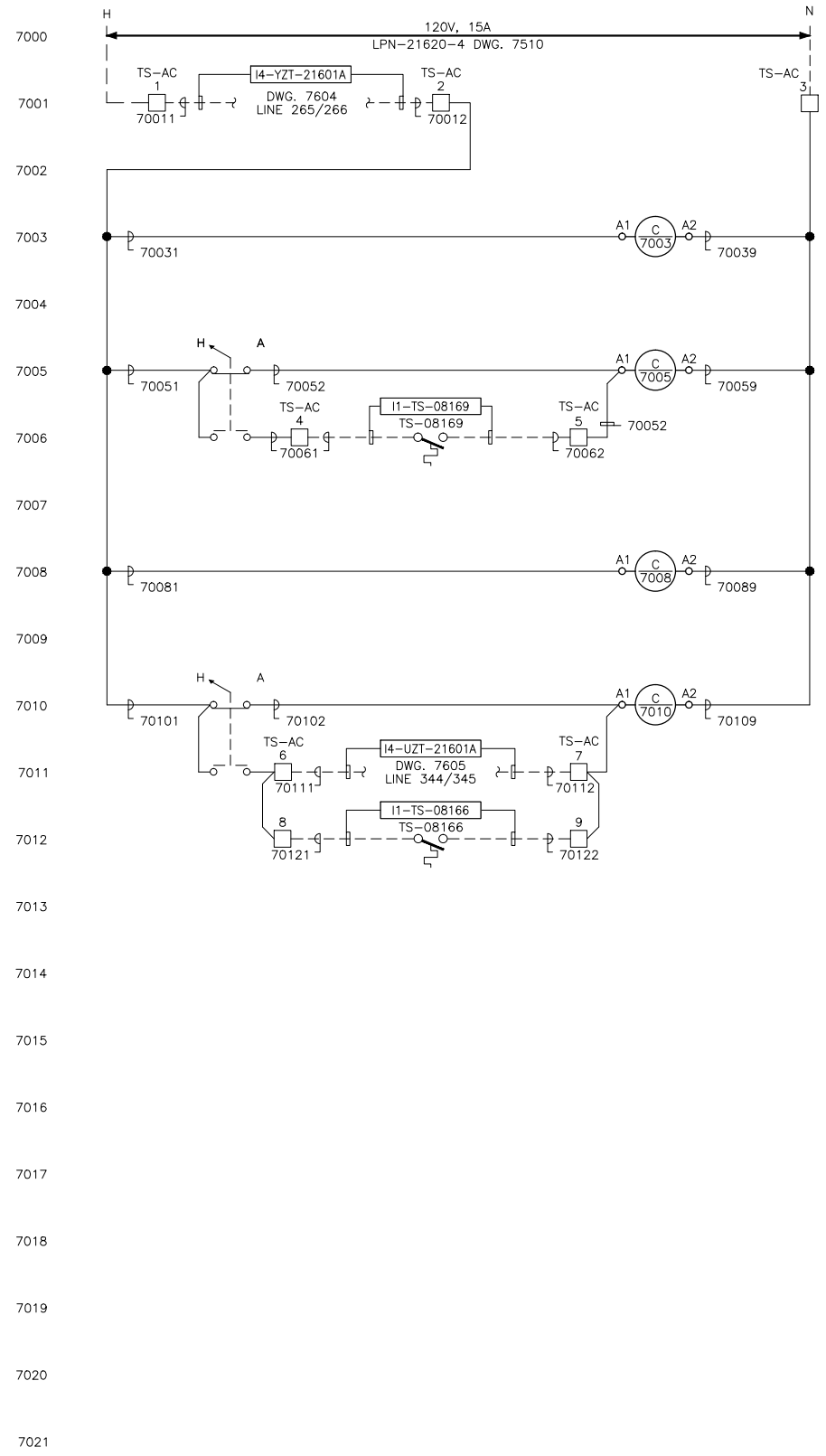
PAGE: 1 OF 1 CAD: N/A REV: 2

CARMON CREEK - CMT - ALARM SCHEDULE

REV	TRIP LOCATION	TAG	BOUNDARY	TRANSMITTER	CONTROL SYSTEM	ASSOCIATED EQUIPMENT	DESCRIPTION	BYPASS CLASS	BTMR [sec]	CLASS B/BC/CB/CR EVENT (TRIGGER)	DEB (Slosh Timer) [sec]	CTMR [sec]	SYSTEM	P&ID	CAUSE & EFFECT/CONTROL NARRATIVE	ENG RANGE MAX	ENG RANGE MIN	SETPOINT	ENG UNIT	COMMENTS		
01	CMT NG HEATER GAS OUTLET	TZH-08071A	HI_HI_ALM	TZT-08071A	IPS	H-08071A	NATURAL GAS HEATER TEMPERATURE TRANSMITTER	A	---	---	---	---	0835 - CMT	338715-100	CCK-4512109130-0735-C14-00001-000 / CCK-4512109130-0735-C14-00002-000	100	-50	72.6	Deg C	Protection from high gas temperature		
01	CMT NG OUTLET LINE	TZL-08071A	LO_LO_ALM	TZT-08071B	IPS	TIT-08071B	GAS OUTLET TEMPERATURE	C	---	---	---	---	0835 - CMT	338715-100	CCK-4512109130-0735-C14-00001-000 / CCK-4512109130-0735-C14-00002-001	100	-50	-10	Deg C	Protection from low gas temperature		
01	CMT NG GAS OUTLET	PZH-08071A	HI_HI_ALM	PZT-08071A	IPS	PIT-08071A	GAS OUTLET PRESSURE	A	---	---	---	---	0835 - CMT	338715-100	CCK-4512109130-0735-C14-00001-000 / CCK-4512109130-0735-C14-00002-002	1034	0	400	kPag	Protection from high pressure		
01	CMT NG PRESSURE REDUCTION SKID	UZHH-21601A	HI_HI_ALM	UZT-21601A	IPS	UZT-21601A	NATURAL GAS HEATER ROOM LEL	A	---	---	---	---	0835 - CMT	338715-100	CCK-4512109130-0735-C14-00001-000 / CCK-4512109130-0735-C14-00002-003	100	0	40	%	2oo2 LEL 40%		
01	CMT NG PRESSURE REDUCTION SKID	UZHH-21601B	HI_HI_ALM	UZT-21601B	IPS	UZT-21601B	NATURAL GAS HEATER ROOM LEL	A	---	---	---	---	0835 - CMT	338715-100	CCK-4512109130-0735-C14-00001-000 / CCK-4512109130-0735-C14-00002-004	100	0	40	%	2oo2 LEL 40%		
01	CMT NG PRESSURE REDUCTION SKID	YZH-21601A	HI_HI_ALM	YZT-21601A	IPS	A-08028	NATURAL GAS HEATER ROOM FIRE	A	---	---	---	---	0835 - CMT	338715-100	CCK-4512109130-0735-C14-00001-000 / CCK-4512109130-0735-C14-00002-005	4	20	13.6	mA	Fire alarm		
01	CMT NG PRESSURE REDUCTION SKID	YZH-21602A		YZT-21602A	IPS	A-08029	NATURAL GAS HEATER ROOM SMOKE	A	---	---	---	---	0835 - CMT	338715-100	CCK-4512109130-0735-C14-00001-000 / CCK-4512109130-0735-C14-00002-006	---	---	---	---	Smoke alarm		
01	CMT NG PRESSURE REDUCTION SKID	SKID ESD		HZS-21601	IPS	PROCESS	EMERGENCY SHUTDOWN STRING	A	---	---	---	---	0835 - CMT	338715-100	CCK-4512109130-0735-C14-00001-000 / CCK-4512109130-0735-C14-00002-007	---	---	---	---	Emergency shutdown activated - HZS-21601A, HZS-21602A or CP-21603 pushbutton pushed, or SHELL DCS activated		

CARMON CREEK - CMT - TRIP SCHEDULE

REV	TRIP LOCATION	TAG	BOUNDARY	TRANSMITTER	CONTROL SYSTEM	ASSOCIATED EQUIPMENT	DESCRIPTION	BYPASS CLASS	BTMR [sec]	CLASS B/BC/CB/CR EVENT (TRIGGER)	DEB (Slosh Timer [sec])	CTMR [sec]	SYSTEM	P&ID	CAUSE & EFFECT/CONTROL NARRATIVE	ENG RANGE MAX	ENG RANGE MIN	SETPOINT	ENG UNIT	COMMENTS
01	CAMP NG HEATER GAS OUTLET	TZH-08064A	HI_HI_ALM	TZT-08064A	SIL Units	T-08064	NATURAL GAS HEATER TEMPERATURE TRANSMITTER	A	---	---	---	---	0864 - CAMP	338715-100	338715	100	-50	72.6	Deg C	Protection from High Gas Temperature
01	CAMP NG OUTLET LINE	TZL-08064B	LO_LO_ALM	TZT-08064B	SIL Units	T-08064	OUTLET GAS TEMPERATURE	C	---	---	---	---	0864 - CAMP	338715-100	338715	100	-50	-10	Deg C	Protection From Low Gas Temperature
01	CAMP NG GAS OUTLET	PZH-08064F	HI_HI_ALM	PZT-08064F	SIL Units	T-08064	GAS OUTLET PRESSURE	A	---	---	---	---	0864 - CAMP	338715-100	338715	1034.2	0	400	kPag	Protection From High Pressure
01	CAMP NG PRESSURE REDUCTION SKID	UZH-21501A	HI_HI_ALM	UZT-08064A	SIL Units	T-21501	NATURAL GAS HEATER ROOM COMBUSTIBLE GAS DETECTION	A	---	---	---	---	0864 - CAMP	338715-100	338715	100	0	40	%	2ooN LEL 40%
01	CAMP NG PRESSURE REDUCTION SKID	UZH-21501B	HI_HI_ALM	UZT-08064A	SIL Units	T-21501	NATURAL GAS HEATER ROOM COMBUSTIBLE GAS DETECTION	A	---	---	---	---	0864 - CAMP	338715-100	338715	100	0	40	%	2ooN LEL 40%
01	CAMP NG PRESSURE REDUCTION SKID	YZH-21501A	HI_HI_ALM	YZT-08064A	SIL Units	T-21501	NATURAL GAS HEATER ROOM FIRE DETECTION	A	---	---	---	---	0864 - CAMP	338715-100	338715	4	20	13.6	mA	Fire Alarm
01	CAMP NG PRESSURE REDUCTION SKID	YZH-21502A	---	---	SIL Units	A-21502	NATURAL GAS CONTROL ROOM SMOKE ALARM	A	---	---	---	---	0864 - CAMP	338715-100	338715	---	---	---	---	Smoke Alarm
01	CAMP NG PRESSURE REDUCTION SKID	HZS-21501A	---	---	SIL Units	A-21501	EMERGENCY SHUTDOWN	A	---	---	---	---	0864 - CAMP	338715-100	338715	---	---	---	---	Emergency Shutdown Button Pushed
01	CAMP NG PRESSURE REDUCTION SKID	HZS-21502A	---	---	SIL Units	A-21502	EMERGENCY SHUTDOWN	A	---	---	---	---	0864 - CAMP	338715-100	338715	---	---	---	---	Emergency Shutdown Button Pushed
01	CAMP NG PRESSURE REDUCTION SKID	HZS-21503A	---	---	SIL Units	A-21503	EMERGENCY SHUTDOWN	A	---	---	---	---	0864 - CAMP	338715-100	338715	---	---	---	---	Emergency Shutdown Button Pushed



- TERMINAL LEGEND**
- FUSED TERMINAL C/W LED
 - FUSE TERMINAL (REMOVABLE FUSE)
 - DISCONNECTED TERMINAL
 - FEED THROUGH TERMINAL
 - RELAY PANEL
 - MOTOR STARTERS
 - VENDOR EQUIPMENT
 - FIELD TERMINAL BOXES

- LINE TYPE**
- FIELD WIRING
 - PANEL WIRING

- LEGEND**
- NORMALLY OPEN CONTACT
 - COIL
 - R=RELAY
 - TDE=TIME DELAY ON ENERGIZING
 - TDD=TIME DELAY ON DE-ENERGIZING
 - RT=RECYCLE TIMER
 - C=CONTACTOR
 - M=MOTOR STARTER
 - TWO POSITION SELECTOR SWITCH
 - TEMPERATURE SWITCH (CLOSES ON RISING TEMPERATURE)
 - OVERLOAD
 - EXHAUST FAN
 - DISCONNECT SWITCH

REFERENCE DRAWINGS:
 DWG. 7290 - CP-21604 PANEL LAYOUT & BOM
 DWG. 7400 - ELECTRICAL POWER LAYOUT & BOM
 DWG. 7500 - CABLE SCHEDULE (1 OF 2)
 DWG. 7510 - 120/208 VAC DISTRIBUTION PANEL SCHEDULE

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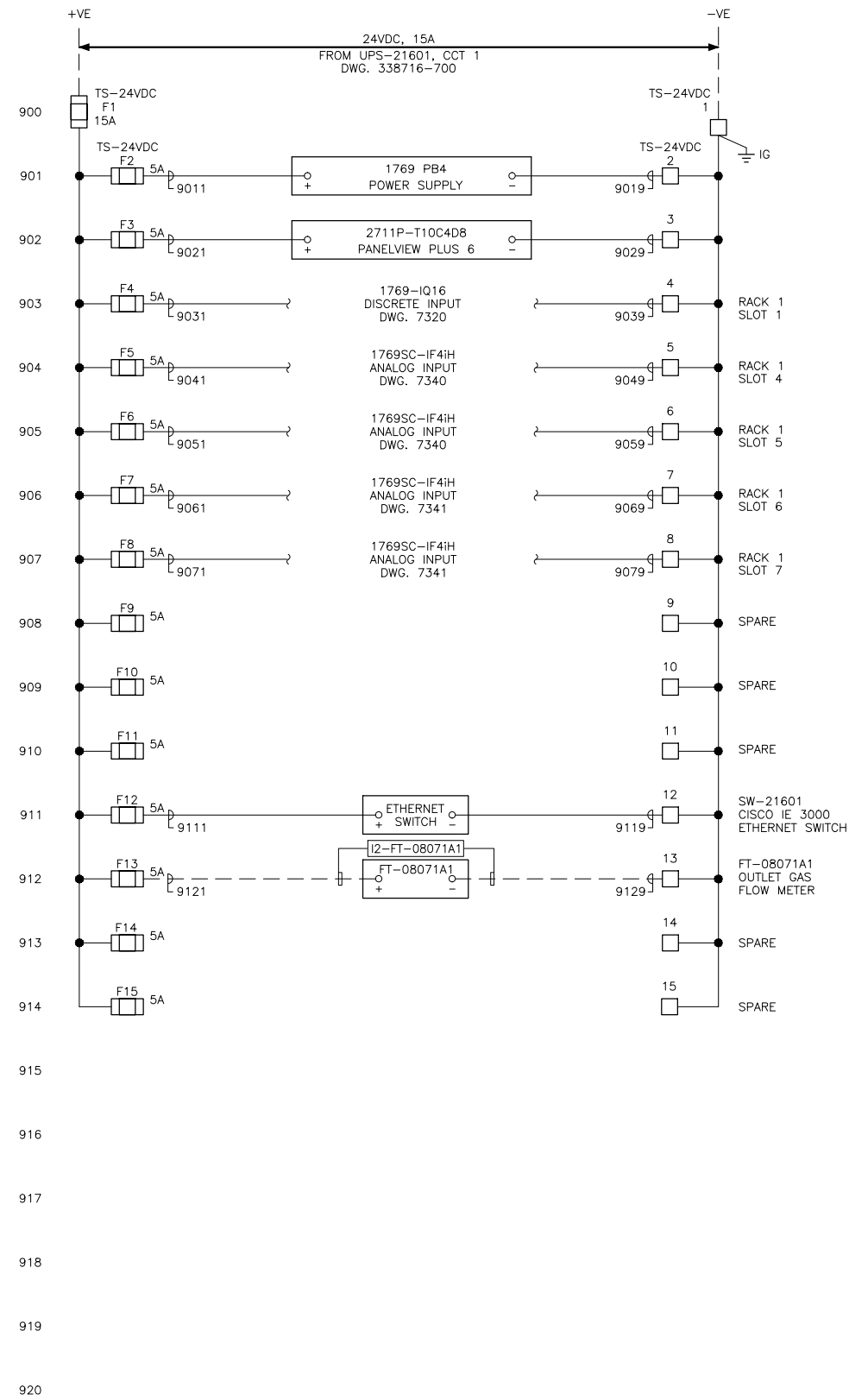


PROJECT NAME:	CARMON CREEK		
CUSTOMER:	SHELL		
LOCATION:	CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2		
TAG:	0735A-08030		
SLS#:	338716	QUOTE:	CGY2014-85
PO#:	4512-109-130		
DWN BY:	KS	DATE:	AUG 14/14
CHK BY:	JS	DATE:	AUG 14/14
APP BY:	-	DATE:	-
PAGE: 1 OF 13		CAD:	N/A
REV: 2			

REV	DESCRIPTION	DWN	CHK	APP	DATE
2	AS-BUILT	LS	JS	-	NOV 09/15
1	ISSUED FOR FIELD CONSTRUCTION	JB	JS	-	AUG 18/15
0	ISSUED FOR CONSTRUCTION	JB	JS	-	MAY 05/15

**CMT NG PRESSURE REDUCTION SKID PACKAGE
 CP-21604 CONTACTOR PANEL SCHEMATICS**

**COLLEAUX
 ENGINEERING
 INC.**



TERMINAL LEGEND

- FUSED TERMINAL C/W LED
- FUSE TERMINAL (REMOVABLE FUSE)
- DISCONNECTED TERMINAL
- FEED THROUGH TERMINAL
- RELAY PANEL
- MOTOR STARTERS
- VENDOR EQUIPMENT
- FIELD TERMINAL BOXES

LINE TYPE

- FIELD WIRING
- PANEL WIRING

INTERNAL PANEL WIRING

POWER

- 24 VDC(+) - RED
- 24 VDC(-) - BLK
- AC (L) - BLK
- AC (N) - WHT

SIGNAL

- 24 VDC(+) - WHT
- 24 VDC(-) - BLK

LEGEND

- THERMOSTAT (CLOSES ON RISING TEMPERATURE)
- DUPLEX RECEPTACLE
- EXHAUST FAN
- ISOLATED GROUND

REFERENCE DRAWINGS:

- DWG. 7300 - CP-21601 PLC PANEL DIMENSIONAL & DOOR LAYOUT
- DWG. 7301 - CP-21601 PLC PANEL BACKPAN LAYOUT & BOM
- DWG. 7309 - CP-21601 PLC PANEL SYSTEM ARCHITECTURE
- DWG. 7320 - CP-21601 PLC DISCRETE INPUT SCHEMATIC
- DWG. 7340 - CP-21601 PLC ANALOG INPUT SCHEMATIC (1 OF 2)
- DWG. 7341 - CP-21601 PLC ANALOG INPUT SCHEMATIC (2 OF 2)
- DWG. 7347 - CP-21601 PLC ANALOG OUTPUT SCHEMATIC
- DWG. 7400 - ELECTRICAL POWER LAYOUT & BOM
- DWG. 7401 - ANALOG & CONTROL GENERAL LAYOUT
- DWG. 7402 - ELECTRICAL ROOM ELEVATIONS
- DWG. 7500 - CABLE SCHEDULE (1 OF 2)
- DWG. 7501 - CABLE SCHEDULE (2 OF 2)
- DWG. 7510 - 120/208 VAC DISTRIBUTION PANEL SCHEDULE

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.



PROJECT NAME:	CARMON CREEK		
CUSTOMER:	SHELL		
LOCATION:	CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2		
TAG:	0735A-08030		
SLS#:	338716	QUOTE:	CGY2014-85
PO#:	4512-109-130		
DWN BY:	KS	DATE:	AUG 14/14
CHK BY:	JS	DATE:	AUG 14/14
APP BY:	-	DATE:	-
DWG #:	214068-7305		
PAGE:	2 OF 13	CAD:	N/A
REV:	2		

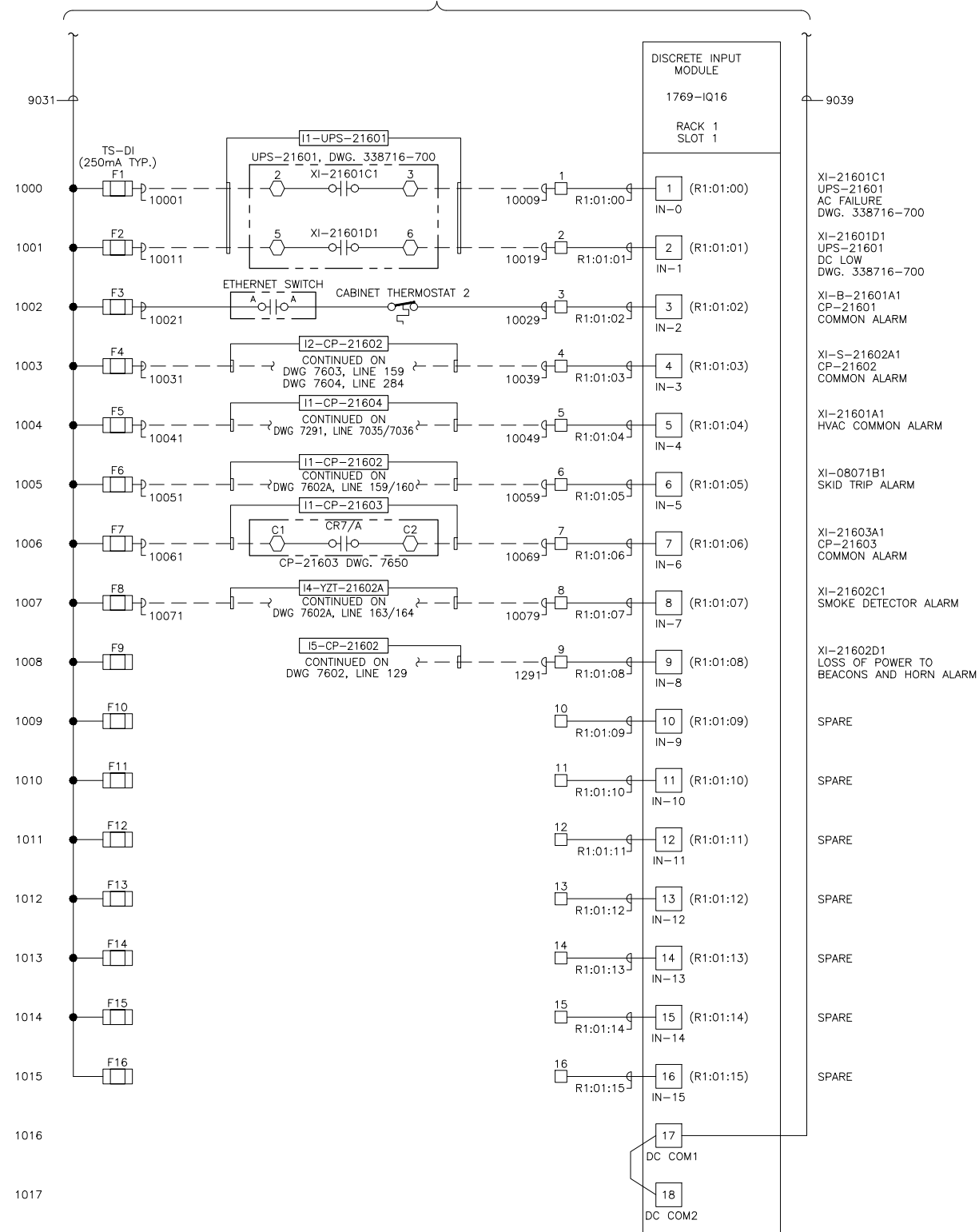
REV	DESCRIPTION	DWN	CHK	APP	DATE
2	AS-BUILT	LS	JS	-	NOV 09/15
1	ISSUED FOR FIELD CONSTRUCTION	JB	JS	-	AUG 18/15
0	ISSUED FOR CONSTRUCTION	JB	JS	-	MAY 05/15

**CMT NG PRESSURE REDUCTION SKID PACKAGE
CP-21601 PLC PANEL POWER DISTRIBUTION**



**COLLEAUX
ENGINEERING
INC.**

CONTINUED FROM
DWG. 7305
LINE 903



TERMINAL LEGEND

- FUSED TERMINAL C/W LED
- FUSE TERMINAL (REMOVABLE FUSE)
- DISCONNECTED TERMINAL
- FEED THROUGH TERMINAL
- RELAY PANEL
- MOTOR STARTERS
- VENDOR EQUIPMENT
- FIELD TERMINAL BOXES

LEGEND

- TEMPERATURE SWITCH (OPENS ON RISING TEMPERATURE)

LINE TYPE

- FIELD WIRING
- PANEL WIRING

INTERNAL PANEL WIRING

POWER

- 24 VDC(+) - RED
- 24 VDC(-) - BLK
- AC (L) - BLK
- AC (N) - WHT

SIGNAL

- 24 VDC(+) - WHT
- 24 VDC(-) - BLK

REFERENCE DRAWINGS:

- DWG. 7301 - CP-21601 PLC PANEL BACKPAN LAYOUT & BOM
- DWG. 7305 - CP-21601 PLC PANEL POWER DISTRIBUTION
- DWG. 7309 - CP-21601 PLC PANEL SYSTEM ARCHITECTURE
- DWG. 7500 - CABLE SCHEDULE (1 OF 2)
- DWG. 7501 - CABLE SCHEDULE (2 OF 2)
- DWG. 7603 - CP-21602 IPS PANEL SCHEMATICS (1 OF 2)
- DWG. 7604 - CP-21602 IPS PANEL SCHEMATICS (2 OF 2)

PLC CARD INDEX

0	1	2	3	4	5	6	7	8
1769-L33ER	1769-IQ16	1769-OW8I	1769-OW8I	1769SC-IF4IH	1769SC-IF4IH	1769SC-IF4IH	1769SC-IF4IH	1769SC-OF4IH

NOTES:
1. ETHERNET SWITCH CONTACT IS SHOWN IN ITS SHELF-STATE. THE NORMALLY OPEN CONTACT IS OPEN (INFINITE RESISTANCE) WHEN THE SWITCH IS NOT ENERGIZED. THE ETHERNET ALARM IS FAIL SAFE AND DE-ENERGIZED WHEN TRIPPED, ENERGIZED WHEN IN NON-ALARM STATE.

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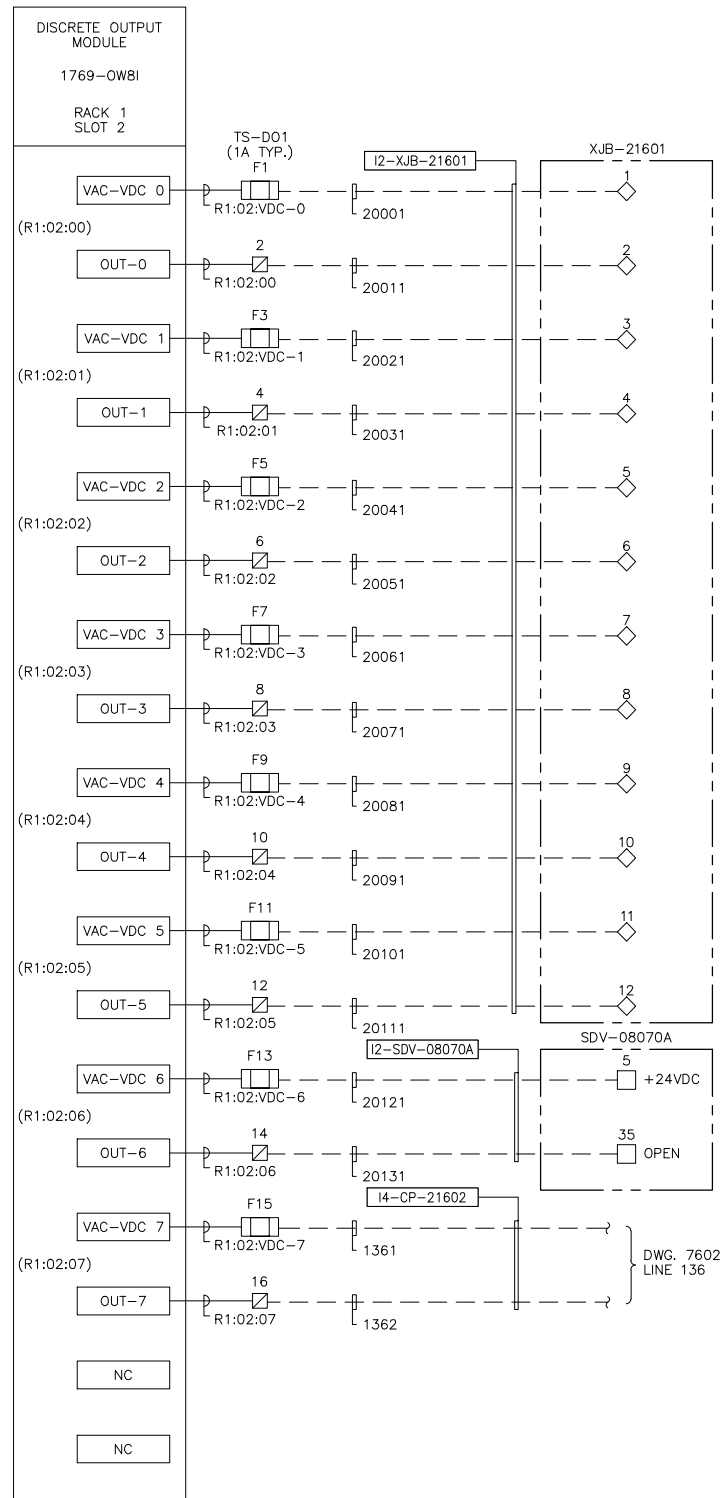


PROJECT NAME: CARMON CREEK	
CUSTOMER: SHELL	
LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2	
TAG: 0735A-08030	
SLS#: 338716	QUOTE: CGY2014-85
PO#: 4512-109-130	
DWN BY: KS	DATE: AUG 14/14
CHK BY: JS	DATE: AUG 14/14
APP BY: -	DATE: -
214068-7320	
PAGE: 3 OF 13	CAD: N/A
REV: 3	

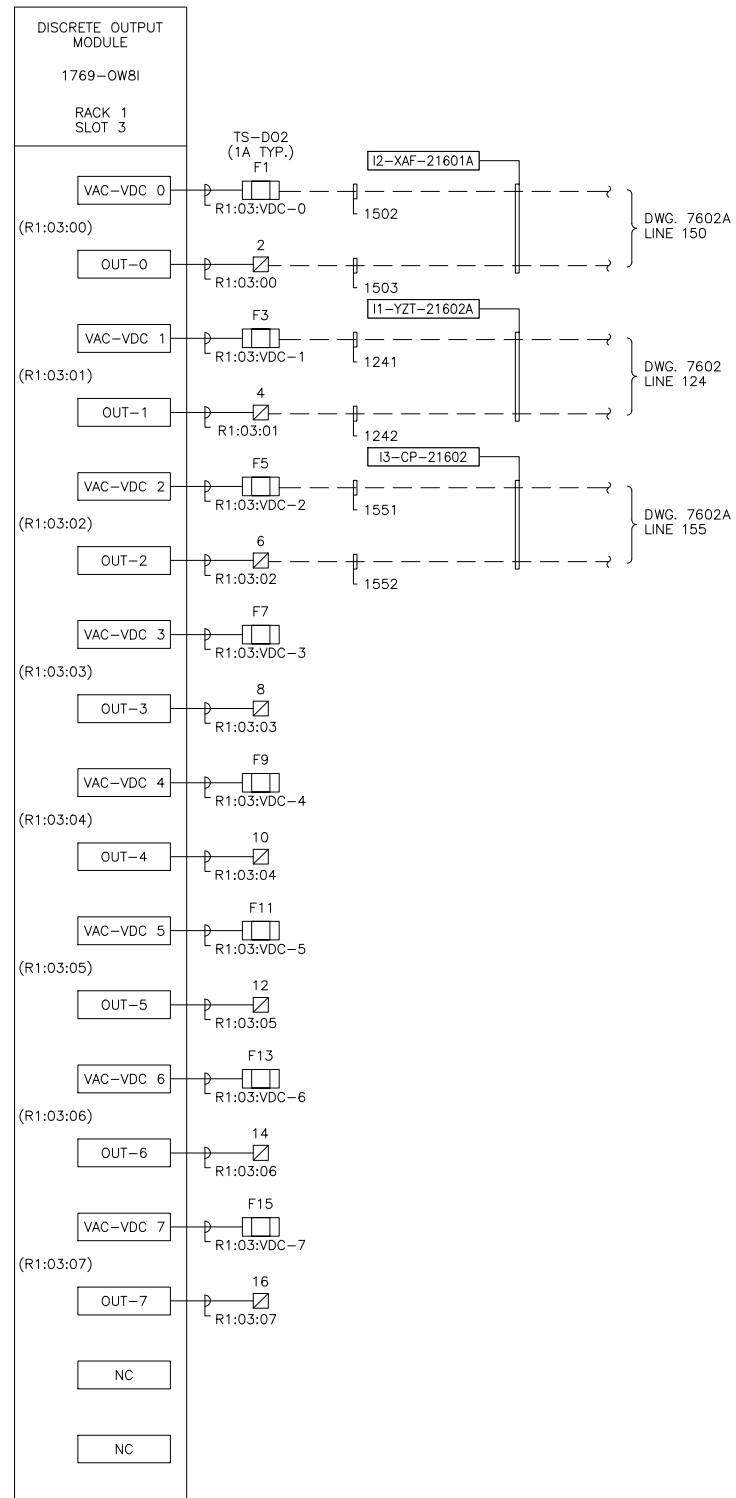
3	AS-BUILT	LS	JS	-	NOV 09/15
2	GENERAL REVISION	JB	JS	-	SEP 22/15
1	ISSUED FOR FIELD CONSTRUCTION	JP	JS	-	AUG 18/15
0	ISSUED FOR CONSTRUCTION	JB	JS	-	MAY 05/15
REV	DESCRIPTION	DWN	CHK	APP	DATE

CMT NG PRESSURE REDUCTION SKID PACKAGE
CP-21601 PLC DISCRETE INPUT SCHEMATIC





- XI-08071A1
LCP-21601/02/03
COMMON ALARM
- XI-08071B1
SKID TRIP
ALARM
- XI-21601A1
HVAC COMMON
ALARM
- XI-21601B1
BLDG.
TEMP ALARM
- XI-21602A1
LEL COMMON
ALARM
- XI-21602B1
BLDG. FLAME
COMMON ALARM
- SDV-08070A
OPEN
DWG. 7650
- XY-21602A1
BEACON/HORN TEST



- XY-21602A2
SILENCE
- XY-21602A3
SMOKE DETECTOR
RESET
- XY-21602A4
TRIP RESET
- SPARE
- SPARE
- SPARE
- SPARE
- SPARE

TERMINAL LEGEND

- FUSED TERMINAL C/W LED
- FUSE TERMINAL (REMOVABLE FUSE)
- DISCONNECTED TERMINAL
- FEED THROUGH TERMINAL
- RELAY PANEL
- MOTOR STARTERS
- VENDOR EQUIPMENT
- FIELD TERMINAL BOXES

LINE TYPE

- FIELD WIRING
- PANEL WIRING

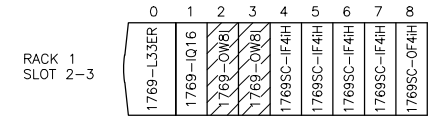
INTERNAL PANEL WIRING

- POWER**
- 24 VDC(+) - RED
 - 24 VDC(-) - BLK
 - AC (L) - BLK
 - AC (N) - WHT
- SIGNAL**
- 24 VDC(+) - WHT
 - 24 VDC(-) - BLK

REFERENCE DRAWINGS:

- DWG. 7301 - CP-21601 PLC PANEL BACKPAN LAYOUT & BOM
- DWG. 7305 - CP-21601 PLC PANEL POWER DISTRIBUTION
- DWG. 7309 - CP-21601 PLC PANEL SYSTEM ARCHITECTURE
- DWG. 7500 - CABLE SCHEDULE (1 OF 2)
- DWG. 7501 - CABLE SCHEDULE (2 OF 2)
- DWG. 7900 - JUNCTION BOX LAYOUTS & BOM

PLC CARD INDEX



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PROJECT NAME: CARMON CREEK

CUSTOMER: SHELL

LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

TAG: 0735A-08030

SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

DWNBY: KS DATE: AUG 14/14 DWG #: 214068-7330
 CHKBY: JS DATE: AUG 14/14
 APPBY: - DATE: - PAGE: 4 OF 13 CAD: N/A REV: 2

REV	DESCRIPTION	DWN	CHK	APP	DATE
2	AS-BUILT	LS	JS	-	NOV 09/15
1	ISSUED FOR FIELD CONSTRUCTION	JP	JS	-	AUG 18/15
0	ISSUED FOR CONSTRUCTION	JB	JS	-	MAY 05/15

CMT NG PRESSURE REDUCTION SKID PACKAGE
 CP-21601 PLC DISCRETE OUTPUT SCHEMATIC



**COLLEAUX
 ENGINEERING
 INC.**

TERMINAL LEGEND

- FUSED TERMINAL C/W LED
- FUSE TERMINAL (REMOVABLE FUSE)
- DISCONNECTED TERMINAL
- FEED THROUGH TERMINAL
- RELAY PANEL
- MOTOR STARTERS
- VENDOR EQUIPMENT
- FIELD TERMINAL BOXES

LEGEND

- IG ISOLATED GROUND

LINE TYPE

- FIELD WIRING
- PANEL WIRING

INTERNAL PANEL WIRING

POWER

- 24 VDC(+) - RED
 - 24 VDC(-) - BLK
 - AC (L) - BLK
 - AC (N) - WHT
- SIGNAL
- 24 VDC(+) - WHT
 - 24 VDC(-) - BLK

REFERENCE DRAWINGS:

- DWG. 7301 - CP-21601 PLC PANEL BACKPAN LAYOUT & BOM
- DWG. 7305 - CP-21601 PLC PANEL POWER DISTRIBUTION
- DWG. 7309 - CP-21601 PLC PANEL SYSTEM ARCHITECTURE
- DWG. 7401 - ANALOG & CONTROL GENERAL LAYOUT
- DWG. 7500 - CABLE SCHEDULE (1 OF 2)
- DWG. 7501 - CABLE SCHEDULE (2 OF 2)

PLC CARD INDEX

0	1	2	3	4	5	6	7	8
1769-L33ER	1769-IQ16	1769-OW8I	1769-OW8I	1769SC-IF4H	1769SC-IF4H	1769SC-IF4H	1769SC-IF4H	1769SC-OF4H

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.



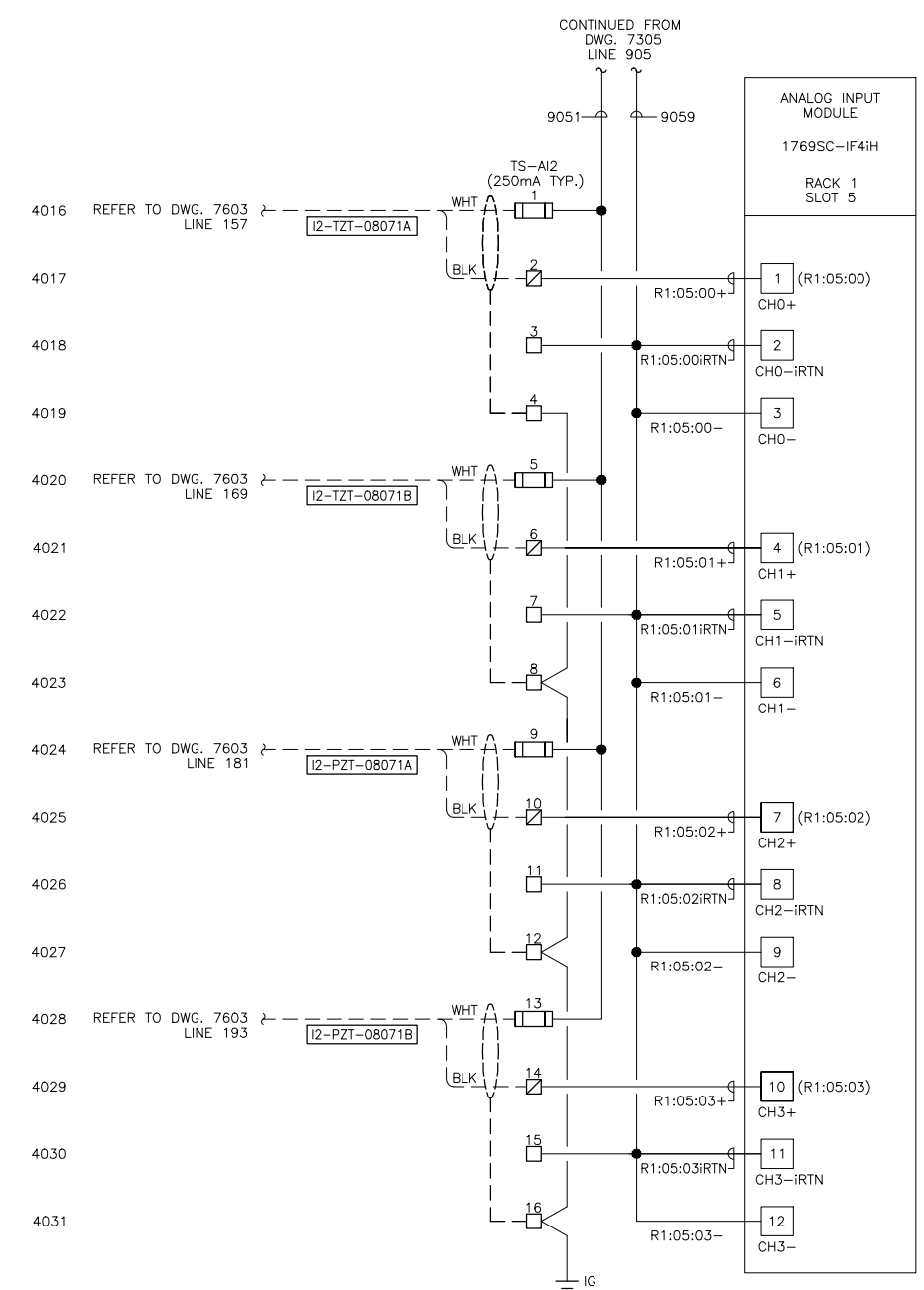
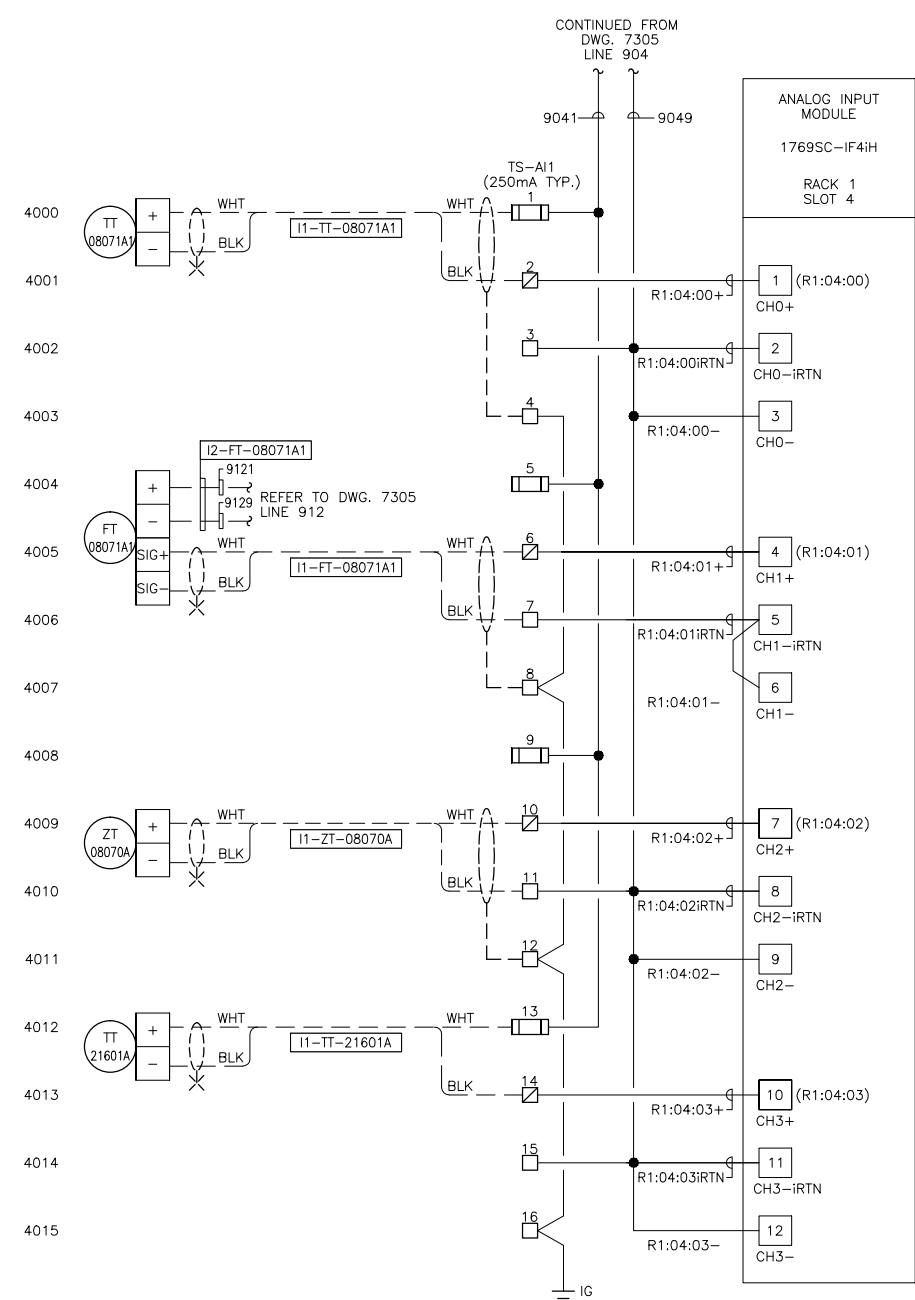
PROJECT NAME:	CARMON CREEK
CUSTOMER:	SHELL
LOCATION:	CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG:	0735A-08030
SLS#: 338716	QUOTE: CGY2014-85
PO#: 4512-109-130	
DWN BY: JP	DATE: JUL 23/14
CHK BY: JS	DATE: JUL 23/14
APP BY: -	DATE: -
214068-7340	
PAGE: 5 OF 13	CAD: N/A
REV: 3	

REV	DESCRIPTION	DWN	CHK	APP	DATE
3	AS-BUILT	LS	JS	-	NOV 09/15
2	RE-ISSUED FOR FIELD CONSTRUCTION	LS	JS	-	OCT 21/15
1	ISSUED FOR FIELD CONSTRUCTION	JB	JS	-	AUG 18/15
0	ISSUED FOR CONSTRUCTION	JB	JS	-	MAY 05/15

CMT NG PRESSURE REDUCTION SKID PACKAGE
CP-21601 PLC ANALOG INPUT SCHEMATIC (1 OF 2)



COLLEAUX ENGINEERING INC.



TZT-08071A NG HEATER TEMP. TRANSMITTER

TZT-08071B GAS OUTLET TEMP. TRANSMITTER

PZT-08071A NATURAL GAS HEATER OUTLET PRESSURE

PZT-08071B NATURAL GAS PRESSURE DOWNSTREAM OF PCV-08071A

RACK 1
SLOT 4-5

TERMINAL LEGEND

- FUSED TERMINAL C/W LED
- FUSE TERMINAL (REMOVABLE FUSE)
- DISCONNECTED TERMINAL
- FEED THROUGH TERMINAL
- RELAY PANEL
- MOTOR STARTERS
- VENDOR EQUIPMENT
- FIELD TERMINAL BOXES

LEGEND

- IG ISOLATED GROUND

LINE TYPE

- FIELD WIRING
- PANEL WIRING

INTERNAL PANEL WIRING

POWER

- 24 VDC(+) - RED
 - 24 VDC(-) - BLK
 - AC (L) - BLK
 - AC (N) - WHT
- SIGNAL
- 24 VDC(+) - WHT
 - 24 VDC(-) - BLK

REFERENCE DRAWINGS:

- DWG. 7301 - CP-21601 PLC PANEL BACKPAN LAYOUT & BOM
- DWG. 7305 - CP-21601 PLC PANEL POWER DISTRIBUTION
- DWG. 7309 - CP-21601 PLC PANEL SYSTEM ARCHITECTURE
- DWG. 7401 - ANALOG & CONTROL GENERAL LAYOUT
- DWG. 7500 - CABLE SCHEDULE (1 OF 2)
- DWG. 7501 - CABLE SCHEDULE (2 OF 2)

PLC CARD INDEX

0	1	2	3	4	5	6	7	8
1769-L33ER	1769-IQ16	1769-OW8I	1769-OW8I	1769SC-IF4H	1769SC-IF4H	1769SC-IF4H	1769SC-IF4H	1769SC-IF4H

RACK 1
SLOT 6-7

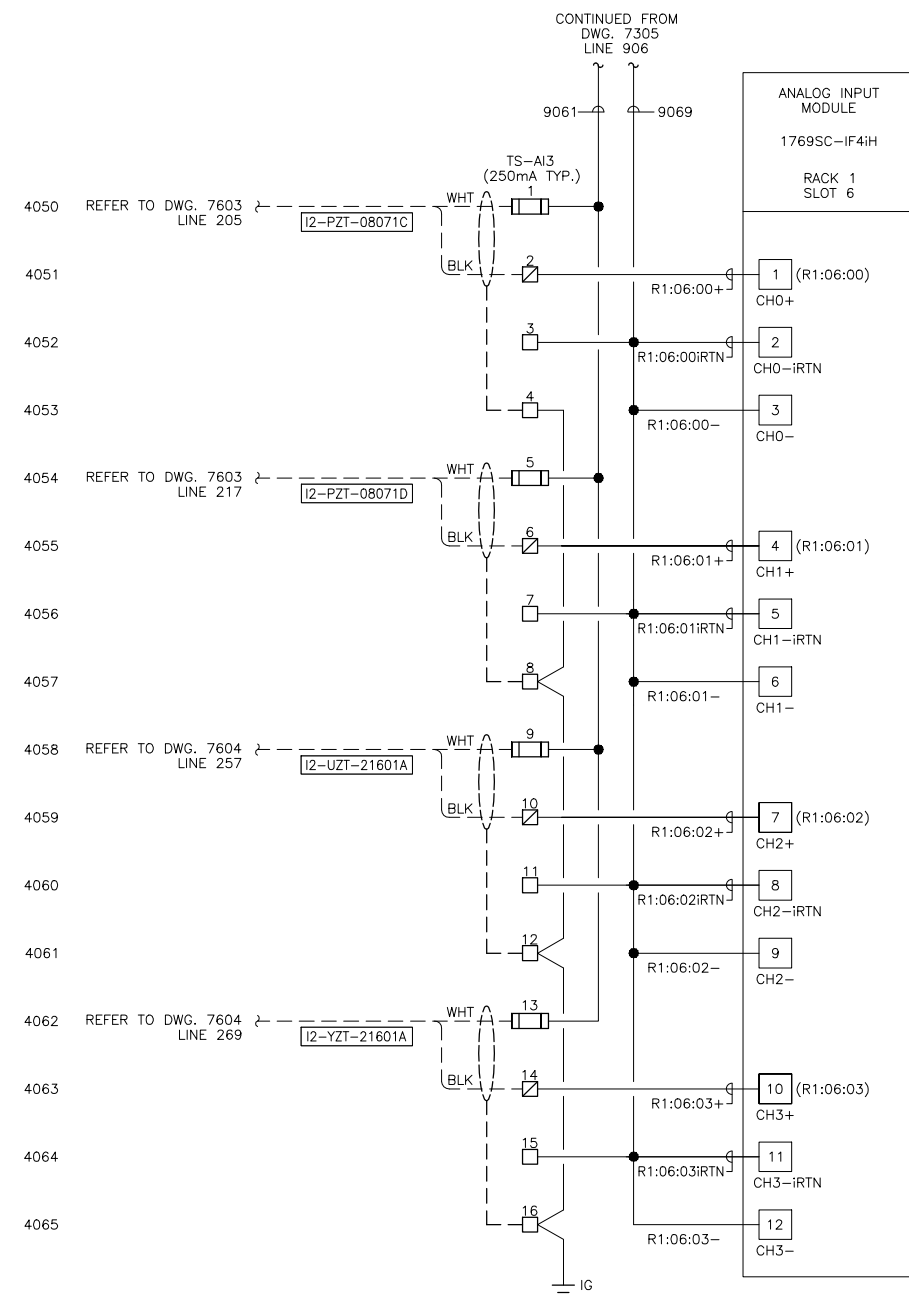
THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.



PROJECT NAME: CARMON CREEK
 CUSTOMER: SHELL
 LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

DWN BY: JP DATE: JUL 23/14 DWG #: 214068-7341
 CHK BY: JS DATE: JUL 23/14
 APP BY: - DATE: - PAGE: 6 OF 13 CAD: N/A REV: 2

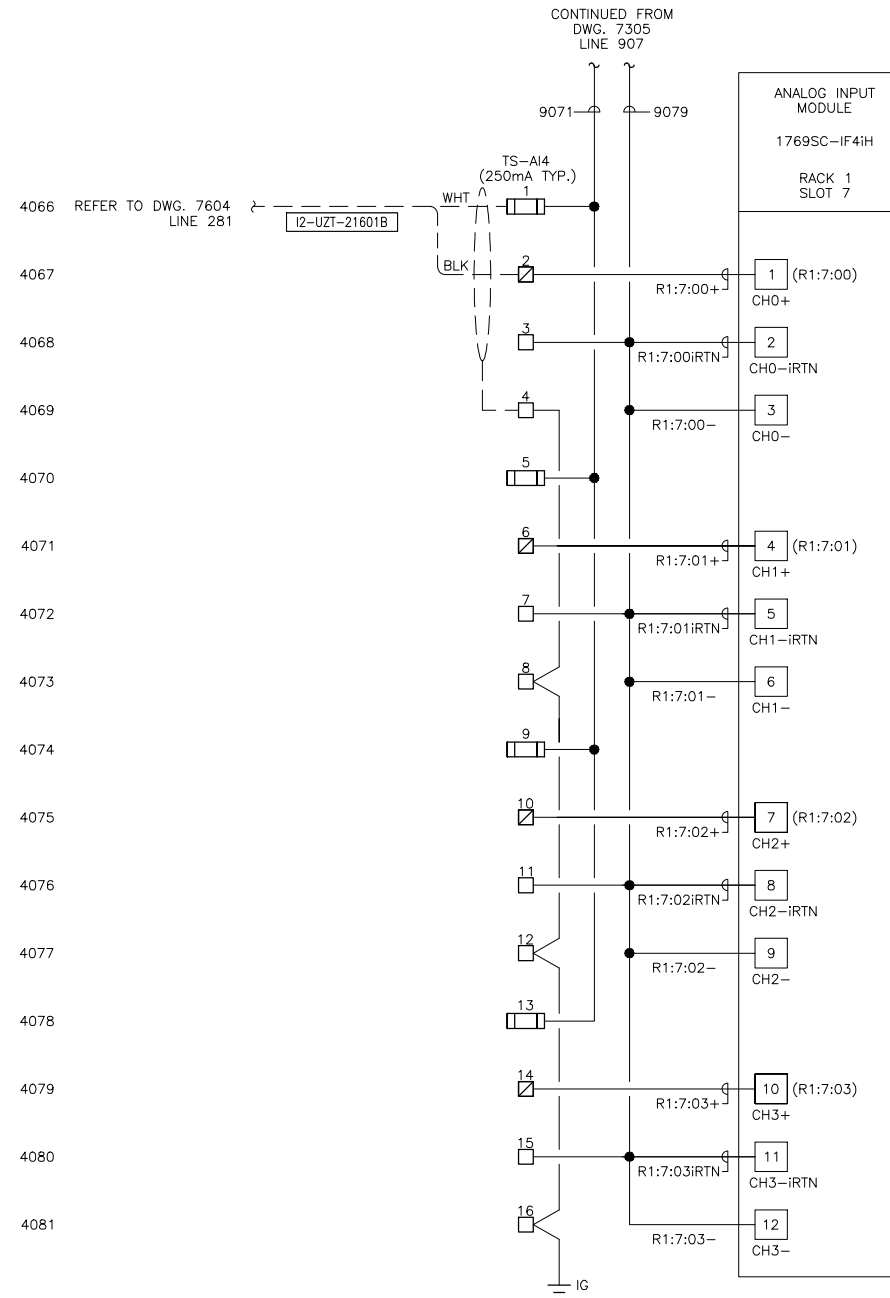


PZT-08071C
NATURAL GAS
PRESSURE
DOWNSTREAM OF PCV-08071B

PZT-08071D
NATURAL GAS
PRESSURE
DOWNSTREAM OF PCV-08071C

UZT-21601A
NG HEATER ROOM
COMBUSTIBLE GAS DETECTION

YZT-21601A
NG HEATER ROOM
FIRE DETECTION



UZT-21601B
NG HEATER ROOM
COMBUSTIBLE GAS DETECTION

SPARE

SPARE

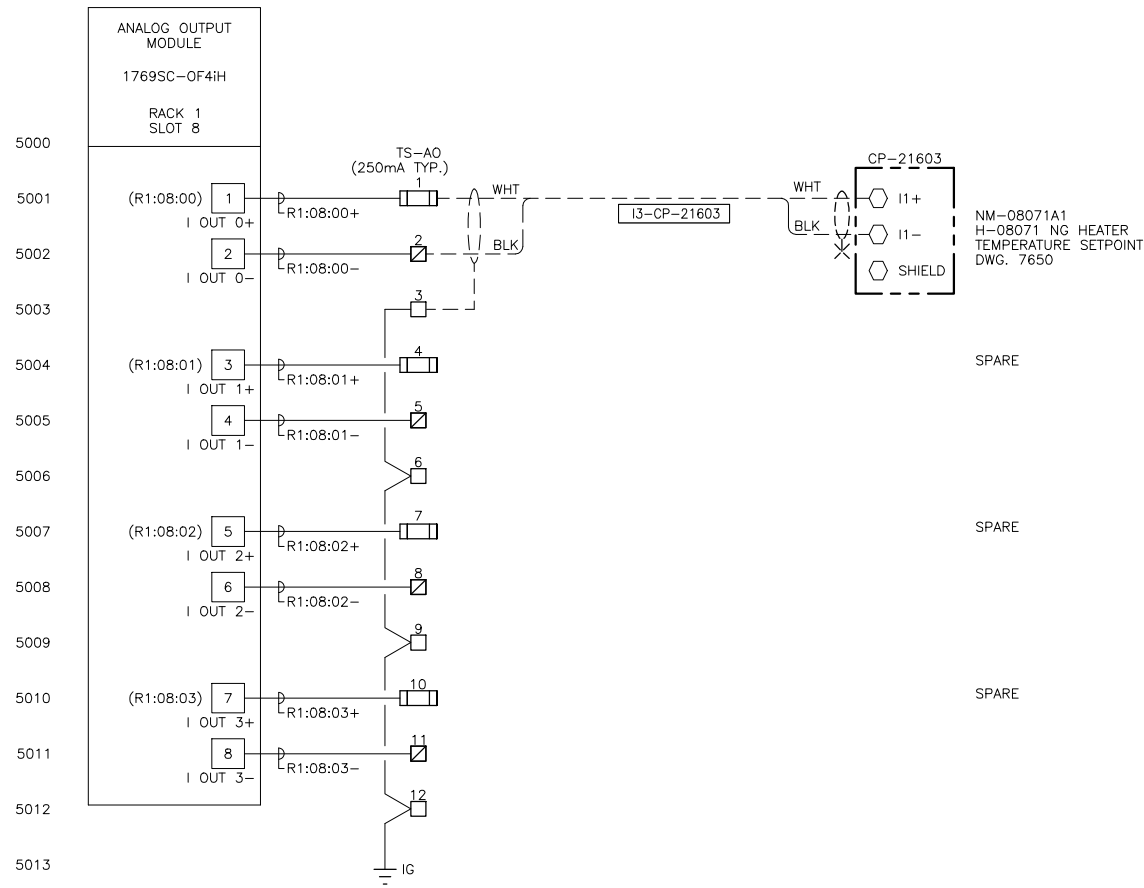
SPARE

2	AS-BUILT	LS	JS	-	NOV 09/15
1	ISSUED FOR FIELD CONSTRUCTION	JP	JS	-	AUG 18/15
0	ISSUED FOR CONSTRUCTION	JB	JS	-	MAY 05/15
REV	DESCRIPTION	DWN	CHK	APP	DATE

CMT NG PRESSURE REDUCTION SKID PACKAGE
 CP-21601 PLC ANALOG INPUT SCHEMATIC (2 OF 2)



**COLLEAUX
ENGINEERING
INC.**



TERMINAL LEGEND

- FUSED TERMINAL C/W LED
- FUSE TERMINAL (REMOVABLE FUSE)
- DISCONNECTED TERMINAL
- FEED THROUGH TERMINAL
- RELAY PANEL
- MOTOR STARTERS
- VENDOR EQUIPMENT
- FIELD TERMINAL BOXES

LEGEND

- IG ISOLATED GROUND

LINE TYPE

- FIELD WIRING
- PANEL WIRING

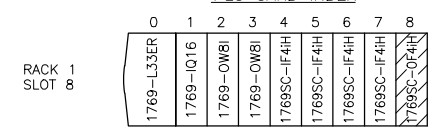
INTERNAL PANEL WIRING

- POWER
- 24 VDC(+) - RED
 - 24 VDC(-) - BLK
 - AC (L) - BLK
 - AC (N) - WHT
- SIGNAL
- 24 VDC(+) - WHT
 - 24 VDC(-) - BLK

REFERENCE DRAWINGS:

- DWG. 7301 - CP-21601 PLC PANEL BACKPAN LAYOUT & BOM
- DWG. 7305 - CP-21601 PLC PANEL POWER DISTRIBUTION
- DWG. 7309 - CP-21601 PLC PANEL SYSTEM ARCHITECTURE
- DWG. 7401 - ANALOG & CONTROL GENERAL LAYOUT
- DWG. 7500 - CABLE SCHEDULE (1 OF 2)
- DWG. 7501 - CABLE SCHEDULE (2 OF 2)

PLC CARD INDEX



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PROJECT NAME: CARMON CREEK

CUSTOMER: SHELL

LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

TAG: 0735A-08030

SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

DWN BY: JP DATE: JUL 23/14 DWG #: 214068-7347

CHK BY: JS DATE: JUL 23/14

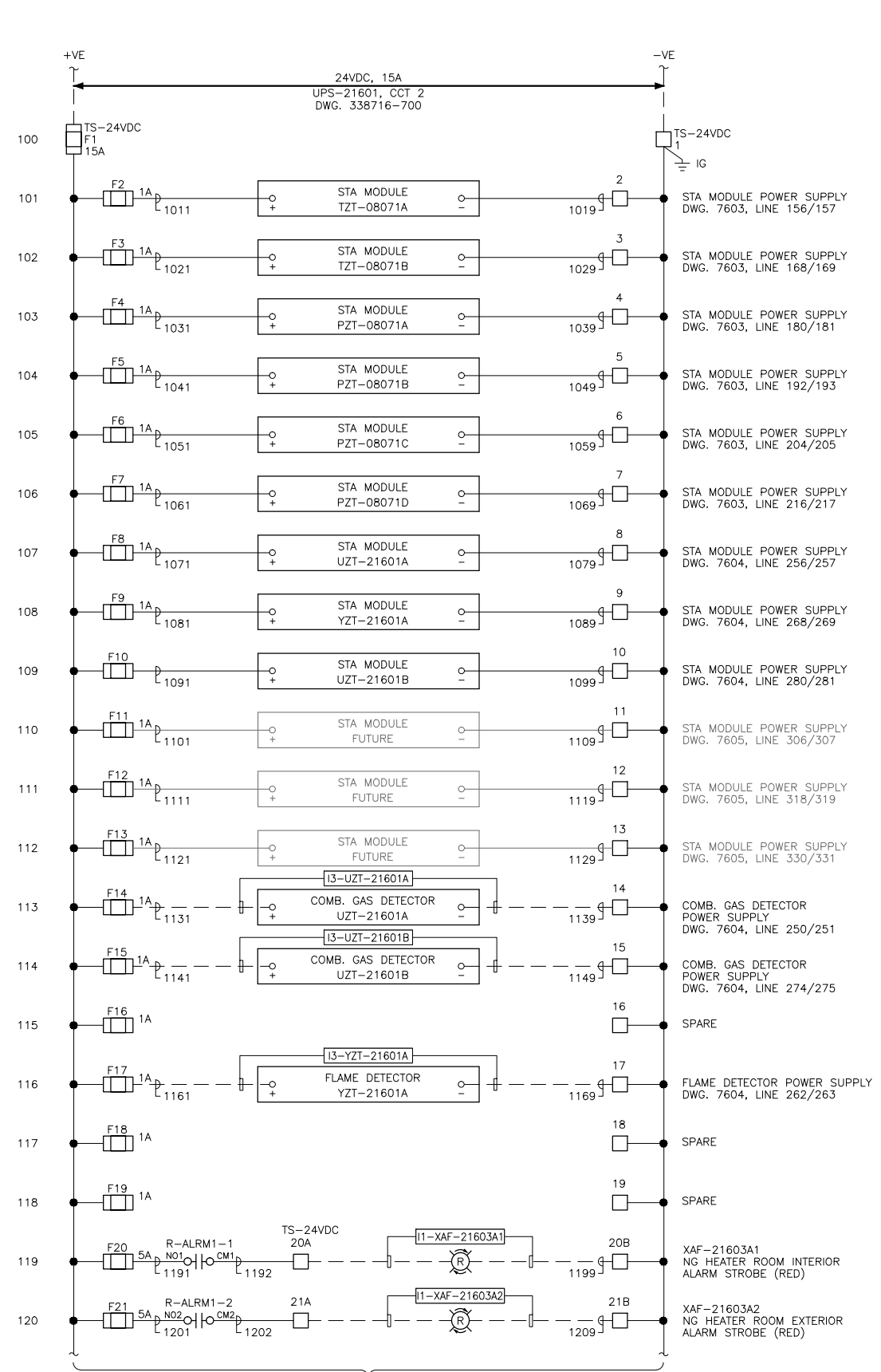
APP BY: - DATE: - PAGE: 7 OF 13 CAD: N/A REV: 2

REV	DESCRIPTION	DWN	CHK	APP	DATE
2	AS-BUILT	LS	JS	-	NOV 09/15
1	ISSUED FOR FIELD CONSTRUCTION	JB	JS	-	AUG 18/15
0	ISSUED FOR CONSTRUCTION	JB	JS	-	MAY 05/15

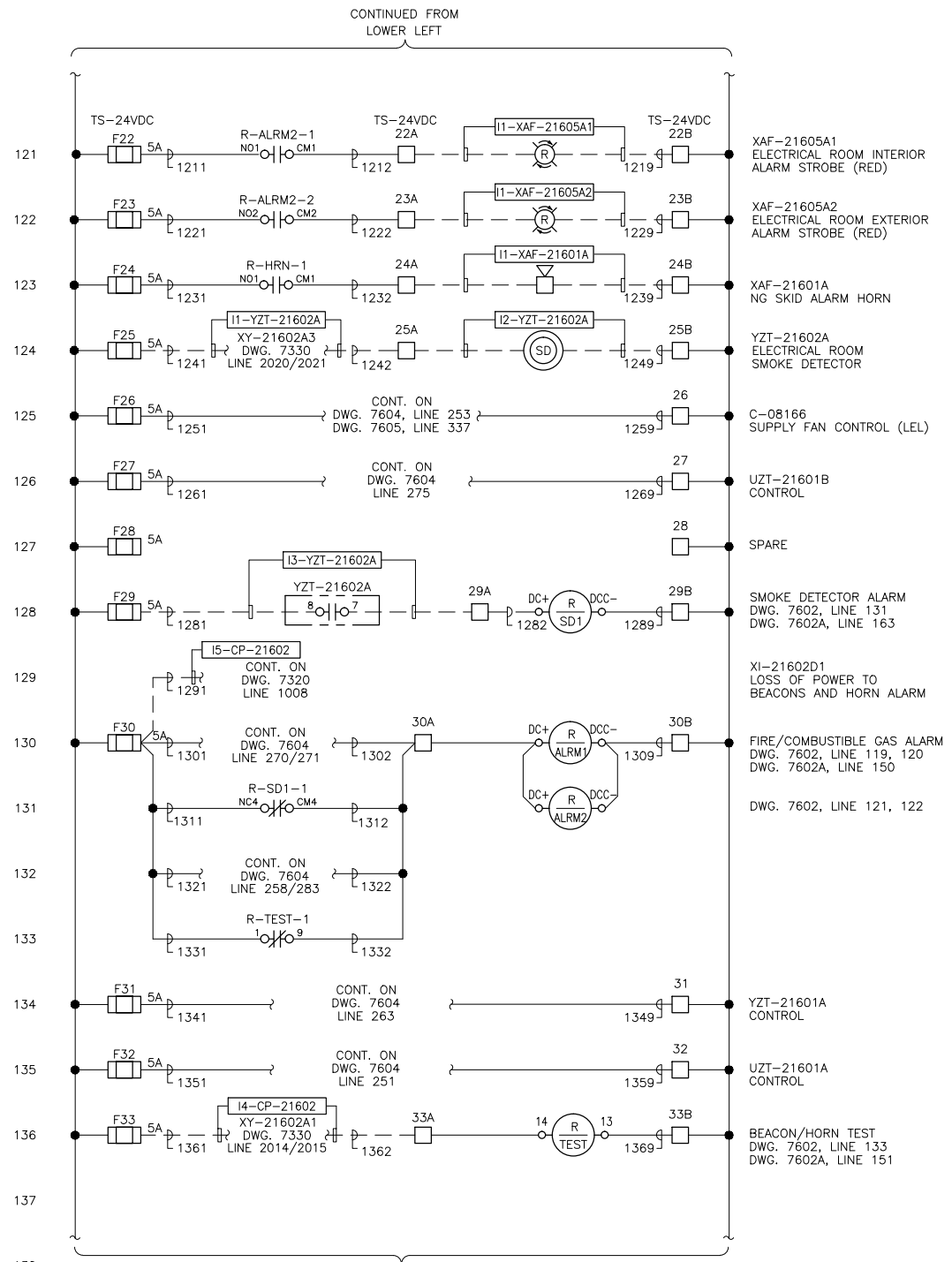
CMT NG PRESSURE REDUCTION SKID PACKAGE
CP-21601 PLC ANALOG OUTPUT SCHEMATIC



COLLEAUX ENGINEERING INC.



CONTINUED ON UPPER RIGHT



CONTINUED ON DWG. 7602A LINE 150

TERMINAL LEGEND

- FUSED TERMINAL C/W LED
- FUSE TERMINAL (REMOVABLE FUSE)
- DISCONNECTED TERMINAL
- FEED THROUGH TERMINAL
- RELAY PANEL
- MOTOR STARTERS
- VENDOR EQUIPMENT
- FIELD TERMINAL BOXES

LINE TYPE

- FIELD WIRING
- PANEL WIRING

INTERNAL PANEL WIRING

POWER

- 24 VDC(+) - RED
- 24 VDC(-) - BLK
- AC (L) - BLK
- AC (N) - WHT

SIGNAL

- 24 VDC(+) - WHT
- 24 VDC(-) - BLK

LEGEND

- NORMALLY OPEN CONTACT
- COIL
- R=RELAY
- TDE=TIME DELAY ON ENERGIZING
- TOD=TIME DELAY ON DE-ENERGIZING
- RT=RECYCLE TIMER
- C=CONTACTOR
- M=MOTOR STARTER
- ROTATING BEACON OR STROBE LIGHT (RED, BLUE LENS)
- HORN
- SMOKE DETECTOR
- IG ISOLATED GROUND

NOTES:

1. INSTALL A JUMPER ACROSS THE CONTACT CLOSURE (CC) TERMINALS OF THE SAFETY RELAY MODULES (SRM).
2. SAFETY RELAY MODULE CASE SHALL BE GROUNDED TO EARTH.

REFERENCE DRAWINGS:

- DWG. 7600 - CP-21602 IPS PANEL DIMENSIONAL & DOOR LAYOUT
- DWG. 7601 - CP-21602 BACKPAN LAYOUT & BOM
- DWG. 7602A - CP-21602 IPS PANEL POWER DISTRIBUTION (2 OF 2)
- DWG. 7603 - CP-21602 IPS PANEL SCHEMATICS (1 OF 3)
- DWG. 7604 - CP-21602 IPS PANEL SCHEMATICS (2 OF 3)
- DWG. 7605 - CP-21602 IPS PANEL SCHEMATICS (3 OF 3)

REV	DESCRIPTION	DWN	CHK	APP	DATE
3	AS-BUILT	LS	JS	-	NOV 09/15
2	GENERAL REVISION	JB	JS	-	SEP 22/15
1	ISSUED FOR FIELD CONSTRUCTION	JB	JS	-	AUG 18/15
0	ISSUED FOR CONSTRUCTION	JB	JS	-	MAY 05/15

CMT NG PRESSURE REDUCTION SKID PACKAGE
CP-21602 IPS PANEL POWER DISTRIBUTION (1 OF 2)

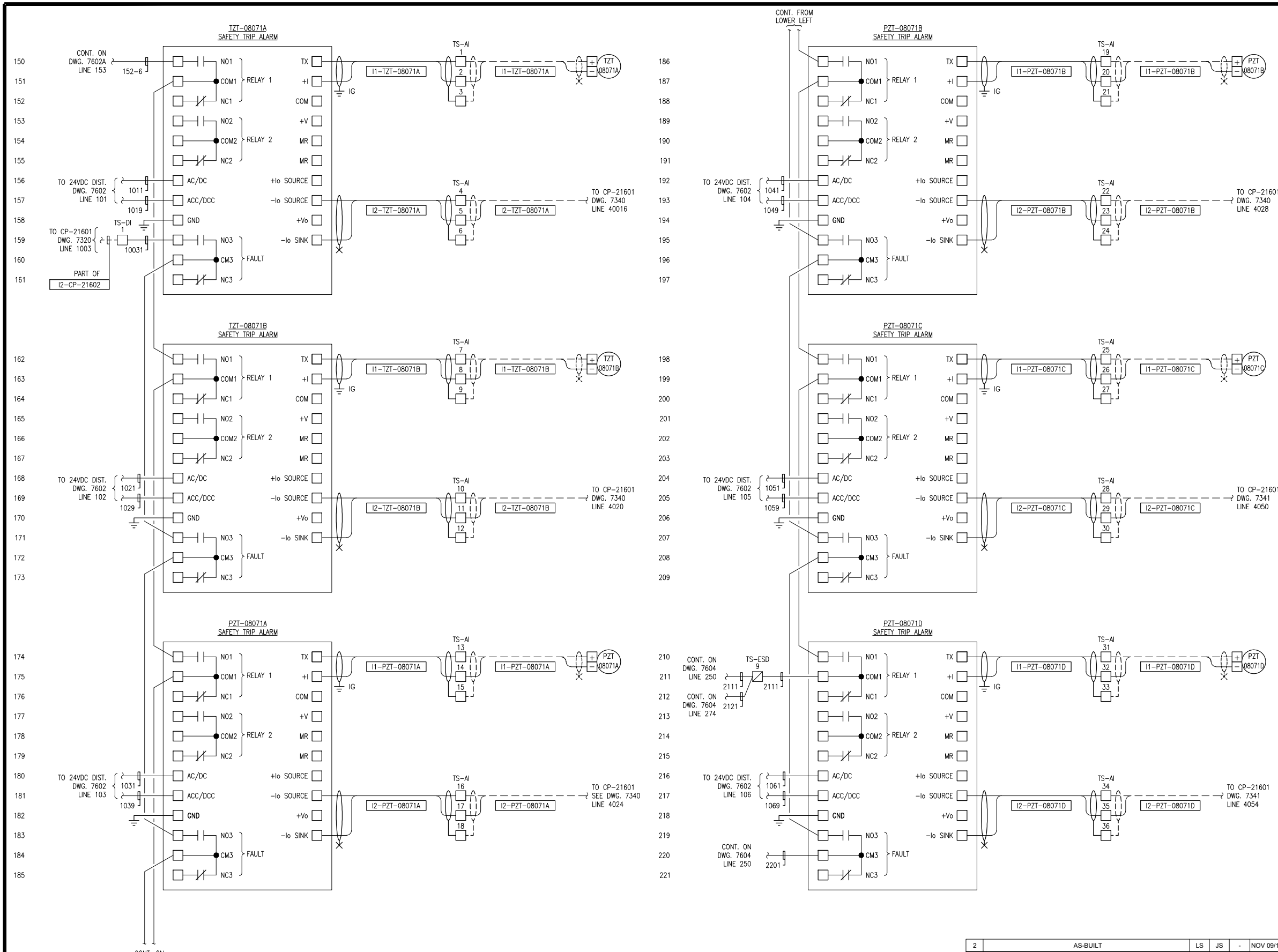
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PROJECT NAME:	CARMON CREEK
CUSTOMER:	SHELL
LOCATION:	CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG:	0735A-08030
SLS#: 338716	QUOTE: CGY2014-85
PO#: 4512-109-130	
DWN BY: KS	DATE: JUL 30/14
CHK BY: JS	DATE: JUL 30/14
APP BY: -	DATE: -
DWG #:	214068-7602
PAGE:	8 OF 13
CAD:	N/A
REV:	3



COLLEAUX ENGINEERING INC.



- TERMINAL LEGEND**
- FUSED TERMINAL C/W LED
 - FUSE TERMINAL (REMOVABLE FUSE)
 - DISCONNECTED TERMINAL
 - FEED THROUGH TERMINAL
 - RELAY PANEL
 - MOTOR STARTERS
 - VENDOR EQUIPMENT
 - FIELD TERMINAL BOXES

LEGEND

IG ISOLATED GROUND

LINE TYPE

----- FIELD WIRING

————— PANEL WIRING

INTERNAL PANEL WIRING

- POWER**
- 24 VDC(+) - RED
 - 24 VDC(-) - BLK
 - AC (L) - BLK
 - AC (N) - WHT
- SIGNAL**
- 24 VDC(+) - WHT
 - 24 VDC(-) - BLK

REFERENCE DRAWINGS:

- DWG. 7600 - CP-21602 IPS PANEL DIMENSIONAL & DOOR LAYOUT
- DWG. 7601 - CP-21602 IPS PANEL BACKPAN LAYOUT & BOM
- DWG. 7602 - CP-21602 IPS PANEL POWER DISTRIBUTION (1 OF 2)
- DWG. 7602A - CP-21602 IPS PANEL POWER DISTRIBUTION (2 OF 2)
- DWG. 7604 - CP-21602 IPS PANEL SCHEMATICS (2 OF 3)
- DWG. 7605 - CP-21602 IPS PANEL SCHEMATICS (3 OF 3)

NOTES:

1. SAFETY TRIP ALARM MODULES (STA) & SAFETY RELAY MODULES (SRM) ARE SHOWN IN THEIR SHELF-STATE. THE CONTACTS OF THE NORMALLY OPEN RELAY ARE OPEN (INFINITE RESISTANCE) WHEN THE RELAY IS NOT ENERGIZED. THE CONTACTS OF A NORMALLY CLOSED RELAY ARE OPEN WHEN THE RELAY IS ENERGIZED (CLOSED WHEN NOT ENERGIZED). THE STA MODULE ALARMS ARE FAIL SAFE AND ARE DE-ENERGIZED WHEN TRIPPED, ENERGIZED WHEN THE PROCESS INPUT IS AT A NON-ALARM LEVEL.

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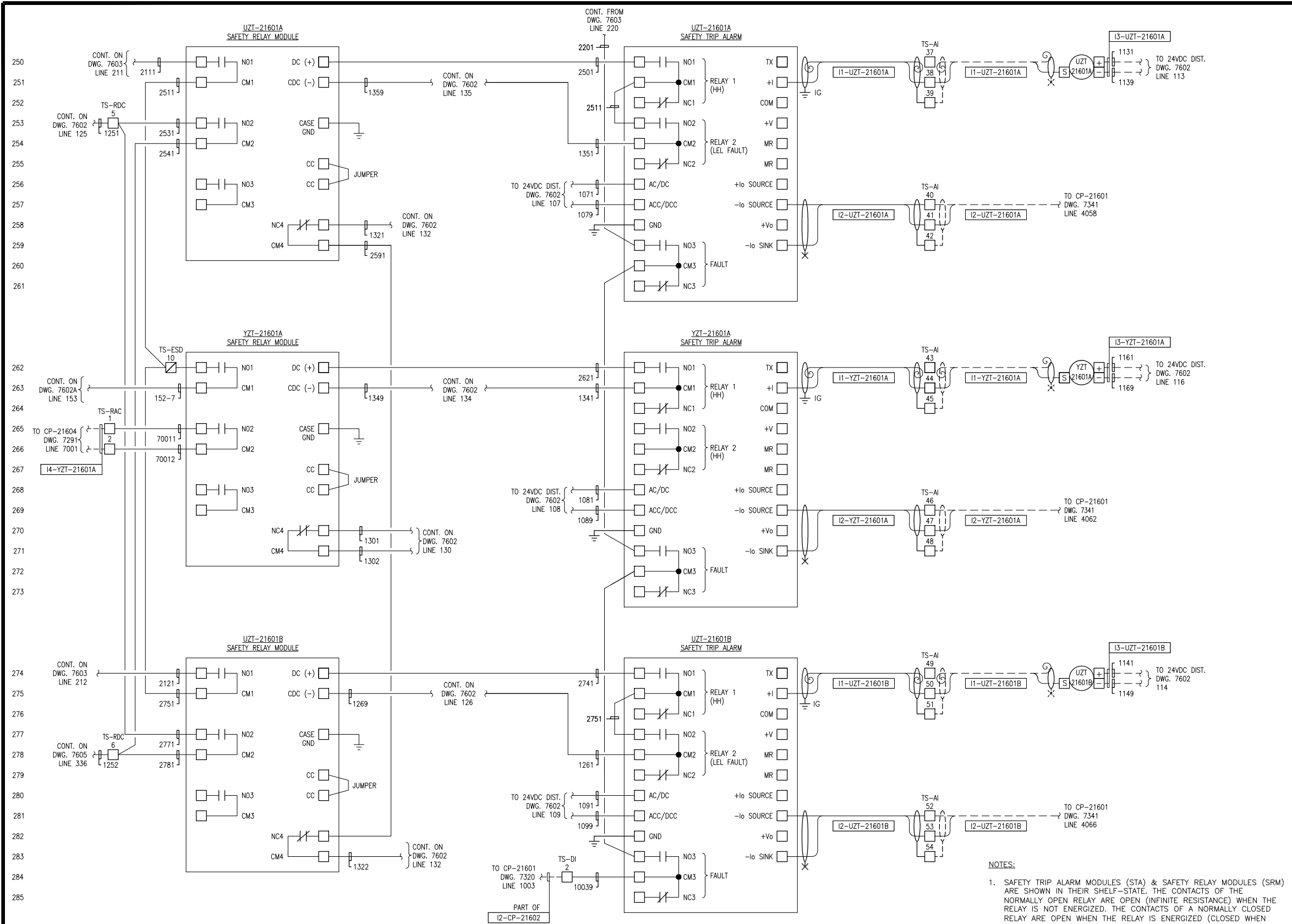
PROJECT NAME: CARMON CREEK	
CUSTOMER: SHELL	
LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2	
TAG: 0735A-08030	
SLS#: 338716	QUOTE: CGY2014-85
PO#: 4512-109-130	
DWNBY: JP	DATE: JAN 29/15
CHKBY: JS	DATE: JAN 29/15
APPBY: -	DATE: -
214068-7603	
PAGE: 10 OF 13	CAD: N/A
REV: 2	

REV	DESCRIPTION	DWN	CHK	APP	DATE
2	AS-BUILT	LS	JS	-	NOV 09/15
1	ISSUED FOR FIELD CONSTRUCTION	JB	JS	-	AUG 18/15
0	ISSUED FOR CONSTRUCTION	JB	JS	-	MAY 05/15

CMT NG PRESSURE REDUCTION SKID PACKAGE
CP-21602 IPS PANEL SCHEMATICS (1 OF 3)



COLLEAUX ENGINEERING INC.



- TERMINAL LEGEND**
- FUSED TERMINAL C/W LED
 - FUSE TERMINAL (REMOVABLE FUSE)
 - DISCONNECTED TERMINAL
 - FEED THROUGH TERMINAL
 - RELAY PANEL
 - MOTOR STARTERS
 - VENDOR EQUIPMENT
 - FIELD TERMINAL BOXES
- LEGEND**
- IG ISOLATED GROUND

- LINE TYPE**
- FIELD WIRING
 - PANEL WIRING
- INTERNAL PANEL WIRING**
- POWER**
- 24 VDC(+) – RED
 - 24 VDC(-) – BLK
 - AC (L) – BLK
 - AC (N) – WHT
- SIGNAL**
- 24 VDC(+) – WHT
 - 24 VDC(-) – BLK

REFERENCE DRAWINGS:

DWG. 7600 – CP-21602 IPS PANEL DIMENSIONAL & DOOR LAYOUT
 DWG. 7601 – CP-21602 IPS PANEL BACKPAN LAYOUT & BOM
 DWG. 7602 – CP-21602 IPS PANEL POWER DISTRIBUTION (1 OF 2)
 DWG. 7602A – CP-21602 IPS PANEL POWER DISTRIBUTION (2 OF 2)
 DWG. 7603 – CP-21602 IPS PANEL SCHEMATICS (1 OF 3)
 DWG. 7605 – CP-21602 IPS PANEL SCHEMATICS (3 OF 3)

NOTES:

- SAFETY TRIP ALARM MODULES (STA) & SAFETY RELAY MODULES (SRM) ARE SHOWN IN THEIR SHELF-STATE. THE CONTACTS OF THE NORMALLY OPEN RELAY ARE OPEN (INFINITE RESISTANCE) WHEN THE RELAY IS NOT ENERGIZED. THE CONTACTS OF A NORMALLY CLOSED RELAY ARE OPEN WHEN THE RELAY IS ENERGIZED (CLOSED WHEN NOT ENERGIZED). THE STA MODULE ALARMS ARE FAIL SAFE AND ARE DE-ENERGIZED WHEN TRIPPED, ENERGIZED WHEN THE PROCESS INPUT IS AT A NON-ALARM LEVEL.

REV	DESCRIPTION	DWN	CHK	APP	DATE
2	AS-BUILT	LS	JS	-	NOV 09/15
1	ISSUED FOR FIELD CONSTRUCTION	JB	JS	-	AUG 18/15
0	ISSUED FOR CONSTRUCTION	JB	JS	-	MAY 05/15

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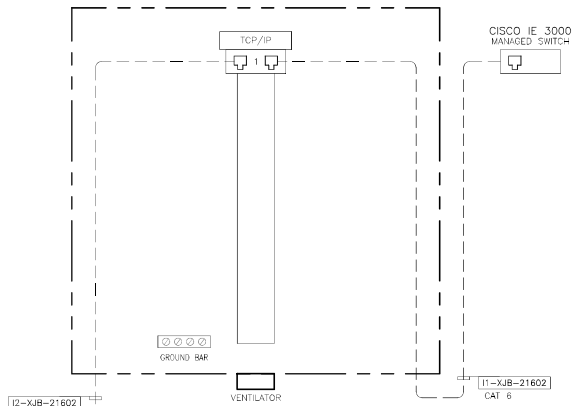
PROJECT NAME: CARMON CREEK
 CUSTOMER: SHELL
 LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130



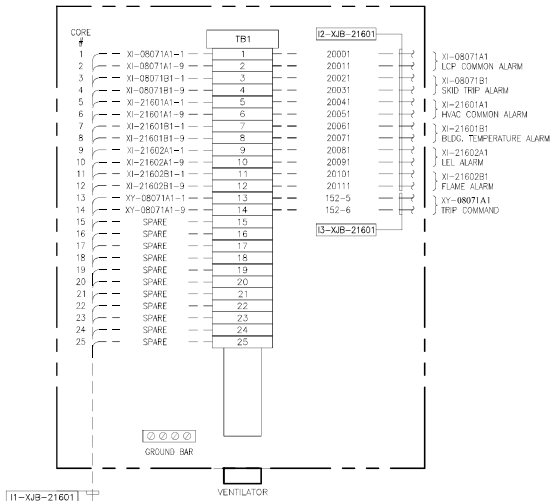
COLLEAUX ENGINEERING INC.

CMT NG PRESSURE REDUCTION SKID PACKAGE
 CP-21602 IPS PANEL SCHEMATICS (2 OF 3)

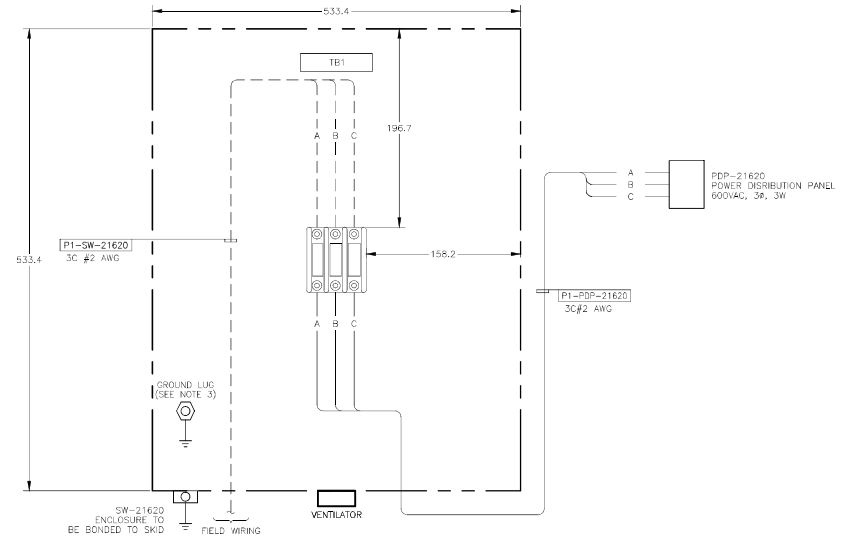
DWN BY: JP DATE: JAN 30/15 DWG #: 214068-7604
 CHK BY: JS DATE: JAN 30/15
 APP BY: - DATE: - PAGE: 11 OF 13 CAD: N/A REV: 2



XJB-21602 (MODBUS JUNCTION BOX)
 HAMMOND PJ16148RT C/W BACKPAN 14R1513
 HOFFMAN A-NMVG DRAIN
 WEIDMULLER NETWORK TERMINAL BLOCK 89446920000
 CAT# 1020100000 FOR T35 RAIL
 CAT# 0292460000 RAIL MARKER



XJB-21601 (DISCRETE JUNCTION BOX)
 HAMMOND PJ16148RT C/W BACKPAN 14R1513
 HOFFMAN A-NMVG DRAIN
 C/W 25 WEIDMULLER WBU 4 TERMINALS
 CAT# 1020100000 FOR T35 RAIL
 CAT# 0292460000 RAIL MARKER



SW-21620 (600VAC JUNCTION BOX)
 HAMMOND PJ24248RT C/W BACKPAN 18P2121
 HOFFMAN A-NMVG DRAIN
 LITTEL FUSE POWR-GARD 0LS212132

REFERENCE DRAWINGS:

- DWG. 7100 - SINGLE LINE DIAGRAM
- DWG. 7309 - CP-21601 PLC PANEL SYSTEM ARCHITECTURE
- DWG. 7320 - CP-21601 PLC DISCRETE INPUT SCHEMATIC
- DWG. 7330 - CP-21601 PLC DISCRETE OUTPUT SCHEMATIC
- DWG. 7400 - ELECTRICAL POWER LAYOUT & BOM
- DWG. 7402 - ELECTRICAL ROOM ELEVATIONS
- DWG. 7500 - CABLE SCHEDULE (1 OF 2)
- DWG. 7501 - CABLE SCHEDULE (2 OF 2)
- DWG. 7600A - CP-21602 IPS PANEL POWER DISTRIBUTION (2 OF 2)
- DWG. 7950 - ELECTRICAL DETAILS

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.



PROJECT NAME:	CARMON CREEK		
CUSTOMER:	SHELL		
LOCATION:	CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2		
TAG:	0735A-08030		
SLS#	338716	QUOTE	CGY2014-85
PO#	4512-109-130		

NOTES:

- ALL ANALOG SIGNAL CABLES SHALL BE AWG #16 TWISTED PAIR C/C TYPE CABLE WITH 330V INSULATION.
- ALL DISCRETE AND CONTROL DEVICES SHALL USE AWG #14, RW30, 600V INSULATION.
- CONDUIT ENTRY TO BE INSTALLED WITH GROUND BUSHING BONDED TO BACKPAN GROUND LUG.
- CABLE SHALL BE TAGGED AT BOTH ENDS WITH HEAT SHRINK WIRE MARKER. MARKERS SHALL BE WHITE WITH MACHINE APPLIED MARKINGS.

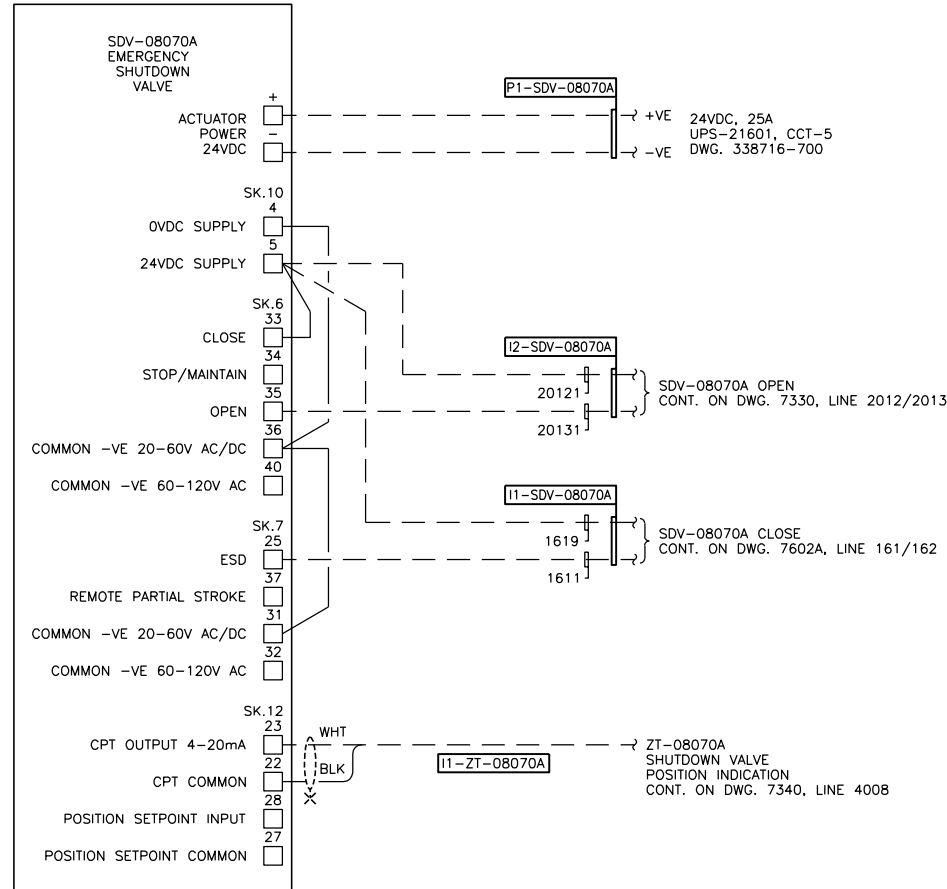
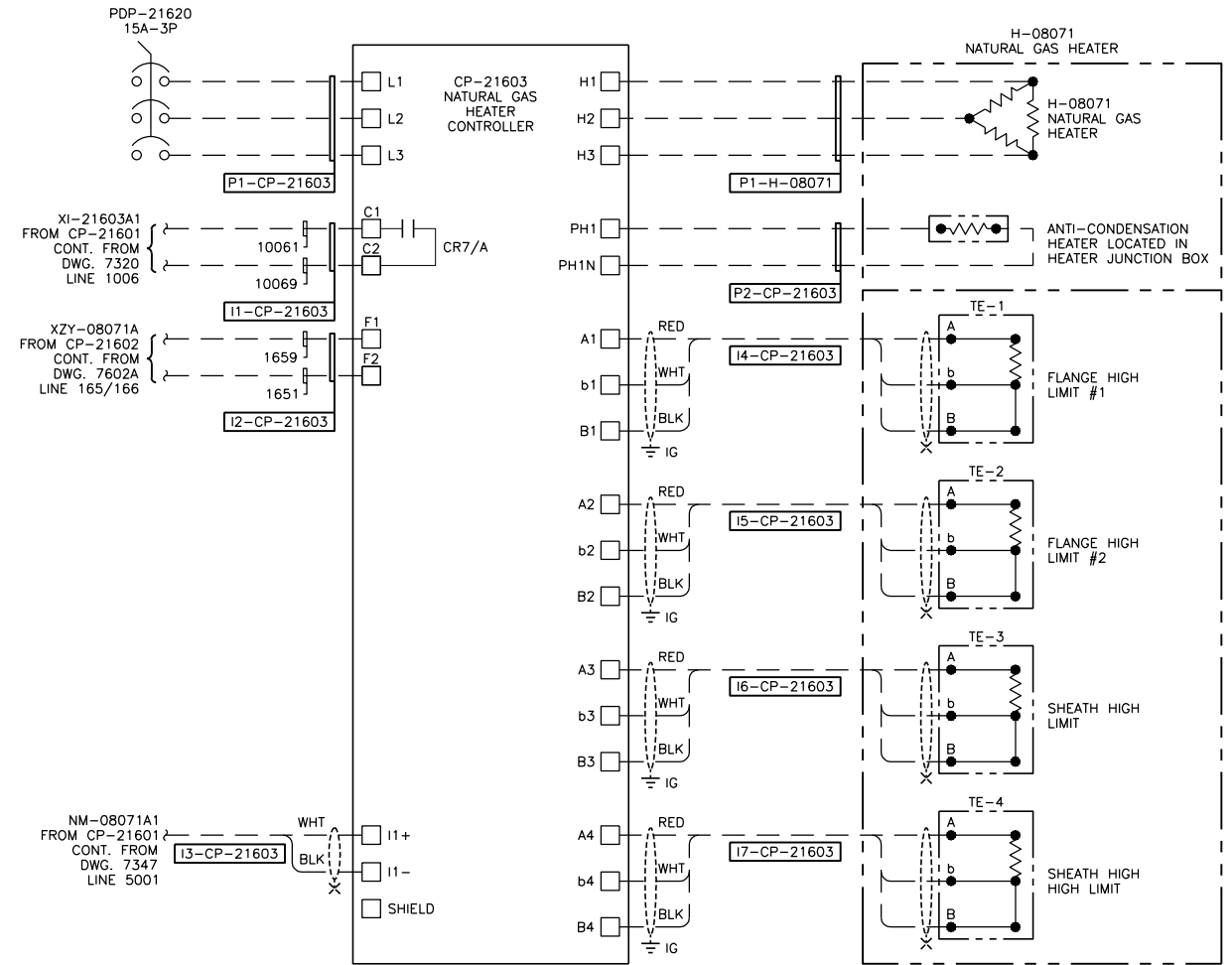
REV	DESCRIPTION	DWN	CHK	APP	DATE
2	AS BUILT	LS	JS	-	NOV 09/15
1	ISSUED FOR FIELD CONSTRUCTION	JB	JS	-	AUG 18/15
0	ISSUED FOR CONSTRUCTION	JB	JS	-	MAY 05/15

**CMT NG PRESSURE REDUCTION SKID PACKAGE
 JUNCTION BOX LAYOUTS & BOM**

DWNR	KS	DATE	AUG 01/14	DWG #	214068-7900
CHKD	JS	DATE	AUG 01/14		
APP'D	-	DATE	-	PAGE	7 OF 7
CAD	N/A	REV	2		



**COLLEAUX
 ENGINEERING
 INC.**



- TERMINAL LEGEND**
- FUSED TERMINAL C/W LED
 - FUSE TERMINAL (REMOVABLE FUSE)
 - DISCONNECTED TERMINAL
 - FEED THROUGH TERMINAL
 - RELAY PANEL
 - MOTOR STARTERS
 - VENDOR EQUIPMENT
 - FIELD TERMINAL BOXES

- LEGEND**
- ISOLATED GROUND

- LINE TYPE**
- FIELD WIRING
 - PANEL WIRING

- INTERNAL PANEL WIRING**
- POWER**
- 24 VDC(+) - RED
 - 24 VDC(-) - BLK
 - AC (L) - BLK
 - AC (N) - WHT
- SIGNAL**
- 24 VDC(+) - WHT
 - 24 VDC(-) - BLK

REFERENCE DRAWINGS:

DWG. 7330 - CP-21601 PLC DISCRETE OUTPUT SCHEMATIC
 DWG. 7341 - CP-21601 PLC ANALOG INPUT SCHEMATIC (2 OF 3)
 DWG. 7347 - CP-21601 PLC ANALOG OUTPUT SCHEMATIC
 DWG. 7602A - CP-21602 IPS PANEL POWER DISTRIBUTION (2 OF 2)

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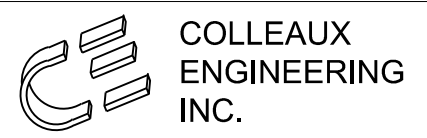


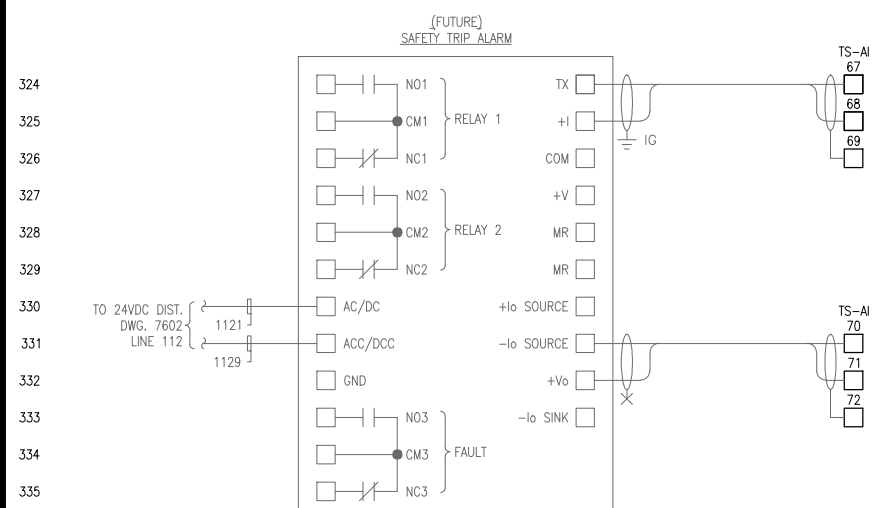
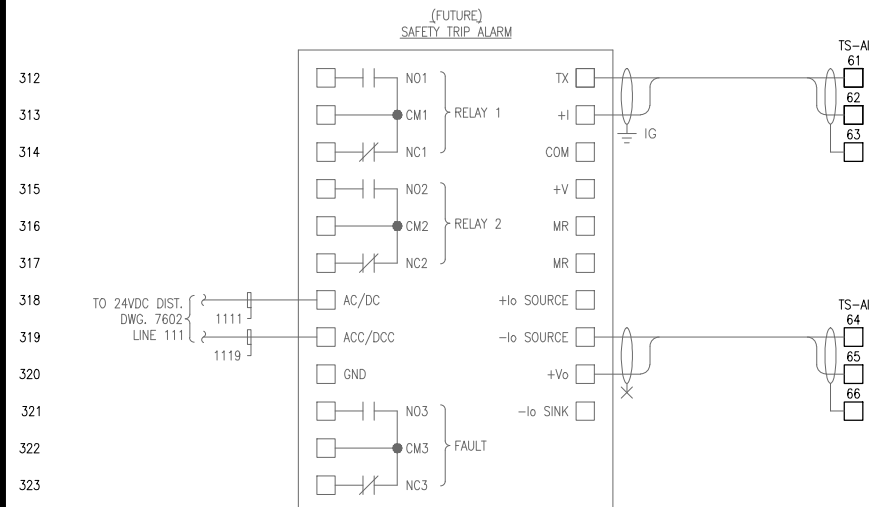
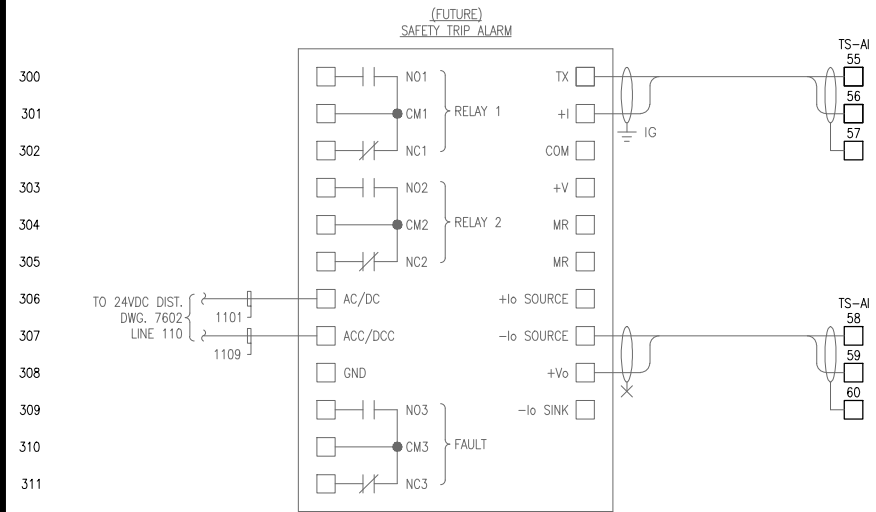
PROJECT NAME: CARMON CREEK
 CUSTOMER: SHELL
 LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

DWN BY: LS DATE: JUN 2/15 DWG #: 214068-7650
 CHK BY: JS DATE: JUN 2/15
 APP BY: - DATE: - PAGE: 13 OF 13 CAD: N/A REV: 2

REV	DESCRIPTION	DWN	CHK	APP	DATE
2	AS-BUILT	JB	JS	-	NOV 23/15
1	AS-BUILT	LS	JS	-	NOV 09/15
0	ISSUED FOR FIELD CONSTRUCTION	LS	JS	-	AUG 18/15

CMT NG PRESSURE REDUCTION SKID PACKAGE
 MISCELLANEOUS SCHEMATICS

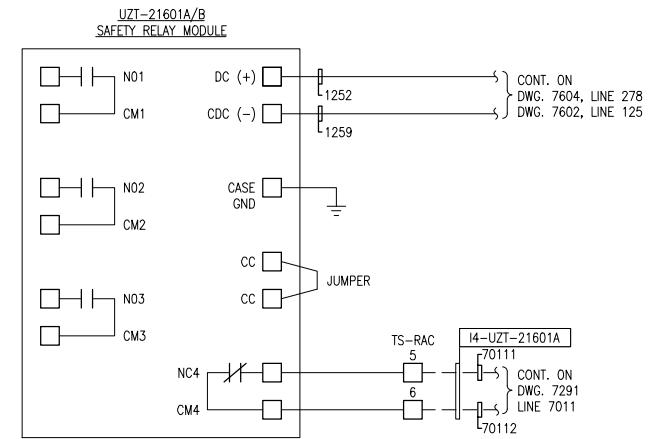




SPARE 336
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SPARE 348
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SPARE 360
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- TERMINAL LEGEND**
- FUSED TERMINAL C/W LED
 - FUSE TERMINAL (REMOVABLE FUSE)
 - DISCONNECTED TERMINAL
 - FEED THROUGH TERMINAL
 - RELAY PANEL
 - MOTOR STARTERS
 - VENDOR EQUIPMENT
 - FIELD TERMINAL BOXES

LEGEND

IG ISOLATED GROUND

LINE TYPE

----- FIELD WIRING
————— PANEL WIRING

INTERNAL PANEL WIRING

POWER

- 24 VDC(+) – RED
- 24 VDC(-) – BLK
- AC (L) – BLK
- AC (N) – WHT

SIGNAL

- 24 VDC(+) – WHT
- 24 VDC(-) – BLK

REFERENCE DRAWINGS:

- DWG. 7600 – CP-21602 IPS PANEL DIMENSIONAL & DOOR LAYOUT
- DWG. 7601 – CP-21602 IPS PANEL BACKPAN LAYOUT & BOM
- DWG. 7602 – CP-21602 IPS PANEL POWER DISTRIBUTION (1 OF 2)
- DWG. 7602A – CP-21602 IPS PANEL POWER DISTRIBUTION (2 OF 2)
- DWG. 7603 – CP-21602 IPS PANEL SCHEMATICS (1 OF 3)
- DWG. 7604 – CP-21602 IPS PANEL SCHEMATICS (2 OF 3)

NOTES:

- SAFETY TRIP ALARM MODULES (STA) & SAFETY RELAY MODULES (SRM) ARE SHOWN IN THEIR SHELF-STATE. THE CONTACTS OF THE NORMALLY OPEN RELAY ARE OPEN (INFINITE RESISTANCE) WHEN THE RELAY IS NOT ENERGIZED. THE CONTACTS OF A NORMALLY CLOSED RELAY ARE OPEN WHEN THE RELAY IS ENERGIZED (CLOSED WHEN NOT ENERGIZED). THE STA MODULE ALARMS ARE FAIL SAFE AND ARE DE-ENERGIZED WHEN TRIPPED, ENERGIZED WHEN THE PROCESS INPUT IS AT A NON-ALARM LEVEL.

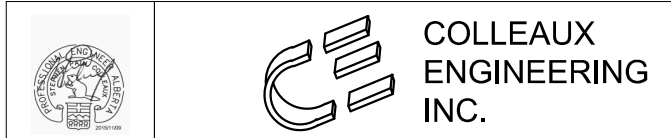
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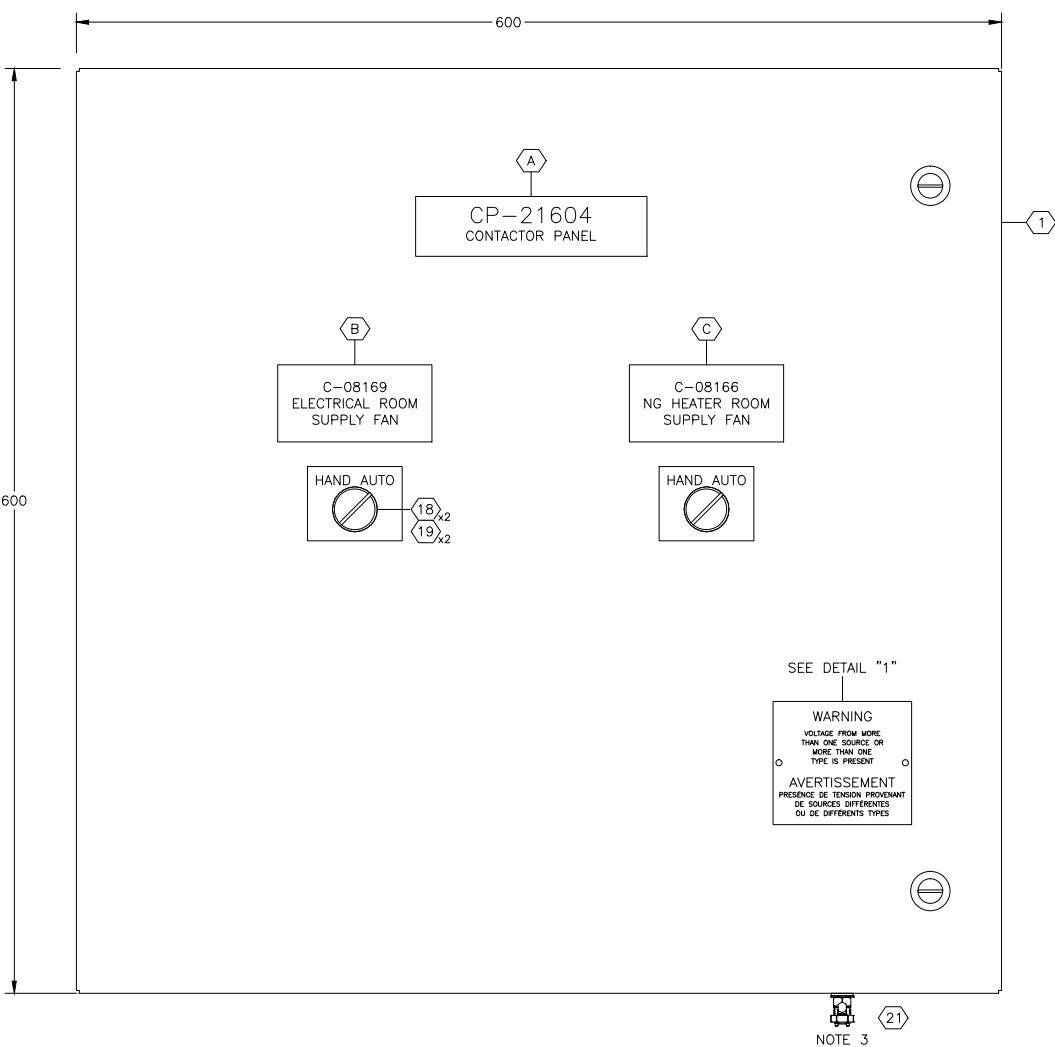
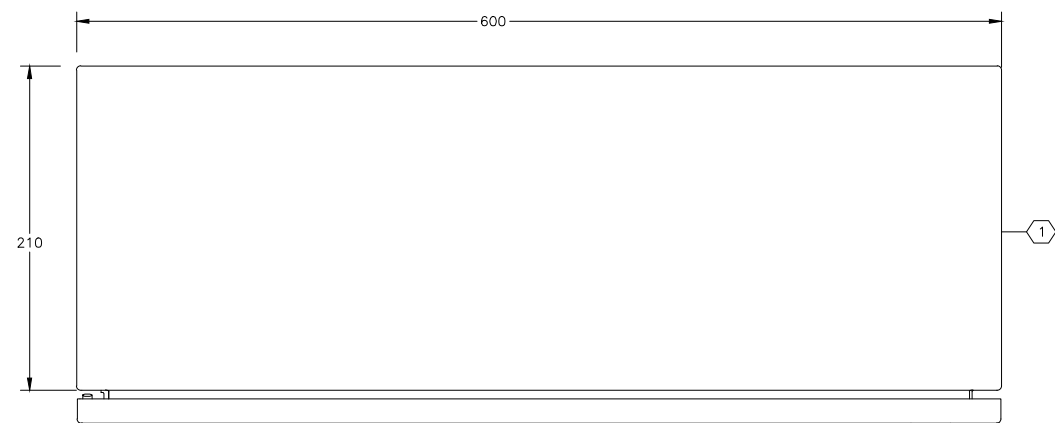
PROJECT NAME: CARMON CREEK
CUSTOMER: SHELL
LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

DWN BY: JP DATE: JAN 30/15 DWG #: 214068-7605
CHK BY: JS DATE: JAN 30/15
APP BY: - DATE: - PAGE: 12 OF 13 CAD: N/A REV: 2

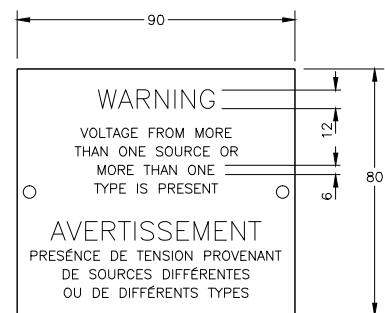
REV	DESCRIPTION	DWN	CHK	APP	DATE
2	AS-BUILT	LS	JS	-	NOV 09/15
1	ISSUED FOR FIELD CONSTRUCTION	JB	JS	-	AUG 18/15
0	ISSUED FOR CONSTRUCTION	JB	JS	-	MAY 05/15

CMT NG PRESSURE REDUCTION SKID PACKAGE
CP-21602 IPS PANEL SCHEMATICS (3 OF 3)

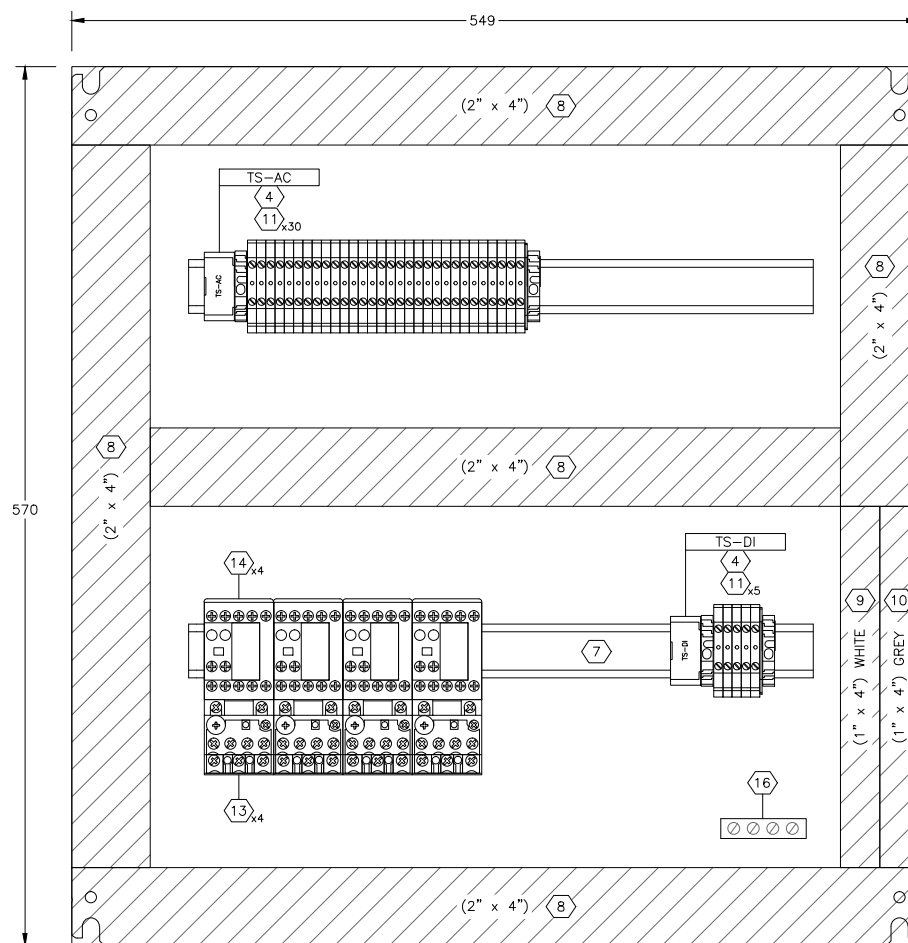




EXTERIOR PANEL VIEW



DETAIL 1
TYPICAL CAUTION NAMEPLATE
(WHITE TEXT ON RED)



INTERIOR PANEL VIEW

BILL OF MATERIALS						O = BY OWNER	V = BY PANEL VENDOR
ITEM	QUANTITY	DESCRIPTION	MANUFACTURER	CATALOG NO.	SUP.		
1	1	WALL MOUNTED ENCLOSURE 600H X 600W X 210D C/W BACKPAN 570H X 549W	RITTAL	1060250 WM242408NC	V		
2							
3							
4	2	RAIL MARKER, SCHT 5	WEIDMULLER	0292460000	V		
5	AS-REQ.	TERMINAL END BRACKET, WEW 35/2	WEIDMULLER	1061200000	V		
6	AS-REQ.	TERMINAL END PLATE, WAP 2.5-10	WEIDMULLER	1050000000	V		
7	AS-REQ.	DIN RAIL TS35 SLOTTED	WEIDMULLER	38340000	V		
8	AS-REQ.	WIRING DUCT & COVER 2"W X 4"H WHITE	PANDUIT	F2X4WH6	V		
9	AS-REQ.	WIRING DUCT & COVER 1"W X 4"H WHITE	PANDUIT	F1X4WH6	V		
10	AS-REQ.	WIRING DUCT & COVER 1"W X 4"H GREY	PANDUIT	F1X4LG6	V		
11	35	FEED THROUGH TERMINAL, WDU 4	WEIDMULLER	1020100000	V		
12							
13	4	ELECTRONIC OVERLOAD RELAY	EATON	XT0B010BC1	V		
14	4	THREE POLE CONTACTOR	EATON	XTCE007B10A	V		
15							
16	1	GROUND BUS BAR BDR NSCH 15x2	ELECTRIPRO	EP03A	V		
17							
18	2	2 POSITION SELECTOR SWITCH, MAINTAINED	ALLEN BRADLEY	800T-H2A	V		
19	2	HAND-AUTO LEGEND PLATE	ALLEN BRADLEY	800T-X510	V		
20							
21	1	SERVIT POST	BURNDY	-	V		
22							
23							
24							
25							

LAMACOID SCHEDULE						
ITEM	FIRST LINE	SECOND LINE	THIRD LINE	FOURTH LINE	SIZE	COLOUR
A	CP-21604	CONTACTOR PANEL			150mm X 25mm	BLACK TEXT ON WHITE
B	C-08169	ELECTRICAL ROOM SUPPLY FAN			100mm X 50mm	BLACK TEXT ON WHITE
C	C-08166	NG HEATER ROOM SUPPLY FAN			100mm X 50mm	BLACK TEXT ON WHITE
D						
E						
F						
G						

NOTES:

- MATERIAL LIST IS A GUIDE ONLY. CONTRACTOR TO VERIFY ALL PART NUMBERS AND QUANTITIES PRIOR TO ORDERING.
- CONTRACTOR MAY USE APPROVED EQUIVALENT.
- REFER TO DWG. 7950 DETAIL 101 FOR PANEL BONDING & GROUNDING.

REFERENCE DRAWINGS

- 7291 - CP-21604 CONTACTOR PANEL SCHEMATICS
- 7400 - ELECTRICAL POWER LAYOUT & BOM
- 7402 - ELECTRICAL ROOM ELEVATIONS
- 7950 - ELECTRICAL DETAILS

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.



PROJECT NAME:	CARMON CREEK
CUSTOMER:	SHELL
LOCATION:	CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG:	0735A-08030
SLS#: 338716	QUOTE: CGY2014-85
PO#: 4512-109-130	
DWN BY: KS	DATE: AUG 14/14
CHK BY: JS	DATE: JUL 30/14
APP BY: -	DATE: -
214068-7290	
PAGE: 1 OF 7	CAD: N/A
REV: 2	

REV	DESCRIPTION	DWN	CHK	APP	DATE
2	AS-BUILT	LS	JS	-	NOV 09/15
1	ISSUED FOR FIELD CONSTRUCTION	JB	JS	-	AUG 18/15
0	ISSUED FOR CONSTRUCTION	JB	JS	-	MAY 05/15

CMT NG PRESSURE REDUCTION SKID PACKAGE
CP-21604 CONTACTOR PANEL LAYOUT & BOM

COLLEAUX
ENGINEERING
INC.

VOLTS <u>120/208V</u>	LOCATION <u>ELECTRICAL ROOM</u>	PANEL <u>LPN-21620</u>	<u>100A</u> AMP BUS
HERTZ <u>60</u>	FEEDER <u>4C#2</u>		<u>100A</u> AMP MAIN CB
PHASE <u>3</u>		LIGHTING PANEL	SOLID NEUTRAL
WIRE <u>4</u>			<u>SURFACE</u> MOUNTING

LOAD DESCRIPTION	LOAD			BKR. SIZE	CCT. NO.	BUS			CCT. NO.	BKR. SIZE	LOAD			LOAD DESCRIPTION		
	A	B	C			A	B	C			A	B	C			
INTERIOR LIGHTS (ELECTRICAL ROOM)	128			15	1	●			2	15	300			INTERIOR LIGHTS (NG HEATER ROOM)		
UPS-21601		1920		20	3		●		4	15		10		CP-21604 CONTACTOR PANEL		
CP-21601 PANEL RECEPTACLE			450	15	5			●	6	15			140	EXTERIOR LIGHTS		
RECEPTACLE (NG HEATER ROOM)	450			20	7	●			8	20	450			RECEPTACLE (ELECTRICAL ROOM)		
EMERGENCY LIGHTS		16		15	9		●		10	15		18		CP-21601 CABINET FAN/THERMOSTAT 1		
C-08165 SUPPLY FAN (NG HEATER ROOM)			373	15	11			●	12	15			373	C-08168 SUPPLY FAN (ELECTRICAL ROOM)		
C-08166 SUPPLY FAN (NG HEATER ROOM)	373			15	13	●			14	15	373			C-08169 SUPPLY FAN (ELECTRICAL ROOM)		
SPARE		-		20	15		●		16	20		-		SPARE		
SPARE			-	15	17			●	18	15			-	SPARE		
SPARE		-		15	19	●			20	15	-			SPARE		
SPARE			-	15	21		●		22	15		-		SPARE		
SPARE			-	15	23			●	24	15			-	SPARE		
LEFT SIDE WATTS PER PHASE				951	1936	823	TOTAL WATTS:			5374	RIGHT SIDE WATTS PER PHASE			1123	28	513
TOTAL WATTS PER PHASE				2074	1964	1336	BRANCH BREAKERS TO HAVE 10ka INTERRUPTING CAPACITY. GFCI BREAKERS TO HAVE 30mA TRIP.									

REFERENCE DRAWINGS:

- DWG. 7100 - SINGLE LINE DIAGRAM
- DWG. 7291 - CP-21604 CONTACTOR PANEL SCHEMATICS
- DWG. 7305 - CP-21601 PLC PANEL POWER DISTRIBUTION
- DWG. 7400 - ELECTRICAL POWER LAYOUT & BOM
- DWG. 7402 - ELECTRICAL ROOM ELEVATIONS
- DWG. 7500 - CABLE SCHEDULE (1 OF 2)
- DWG. 7501 - CABLE SCHEDULE (2 OF 2)

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PROJECT NAME: **CARMON CREEK**
 CUSTOMER: **SHELL**
 LOCATION: **CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2**

TAG: **0735A-08030**
 SLS#: **338716** QUOTE: **CGY2014-85** PO#: **4512-109-130**

DWN BY: **KS** DATE: **AUG 11/14** DWG #: **214068-7510**
 CHK BY: **JS** DATE: **AUG 11/14**
 APP BY: **-** DATE: **-** PAGE: **4 OF 7** CAD: **N/A** REV: **1**

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	AS-BUILT	LS	JS	-	NOV 09/15
0	ISSUED FOR FIELD CONSTRUCTION	RS	JS	-	AUG 18/15

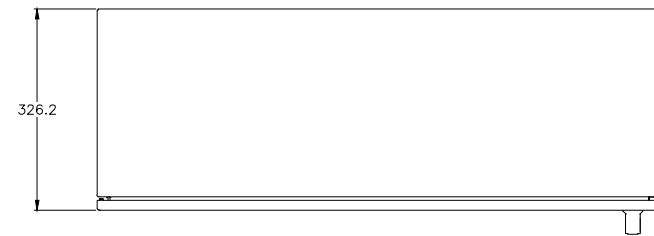
**CMT NG PRESSURE REDUCTION SKID PACKAGE
120/208 VAC DISTRIBUTION PANEL SCHEDULE**



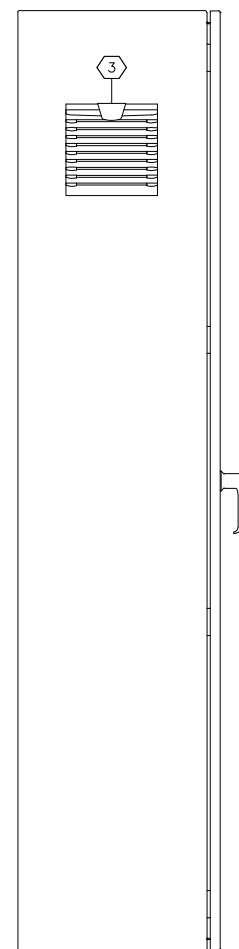
**COLLEAUX
ENGINEERING
INC.**

LAMACOID SCHEDULE

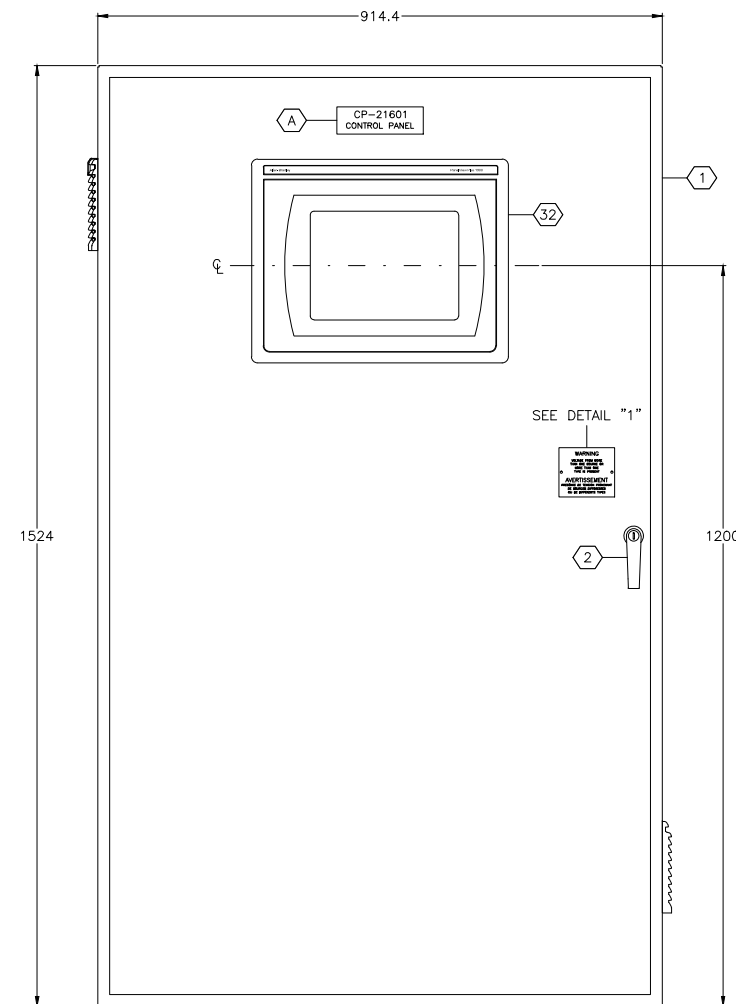
ITEM	FIRST LINE	SECOND LINE	THIRD LINE	FOURTH LINE	SIZE	COLOUR
A	CP-21601	CONTROL PANEL			140mm X 50mm	BLACK TEXT ON WHITE
B						
C						
D						
E						
F						
G						



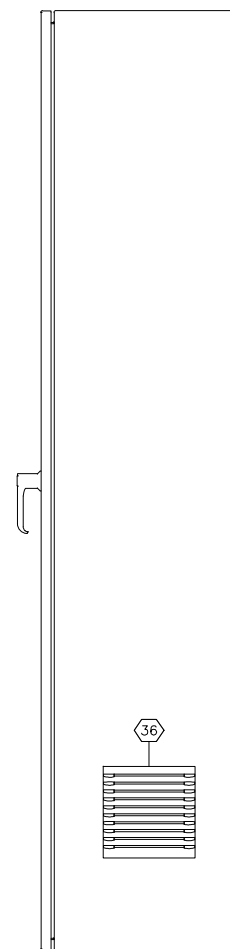
TOP VIEW



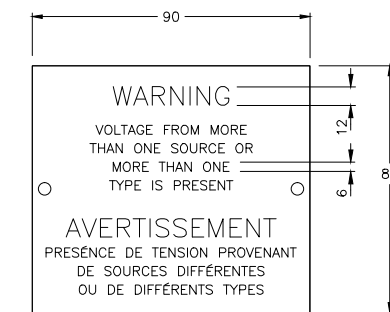
LEFT SIDE VIEW



FRONT VIEW



RIGHT SIDE VIEW



DETAIL 1
TYPICAL CAUTION NAMEPLATE
(WHITE TEXT ON RED)

NOTES:

1. REFER TO DWG. 7950, DETAIL 101 FOR PANEL BONDING & GROUNDING.

REFERENCE DRAWINGS:

DWG. 7301 - CP-21601 PLC PANEL BACKPAN LAYOUT & BOM
 DWG. 7400 - ELECTRICAL POWER LAYOUT & BOM
 DWG. 7401 - ANALOG & CONTROL GENERAL LAYOUT
 DWG. 7402 - ELECTRICAL ROOM ELEVATIONS

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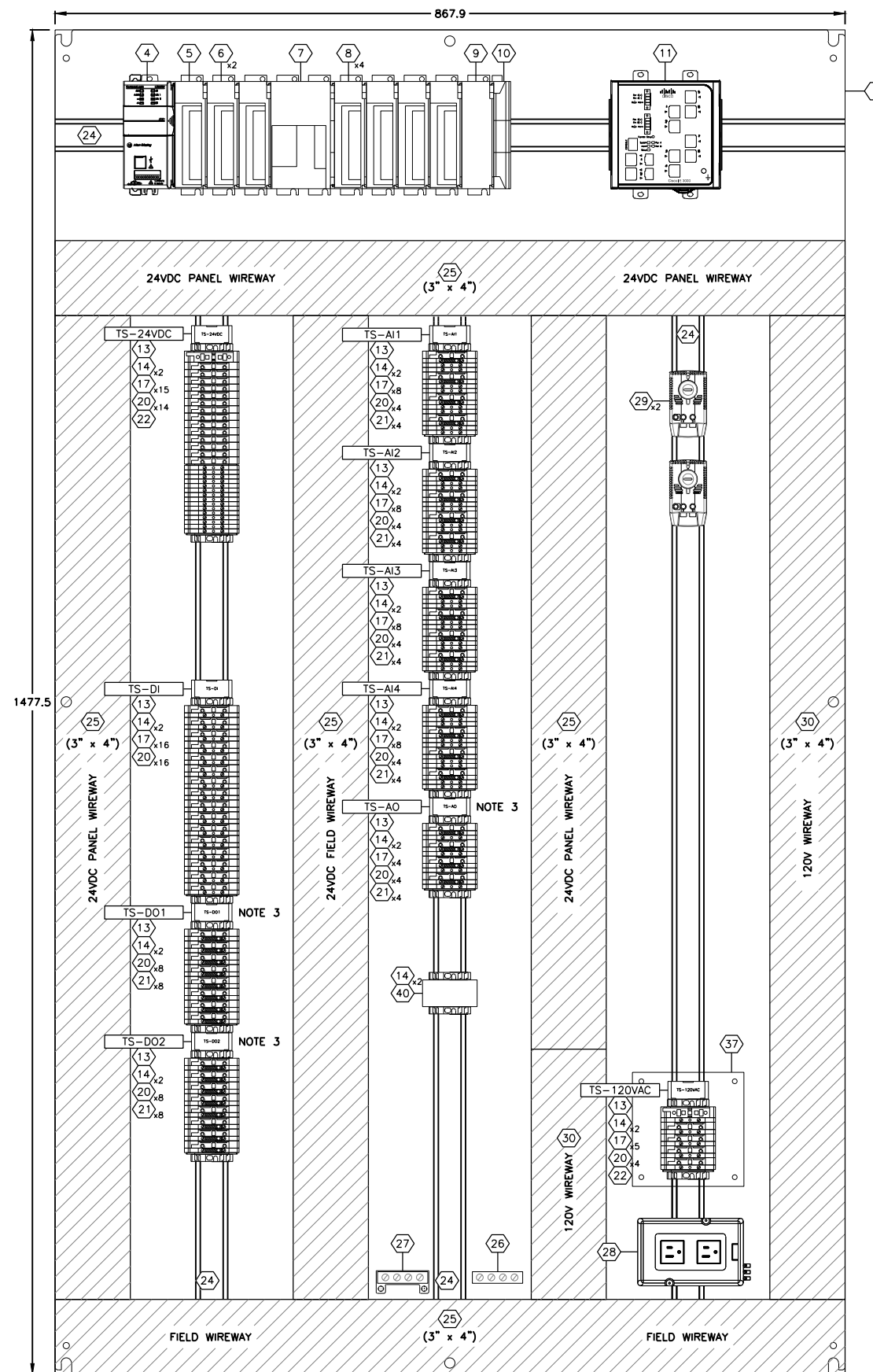
PROJECT NAME:	CARMON CREEK
CUSTOMER:	SHELL
LOCATION:	CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG:	0735A-08030
SLS#: 338716	QUOTE: CGY2014-85
PO#: 4512-109-130	
DWN BY: KS	DATE: AUG 14/14
CHK BY: JS	DATE: AUG 14/14
APP BY: -	DATE: -
214068-7300	
PAGE: 2 OF 7	CAD: N/A
REV: 2	

REV	DESCRIPTION	DWN	CHK	APP	DATE
2	AS-BUILT	LS	JS	-	NOV 09/15
1	ISSUED FOR FIELD CONSTRUCTION	JB	JS	-	AUG 18/15
0	ISSUED FOR CONSTRUCTION	JB	JS	-	MAY 05/15

CMT NG PRESSURE REDUCTION SKID PACKAGE
 CP-21601 PLC PANEL DIMENSIONAL & DOOR LAYOUT



**COLLEAUX
ENGINEERING
INC.**



BACKPAN VIEW

BILL OF MATERIALS					
ITEM	QUANTITY	DESCRIPTION	MANUFACTURER	CATALOG NO.	SUP.
1	1	WALL MOUNTED ENCLOSURE, 1524H X 914.4W X 326D C/W BACKPAN, 1477.5H X 867.9W	RITTAL	8017591 WM603612NC	V
2	1	L-HANDLE KEYLOCK	RITTAL	8015168 WMLHKL	V
3	1	FILTER FAN AND FILTER UNIT	RITTAL	3238.110	V
4	1	COMPACT LOGIX CPU	ALLEN BRADLEY	1769-L33ER	V
5	1	16 PT DISCRETE INPUT MODULE	ALLEN BRADLEY	1769-IQ16	V
6	2	8 PT DISCRETE OUTPUT MODULE	ALLEN BRADLEY	1769-OW8I	V
7	1	24VDC POWER SUPPLY	ALLEN BRADLEY	1769-PB4	V
8	4	4 PT ANALOG INPUT MODULE	ALLEN BRADLEY	1769SC-IF4IH	V
9	1	4 PT ANALOG OUTPUT MODULE	ALLEN BRADLEY	1769SC-OF4IH	V
10	1	RIGHT END CAP	ALLEN BRADLEY	1769-ECR	V
11	1	CISCO 8 PORT & 2 UPLINK ETHERNET SWITCH	CISCO	IE-3000-8TC	V
12					
13	10	MARKER CARRIER, SCHT 5	WEIDMULLER	0292460000	V
14	22	TERMINAL END BRACKET, WEW 35/2	WEIDMULLER	1061200000	V
15	AS-REQ.	TERMINAL END PLATE	WEIDMULLER	1050000000	V
16					
17	72	FEED THROUGH TERMINAL, WDU 2.5	WEIDMULLER	1020000000	V
18					
19					
20	70	FUSE BLOCK, WSI-6	WEIDMULLER	1011000000	V
21	36	DISCONNECT TERMINAL, WTR 2.5	WEIDMULLER	1855610000	V
22	2	FUSE BLOCK, WSI 6/2	WEIDMULLER	1014000000	V
23					
24	AS-REQ.	DIN RAIL TS35, SLOTTED	WEIDMULLER	038340	V
25	AS-REQ.	WIRING DUCT & COVER, 3"W X 4"H WHITE	PANDUIT	F3X4WH6	V
26	1	AC GROUND BUS BAR	ELECTRIPRO	EPOBAR	V
27	1	ISOLATED GROUND BUS BAR	BGS	1100-AL	V
28	1	DIN RAIL RECEPTACLE	WEIDMULLER	6720005422	V
29	2	THERMOSTAT	RITTAL	SK 3110.00	V
30	AS-REQ.	WIRING DUCT & COVER, 3"W X 4"H GREY	PANDUIT	F3X4LG6	V
31					
32	1	PANELVIEW PLUS 1500, 10.5" TOUCHSCREEN	ALLEN BRADLEY	2711P-T10C4D8	V
33					
34	1	SERVIT POST	BURNDY	KC23	V
35					
36	1	INTAKE GRILLE	RITTAL	SK 3238.200	V
37	1	FLEXI GLASS COVER	OPEN	OPEN	V
38	3	CAT-5e CABLE	SIGNAMAX	C5E-114BU-7FB	V
39					
40	1	FUSE HOLDER BOX	WEIDMULLER	7914760001	V
41					
42					
43					
44					

O = BY OWNER
V = BY PANEL VENDOR

- REFERENCE DRAWINGS:
- DWG. 7300 - CP-21601 PLC PANEL DIMENSIONAL & DOOR LAYOUT
 - DWG. 7301 - CP-21601 PLC PANEL BACKPAN LAYOUT & BOM
 - DWG. 7305 - CP-21601 PLC PANEL POWER DISTRIBUTION
 - DWG. 7309 - CP-21601 PLC PANEL SYSTEM ARCHITECTURE
 - DWG. 7320 - CP-21601 PLC DISCRETE INPUT SCHEMATIC
 - DWG. 7330 - CP-21601 PLC DISCRETE OUTPUT SCHEMATIC
 - DWG. 7340 - CP-21601 PLC ANALOG INPUT SCHEMATIC (1 OF 2)
 - DWG. 7341 - CP-21601 PLC ANALOG INPUT SCHEMATIC (2 OF 2)
 - DWG. 7347 - CP-21601 PLC ANALOG OUTPUT SCHEMATIC

- NOTES:
- MATERIAL LIST IS A GUIDE ONLY. CONTRACTOR TO VERIFY ALL PART NUMBERS AND QUANTITIES PRIOR TO ORDERING.
 - CONTRACTOR MAY USE APPROVED EQUIVALENT.
 - CPU/AO/DO MODULES RECEIVE 24VDC POWER THROUGH THE BUS INTERFACE. NO EXTERNAL POWER REQUIRED.

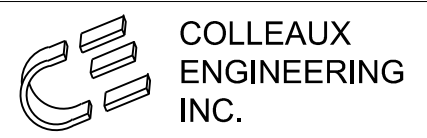
THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.

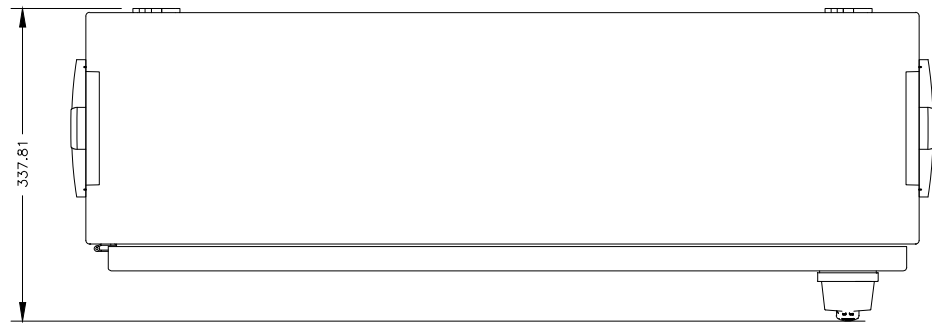


PROJECT NAME:	CARMON CREEK
CUSTOMER:	SHELL
LOCATION:	CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG:	0735A-08030
SLS#: 338716	QUOTE: CGY2014-85
PO#: 4512-109-130	
DWNBY: KS	DATE: AUG 14/14
CHKBY: JS	DATE: AUG 14/14
APPBY: -	DATE: -
DWG #: 214068-7301	
PAGE: 3 OF 7	CAD: N/A
REV: 3	

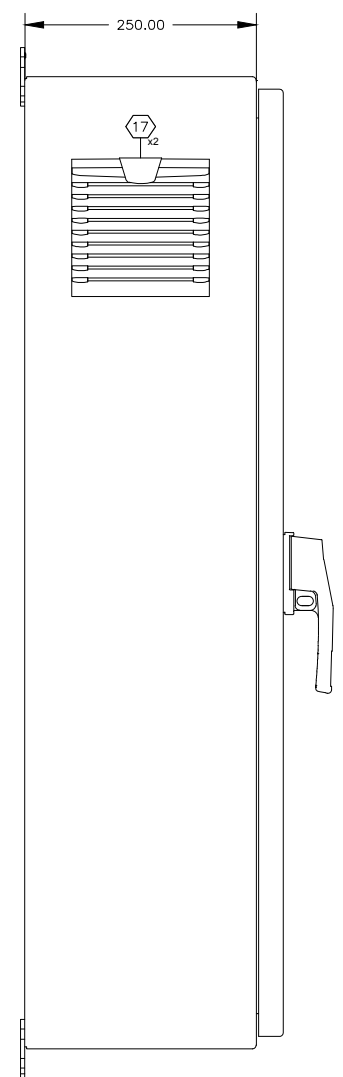
REV	DESCRIPTION	DWN	CHK	APP	DATE
3	AS-BUILT	JB	JS	-	NOV 23/15
2	AS-BUILT	LS	JS	-	NOV 09/15
1	ISSUED FOR FIELD CONSTRUCTION	JB	JS	-	AUG 18/15
0	ISSUED FOR CONSTRUCTION	JB	JS	-	MAY 05/15

CMT NG PRESSURE REDUCTION SKID PACKAGE
CP-21601 PLC PANEL BACK-PAN LAYOUT & BOM

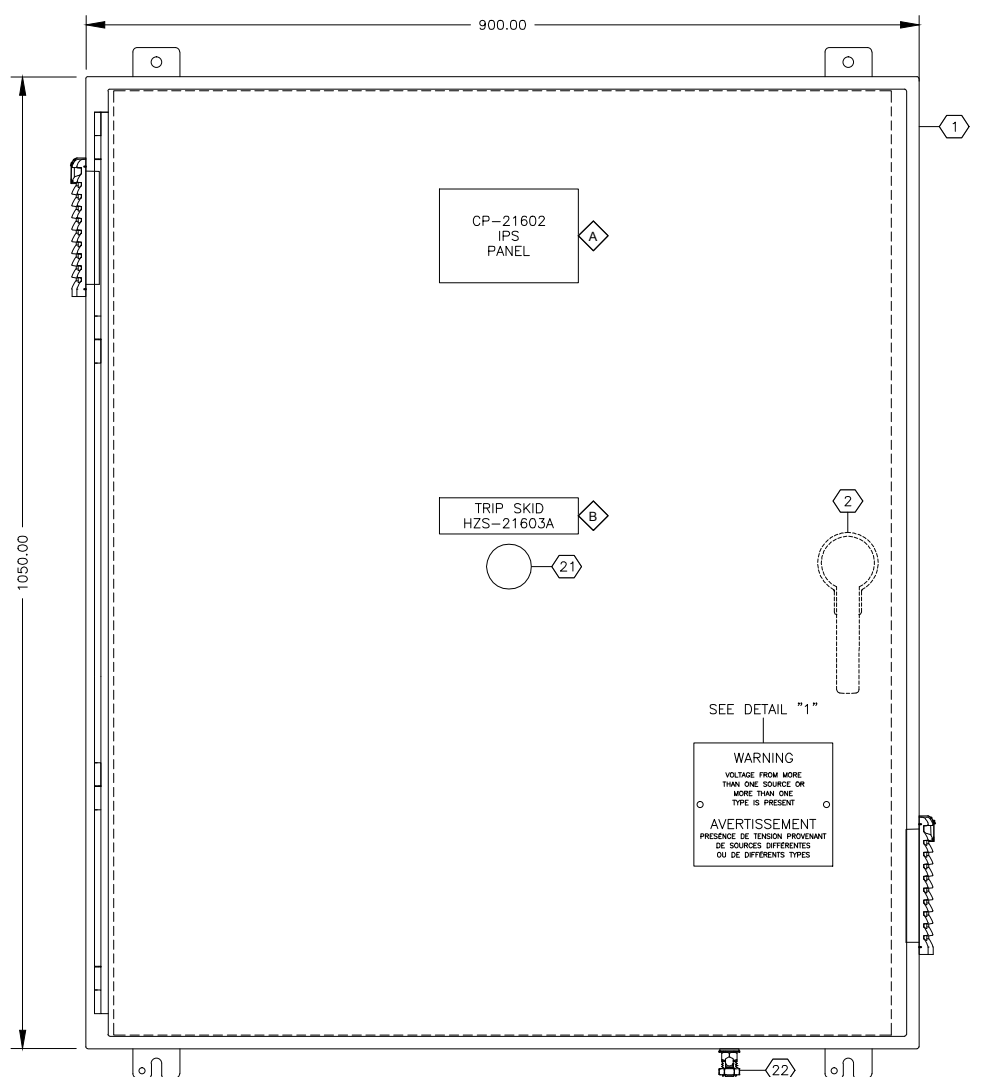




TOP VIEW

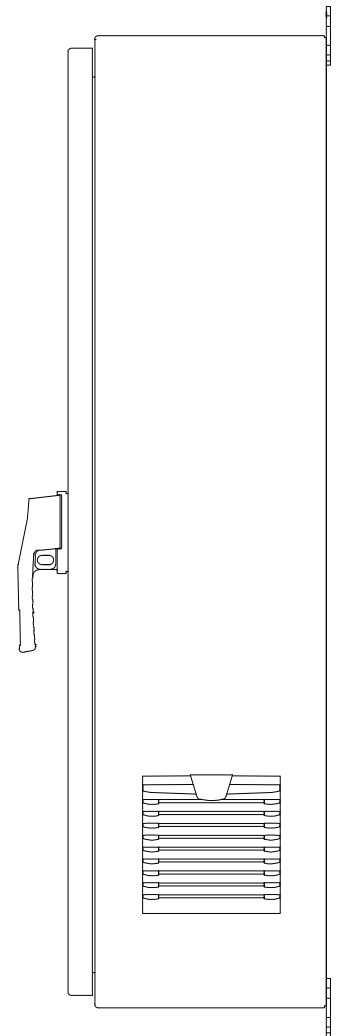


LEFT SIDE VIEW



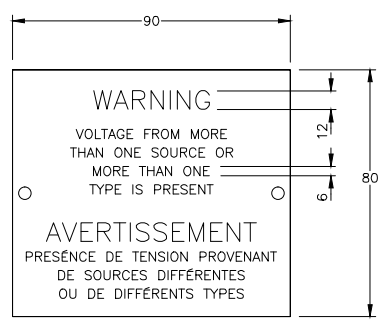
FRONT VIEW

NOTE 1



RIGHT SIDE VIEW

LAMACOID SCHEDULE						
ITEM	FIRST LINE	SECOND LINE	THIRD LINE	FOURTH LINE	SIZE	COLOUR
A	CP-21602	IPS	PANEL			
B	TRIP SKID	HZS-21603A				
C						
D						
E						
F						
G						



DETAIL 1
TYPICAL CAUTION NAMEPLATE
(WHITE TEXT ON RED)

NOTES:
1. REFER TO DWG. 7950, DETAIL 101 FOR PANEL BONDING & GROUNDING.

REFERENCE DRAWINGS:
DWG. 7601 - CP-21602 BACKPAN LAYOUT & BOM
DWG. 7602 - CP-21602 IPS PANEL POWER DISTRIBUTION (1 OF 2)
DWG. 7602A - CP-21602 IPS PANEL POWER DISTRIBUTION (2 OF 2)
DWG. 7603 - CP-21602 IPS PANEL SCHEMATICS (1 OF 3)
DWG. 7604 - CP-21602 IPS PANEL SCHEMATICS (2 OF 3)
DWG. 7605 - CP-21602 IPS PANEL SCHEMATICS (3 OF 3)

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PROJECT NAME: CARMON CREEK
CUSTOMER: SHELL
LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

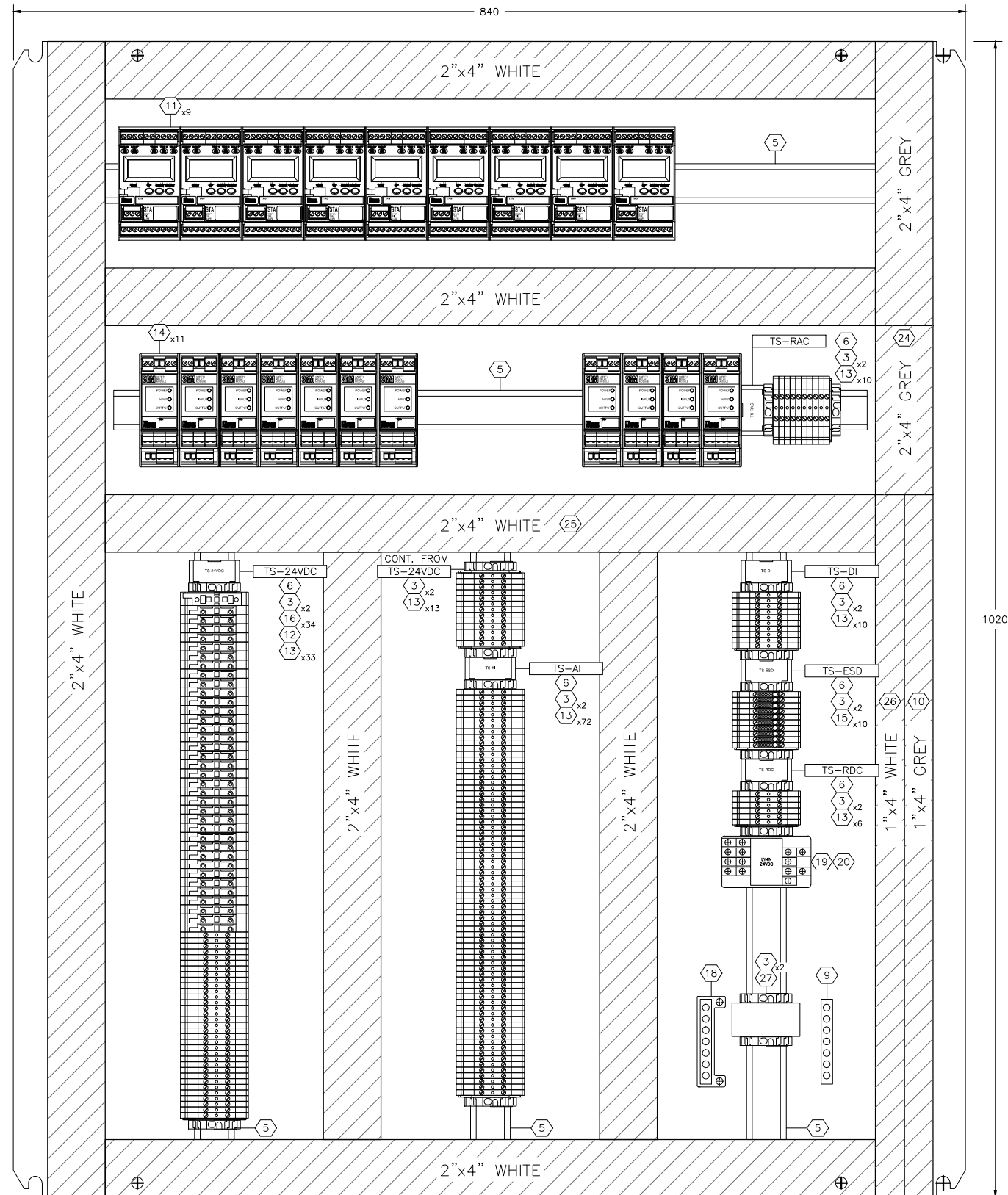
REV	DESCRIPTION	DWN	CHK	APP	DATE
2	AS-BUILT	LS	JS	-	NOV 09/15
1	ISSUED FOR FIELD CONSTRUCTION	JB	JS	-	AUG 18/15
0	ISSUED FOR CONSTRUCTION	JB	JS	-	MAY 05/15

CMT NG PRESSURE REDUCTION SKID PACKAGE
CP-21602 IPS PANEL DIMENSIONAL & DOOR LAYOUT



COLLEAUX ENGINEERING INC.

DWN BY: JP DATE: JAN 30/15 DWG #: 214068-7600
CHK BY: JS DATE: JAN 30/15
APP BY: - DATE: - PAGE: 5 OF 7 CAD: N/A REV: 2



BACKPAN VIEW

BILL OF MATERIALS					
ITEM	QUANTITY	DESCRIPTION	MANUFACTURER	CATALOG NO.	SUP.
1	1	WALL MOUNTED ENCLOSURE, 1050H x 760W x 210D C/W BACKPAN, 1020H x 704W	RITTAL	8017558 WM423008NC	V
2	1	L-HANDLE KEYLOCK	RITTAL	WMLHKL	V
3	16	END BRACKET, WEW 35/2	WEIDMULLER	1061200000	V
4	AS REQ.	END PLATE	WEIDMULLER	1050000000	V
5	AS REQ.	TS-35 DIN RAIL	WEIDMULLER	38340000	V
6	6	TERMINAL STRIP LABEL HOLDER (SCHT5)	WEIDMULLER	0292460000	V
7	AS REQ.	DEKAFIX 5x6	WEIDMULLER	0133360001	V
8	1	BREATHER DRAIN	CROUSE HINDS	ECD15	V
9	1	AC GROUND STRIP	ELETRIPRO	EPOBAR	V
10	AS REQ.	PANDUIT 1"x4" GREY	PANDUIT	F1X4LG6	V
11	9	STA (SAFETY TRIP MODULE)	MOORE	STA/HLPRG/3PRG/24VDC/-AO[DIN]	V
12	1	FUSED TERMINALS, WSI 6/2	WEIDMULLER	1014000000	V
13	144	FEED THROUGH TERMINALS, WDU 2.5	WEIDMULLER	1020000000	V
14	11	SRM (SAFETY RELAY MODULE)	MOORE	SRM/CC/3RO/24VDC[DIN]	V
15	10	DISCONNECT TERMINAL, WTR 2.5	WEIDMULLER	1885561000	V
16	34	FUSED TERMINALS, WSI 6	WEIDMULLER	1011000000	V
17	2	OUTLET FILTER DIMENSION (116 x 16) W/ MAT	RITTAL	3237.060	V
18	1	ISOLATED GROUND	BGS	1100-AL	V
19	1	4 POLE RELAY	OMRON	LY4N-DC24	V
20	1	4 POLE RELAY BASE	OMRON	PTF14A-E	V
21	1	ESD PUSH BUTTON	ALLEN BRADLEY	800T-FX6D4	V
22	1	SERVIT POST	BURNDY	KC23	V
23	AS REQ.	WALL MOUNTING BRACKET	RITTAL	2508100	V
24	AS REQ.	PANDUIT 2"x4" GREY	PANDUIT	F2X4LG6	V
25	AS REQ.	PANDUIT 2"x4" WHITE	PANDUIT	F2X4WH6	V
26	AS REQ.	PANDUIT 1"x4" WHITE	PANDUIT	F1X4WH6	V
27	1	FUSE HOLDER BOX	WEIDMULLER	7914760001	V

NOTES 1, 2

REFERENCE DRAWINGS:

- DWG. 7600 - CP-21602 IPS PANEL DIMENSIONAL & DOOR LAYOUT
- DWG. 7602 - CP-21602 IPS PANEL POWER DISTRIBUTION (1 OF 2)
- DWG. 7602A - CP-21602 IPS PANEL POWER DISTRIBUTION (2 OF 2)
- DWG. 7603 - CP-21602 IPS PANEL SCHEMATICS (1 OF 3)
- DWG. 7604 - CP-21602 IPS PANEL SCHEMATICS (2 OF 3)
- DWG. 7605 - CP-21602 IPS PANEL SCHEMATICS (3 OF 3)

NOTES:

- MATERIAL LIST IS A GUIDE ONLY. CONTRACTOR TO VERIFY ALL PART NUMBERS AND QUANTITIES PRIOR TO ORDERING.
- CONTRACTOR MAY USE APPROVED EQUIVALENT.

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PROJECT NAME: CARMON CREEK
 CUSTOMER: SHELL
 LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030
 SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

REV	DESCRIPTION	DWN	CHK	APP	DATE
2	AS-BUILT	LS	JS	-	NOV 09/15
1	ISSUED FOR FIELD CONSTRUCTION	JB	JS	-	AUG 18/15
0	ISSUED FOR CONSTRUCTION	JB	JS	-	MAY 05/15

CMT NG PRESSURE REDUCTION SKID PACKAGE
 CP-21602 BACK-PAN LAYOUT AND BOM

DWN BY: JP DATE: JAN 30/15 DWG #: 214068-7601
 CHK BY: JS DATE: JAN 30/15
 APP BY: - DATE: - PAGE: 6 OF 7 CAD: N/A REV: 2

COLLEAUX ENGINEERING INC.

CONDUIT OR CABLE No.	APPLICATION	LOAD		ROUTING				COND./CABLE		CONDUCTORS					REMARKS	DRAWING REFERENCE NUMBER	
		HP OR KVA	VOLTS	FROM	VIA	TO			TYPE	LENGTH	SIZE	# OF COND.	INSUL.	VOLTS			SPARE
						BLDG.	DEVICE	DESCRIPTION									
P1-SW-21620	FEEDER		600	SHELL PWR DIST.	SURFACE	BU-216	SW-21620	600 VAC JUNCTION BOX	TECK 90		#2	3	RW90	1000		214068-7100	
P1-PDP-21620	FEEDER		600	SW-21620	SURFACE	BU-216	PDP-21620	POWER DISTRIBUTION PANEL	RAC		#2	3	RW90	1000		214068-7100	
P1-H-08071	POWER	4.4kW	600	CP-21603	SURFACE	BU-216	H-08071	NATURAL GAS HEATER	RAC		#12	3	RW90	1000		214068-7100	
P1-H-08167	POWER	20 kW	600	PDP-21620	SURFACE	BU-216	H-08167	UNIT HEATER	RAC		#10	3	RW90	1000		214068-7100	
P1-H-08170	POWER	10 kW	600	PDP-21620	SURFACE	BU-216	H-08170	UNIT HEATER	RAC		#12	3	RW90	1000		214068-7100	
P1-XFMR-21620	POWER	30 kVA	600	PDP-21620	SURFACE	BU-216	XFMR-21620	600-208/120 V TRANSFORMER	RAC		#8	3	RW90	1000		214068-7100	
P1-LPN-21620	FEEDER		208	XFMR-21620	SURFACE	BU-216	LPN-21620	LIGHTING PANEL	RAC		#2	4	RW90	600		214068-7100	
P1-ELEC-LIGHTS-216	POWER		120	LPN-21620	SURFACE	BU-216		ELECT. ROOM INTERIOR LIGHTS	RAC		#12	2	RW90	600		214068-7510	
P1-NG-LIGHTS-216	POWER		120	LPN-21620	SURFACE	BU-216		NG HEATER ROOM INTERIOR LIGHTS	RAC		#12	2	RW90	600		214068-7510	
P1-EXT-LIGHTS-216	POWER		120	LPN-21620	SURFACE	BU-216		EXTERIOR LIGHTS	RAC		#12	2	RW90	600		214068-7510	
P1-ELEC-RECPT-216	POWER		120	LPN-21620	SURFACE	BU-216		ELECTRICAL ROOM RECEPTACLE	RAC		#12	2	RW90	600		214068-7510	
P1-NG-RECPT-216	POWER		120	LPN-21620	SURFACE	BU-216		NG HEATER ROOM RECEPTACLE	RAC		#12	2	RW90	600		214068-7510	
P1-EMRG-LIGHTS-216	POWER		120	LPN-21620	SURFACE	BU-216		EMERGENCY LIGHTS	RAC		#12	2	RW90	600		214068-7510	
P1-UPS-21601	POWER		120	LPN-21620	SURFACE	BU-216	UPS-21601	UNINTERRUPTIBLE POWER SUPPLY	RAC		#10	2	RW90	600		214068-7510	
P1-SDV-08070A	POWER		24	UPS-21601	SURFACE	BU-216	SDV-08070A	EMERGENCY SHUT DOWN VALVE	RAC		#10	2	RW90	600		214068-7650	
P1-C-08165	POWER		120	LPN-21620	SURFACE	BU-216	CP-21604	CONTACTOR PANEL	RAC		#12	2	RW90	600		214068-7291	
P2-C-08165	POWER		120	CP-21604	SURFACE	BU-216	C-08165	SUPPLY FAN	RAC		#12	2	RW90	600		214068-7291	
P1-C-08166	POWER		120	LPN-21620	SURFACE	BU-216	CP-21604	CONTACTOR PANEL	RAC		#12	2	RW90	600		214068-7291	
P2-C-08166	POWER		120	CP-21604	SURFACE	BU-216	C-08166	SUPPLY FAN	RAC		#12	2	RW90	600		214068-7291	
P1-C-08168	POWER		120	LPN-21620	SURFACE	BU-216	CP-21604	CONTACTOR PANEL	RAC		#12	2	RW90	600		214068-7291	
P2-C-08168	POWER		120	CP-21604	SURFACE	BU-216	C-08168	SUPPLY FAN	RAC		#12	2	RW90	600		214068-7291	
P1-C-08169	POWER		120	LPN-21620	SURFACE	BU-216	CP-21604	CONTACTOR PANEL	RAC		#12	2	RW90	600		214068-7291	
P2-C-08169	POWER		120	CP-21604	SURFACE	BU-216	C-08169	SUPPLY FAN	RAC		#12	2	RW90	600		214068-7291	
P1-CP-21601	POWER		24	UPS-21601	SURFACE	BU-216	CP-21601	PLC PANEL	RAC		#10	2	RW90	600		214068-7305	
P2-CP-21601	POWER		120	LPN-21620	SURFACE	BU-216	CP-21601	PLC PANEL (FAN)	RAC		#12	2	RW90	600		214068-7305	
P3-CP-21601	POWER		120	LPN-21620	SURFACE	BU-216	CP-21601	PLC PANEL (RECEPTACLE)	RAC		#12	2	RW90	600		214068-7305	
P1-CP-21602	POWER		24	UPS-21601	SURFACE	BU-216	CP-21602	IPS PANEL	RAC		#10	2	RW90	600		214068-7602	
P1-CP-21603	POWER		600	PDP-21620	SURFACE	BU-216	CP-21603	NATURAL GAS HEATER CONTROLLER	RAC		#12	3	RW90	1000		214068-7100	
P2-CP-21603	POWER		120	CP-21603	SURFACE	BU-216		ANTI-CONDENSATION HEATER	RAC		#12	2	RW90	600		214068-7650	
P1-CP-21604	POWER		120	LPN-21620	SURFACE	BU-216	CP-21604	CONTACTOR PANEL	RAC		#12	2	RW90	600		214068-7291	
I1-TS-08166	CONTROL		120	CP-21604	SURFACE	BU-216	TS-08166	THERMOSTAT	RAC		#14	2	RW90	600		214068-7291	
I1-TS-08167	CONTROL		120	H-08167	SURFACE	BU-216	TS-08167	THERMOSTAT	RAC		#14	2	RW90	600		214068-7100	
I1-TS-08169	CONTROL		120	CP-21604	SURFACE	BU-216	TS-08169	THERMOSTAT	RAC		#14	2	RW90	600		214068-7291	
I1-TS-08170	CONTROL		120	H-08170	SURFACE	BU-216	TS-08170	THERMOSTAT	RAC		#14	2	RW90	600		214068-7100	
I1-CP-21602	CONTROL		24	CP-21601	SURFACE	BU-216	CP-21602	IPS PANEL	RAC		#14	2	RW90	600		214068-7602A	
I2-CP-21602	CONTROL		24	CP-21601	SURFACE	BU-216	CP-21602	IPS PANEL	RAC		#14	2	RW90	600		214068-7320	
I3-CP-21602	CONTROL		24	CP-21601	SURFACE	BU-216	CP-21602	IPS PANEL	RAC		#14	2	RW90	600		214068-7602A	
I4-CP-21602	CONTROL		24	CP-21601	SURFACE	BU-216	CP-21602	IPS PANEL	RAC		#14	2	RW90	600		214068-7602	
I5-CP-21602	CONTROL		24	CP-21601	SURFACE	BU-216	CP-21602	IPS PANEL	RAC		#14	1	RW90	600		214068-7602	
I1-CP-21603	CONTROL		24	CP-21601	SURFACE	BU-216	CP-21603	NG HEATER CONTROLLER	RAC		#14	2	RW90	600		214068-7320	
I2-CP-21603	CONTROL		120	CP-21602	SURFACE	BU-216	CP-21603	NG HEATER CONTROLLER	RAC		#14	2	RW90	600		214068-7602A	
I3-CP-21603	ANALOG		4-20 mA	CP-21601	SURFACE	BU-216	CP-21603	NG HEATER CONTROLLER	RAC		#16	1 PAIR	CIC	300		214068-7347	
I4-CP-21603	ANALOG		RTD	TE-1	SURFACE	BU-216	CP-21603	NG HEATER CONTROLLER	RAC		#16	1 TRIAD	CIC	300		214068-7650	
I5-CP-21603	ANALOG		RTD	TE-2	SURFACE	BU-216	CP-21603	NG HEATER CONTROLLER	RAC		#16	1 TRIAD	CIC	300		214068-7650	
I6-CP-21603	ANALOG		RTD	TE-3	SURFACE	BU-216	CP-21603	NG HEATER CONTROLLER	RAC		#16	1 TRIAD	CIC	300		214068-7650	
I7-CP-21603	ANALOG		RTD	TE-4	SURFACE	BU-216	CP-21603	NG HEATER CONTROLLER	RAC		#16	1 TRIAD	CIC	300		214068-7650	
I1-CP-21604	CONTROL		24	CP-21601	SURFACE	BU-216	CP-21604	CONTACTOR PANEL	RAC		#14	2	RW90	600		214068-7291	
I1-UPS-21601	CONTROL		24	CP-21601	SURFACE	BU-216	UPS-21601	UNINTERRUPTIBLE POWER SUPPLY	RAC		#14	4	RW90	600		214068-7320	

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PROJECT NAME: CARMON CREEK
CUSTOMER: SHELL
LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030
SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	AS-BUILT	LS	JS	-	NOV 09/15
0	ISSUED FOR CONSTRUCTION	JB	JS	-	SEP 21/15
D	ISSUED FOR INFORMATION	JP	JS	-	SEP 10/15
C	RE-ISSUED FOR APPROVAL	JP	JS	-	MAR 26/15
B	ISSUED FOR APPROVAL	RS	JS	-	JAN 30/15
A	ISSUED FOR INFORMATION	KS	JS	-	AUG 1/14

CMT NG PRESSURE REDUCTION SKID PACKAGE
CABLE SCHEDULE SHEET 1



COLLEAUX ENGINEERING INC.

DWN BY: KS DATE: AUG 1/14 DWG #: 214068-7500
CHK BY: JS DATE: AUG 1/14
APP BY: - DATE: - PAGE: 1 OF 2 CAD: N/A REV: 1

CONDUIT OR CABLE No.	APPLICATION	LOAD		ROUTING				COND./CABLE		CONDUCTORS					REMARKS	DRAWING REFERENCE NUMBER	
		HP OR kVA	VOLTS	FROM	VIA	TO			TYPE	LENGTH	SIZE	# OF COND.	INSUL.	VOLTS			SPARE
						BLDG.	DEVICE	DESCRIPTION									
I1-HZS-21601A	CONTROL		24	CP-21602	SURFACE	BU-216	HZS-21601A	ESD PUSHBUTTON	RAC		#14	2	RW90	600		214068-7602A	
I1-HZS-21602A	CONTROL		24	CP-21602	SURFACE	BU-216	HZS-21602A	ESD PUSHBUTTON	RAC		#14	2	RW90	600		214068-7602A	
I1-TT-08071A1	ANALOG		4-20 mA	CP-21601	SURFACE	BU-216	TT-08071A1	TEMPERATURE TRANSMITTER	RAC		#16	1 PAIR	CIC	300		214068-7340	
I1-FT-08071A1	ANALOG		4-20 mA	CP-21601	SURFACE	BU-216	FT-08071A1	FLOW TRANSMITTER	RAC		#16	1 PAIR	CIC	300		214068-7340	
I2-FT-08071A1	POWER		24	CP-21601	SURFACE	BU-216	FT-08071A1	FLOW TRANSMITTER	RAC		#14	2	RW90	600		214068-7340	
I1-ZT-08070A	ANALOG		4-20 mA	CP-21601	SURFACE	BU-216	ZT-08070A	SDV POSITION INDICATOR	RAC		#16	1 PAIR	CIC	300		214068-7340	
I1-TT-21601A	ANALOG		4-20 mA	CP-21601	SURFACE	BU-216	TT-21601A	TEMPERATURE TRANSMITTER	RAC		#16	1 PAIR	CIC	300		214068-7340	
I1-TZT-08071A	ANALOG		4-20 mA	CP-21602	SURFACE	BU-216	TZT-08071A	TEMPERATURE TRANSMITTER	RAC		#16	1 PAIR	CIC	300		214068-7603	
I2-TZT-08071A	ANALOG		4-20 mA	CP-21601	SURFACE	BU-216	CP-21602	IPS PANEL	RAC		#16	1 PAIR	CIC	300		214068-7603	
I1-TZT-08071B	ANALOG		4-20 mA	CP-21602	SURFACE	BU-216	TZT-08071B	TEMPERATURE TRANSMITTER	RAC		#16	1 PAIR	CIC	300		214068-7603	
I2-TZT-08071B	ANALOG		4-20 mA	CP-21601	SURFACE	BU-216	CP-21602	IPS PANEL	RAC		#16	1 PAIR	CIC	300		214068-7603	
I1-PZT-08071A	ANALOG		4-20 mA	CP-21602	SURFACE	BU-216	PZT-08071A	PRESSURE TRANSMITTER	RAC		#16	1 PAIR	CIC	300		214068-7603	
I2-PZT-08071A	ANALOG		4-20 mA	CP-21601	SURFACE	BU-216	CP-21602	IPS PANEL	RAC		#16	1 PAIR	CIC	300		214068-7603	
I1-PZT-08071B	ANALOG		4-20 mA	CP-21602	SURFACE	BU-216	PZT-08071B	PRESSURE TRANSMITTER	RAC		#16	1 PAIR	CIC	300		214068-7603	
I2-PZT-08071B	ANALOG		4-20 mA	CP-21601	SURFACE	BU-216	CP-21602	IPS PANEL	RAC		#16	1 PAIR	CIC	300		214068-7603	
I1-PZT-08071C	ANALOG		4-20 mA	CP-21602	SURFACE	BU-216	PZT-08071C	PRESSURE TRANSMITTER	RAC		#16	1 PAIR	CIC	300		214068-7603	
I2-PZT-08071C	ANALOG		4-20 mA	CP-21601	SURFACE	BU-216	CP-21602	IPS PANEL	RAC		#16	1 PAIR	CIC	300		214068-7603	
I1-PZT-08071D	ANALOG		4-20 mA	CP-21602	SURFACE	BU-216	PZT-08071D	PRESSURE TRANSMITTER	RAC		#16	1 PAIR	CIC	300		214068-7603	
I2-PZT-08071D	ANALOG		4-20 mA	CP-21601	SURFACE	BU-216	CP-21602	IPS PANEL	RAC		#16	1 PAIR	CIC	300		214068-7603	
I1-UZT-21601A	ANALOG		4-20 mA	CP-21602	SURFACE	BU-216	UZT-21601A	COMBUSTIBLE GAS DETECTOR	RAC		#16	1 PAIR	CIC	300		214068-7604	
I2-UZT-21601A	ANALOG		4-20 mA	CP-21601	SURFACE	BU-216	CP-21602	IPS PANEL	RAC		#16	1 PAIR	CIC	300		214068-7604	
I3-UZT-21601A	POWER		24	CP-21602	SURFACE	BU-216	UZT-21601A	COMBUSTIBLE GAS DETECTOR	RAC		#14	2	RW90	600		214068-7602	
I4-UZT-21601A	CONTROL		120	CP-21602	SURFACE	BU-216	CP-21604	CONTACTOR PANEL	RAC		#14	2	RW90	600		214068-7605	
I1-YZT-21601A	ANALOG		4-20 mA	CP-21602	SURFACE	BU-216	YZT-21601A	FLAME DETECTOR	RAC		#16	1 PAIR	CIC	300		214068-7604	
I2-YZT-21601A	ANALOG		4-20 mA	CP-21601	SURFACE	BU-216	CP-21602	IPS PANEL	RAC		#16	1 PAIR	CIC	300		214068-7604	
I3-YZT-21601A	POWER		24	CP-21602	SURFACE	BU-216	YZT-21601A	FLAME DETECTOR	RAC		#14	2	RW90	600		214068-7602	
I4-YZT-21601A	CONTROL		120	CP-21602	SURFACE	BU-216	CP-21604	CONTACTOR PANEL	RAC		#14	2	RW90	600		214068-7604	
I1-XAF-21601A	POWER		24	CP-21602	SURFACE	BU-216	XAF-21601A	ALARM HORN	RAC		#14	2	RW90	600		214068-7602	
I2-XAF-21601A	CONTROL		24	CP-21601	SURFACE	BU-216	CP-21602	IPS PANEL	RAC		#14	2	RW90	600		214068-7602A	
I1-XAF-21603A1	POWER		24	CP-21602	SURFACE	BU-216	XAF-21603A1	ALARM STROBE	RAC		#14	2	RW90	600		214068-7602	
I1-XAF-21603A2	POWER		24	CP-21602	SURFACE	BU-216	XAF-21603A2	ALARM STROBE	RAC		#14	2	RW90	600		214068-7602	
I1-XAF-21605A1	POWER		24	CP-21602	SURFACE	BU-216	XAF-21605A1	ALARM STROBE	RAC		#14	2	RW90	600		214068-7602	
I1-XAF-21605A2	POWER		24	CP-21602	SURFACE	BU-216	XAF-21605A2	ALARM STROBE	RAC		#14	2	RW90	600		214068-7602	
I1-YZT-21602A	CONTROL		24	CP-21601	SURFACE	BU-216	CP-21602	IPS PANEL	RAC		#14	2	RW90	600		214068-7602	
I2-YZT-21602A	POWER		24	CP-21602	SURFACE	BU-216	YZT-21602A	SMOKE DETECTOR	RAC		#14	2	RW90	600		214068-7602	
I3-YZT-21602A	CONTROL		24	CP-21602	SURFACE	BU-216	YZT-21602A	SMOKE DETECTOR	RAC		#14	2	RW90	600		214068-7602	
I4-YZT-21602A	CONTROL		24	CP-21602	SURFACE	BU-216	CP-21601	PLC PANEL	RAC		#14	2	RW90	600		214068-7602A	
I1-XJB-21601	CONTROL		24	SHELL DCS	TRAY	BU-216	XJB-21601	DISCRETE JUNCTION BOX	TECK 90		#14	25	RW90	600		214068-7900	
I2-XJB-21601	CONTROL		24	CP-21601	SURFACE	BU-216	XJB-21601	DISCRETE JUNCTION BOX	RAC		#14	12	RW90	600		214068-7900	
I3-XJB-21601	CONTROL		24	CP-21602	SURFACE	BU-216	XJB-21601	DISCRETE JUNCTION BOX	RAC		#14	2	RW90	600		214068-7900	
I1-XJB-21602	CONTROL		COMM.	SW-21601	SURFACE	BU-216	XJB-21602	MODBUS JUNCTION BOX	RAC				CAT6			214068-7900	
I2-XJB-21602	CONTROL		COMM.	FIELD I/O CABINET	TRAY	BU-216	XJB-21602	MODBUS JUNCTION BOX	TRAY				CAT6			214068-7900	
I1-SDV-08070A	CONTROL		24	CP-21602	SURFACE	BU-216	SDV-08070A	EMERGENCY SHUT DOWN VALVE	RAC		#14	2	RW90	600		214068-7602A	
I2-SDV-08070A	CONTROL		24	CP-21601	SURFACE	BU-216	SDV-08070A	EMERGENCY SHUT DOWN VALVE	RAC		#14	2	RW90	600		214068-7330	
I1-UZT-21601B	ANALOG		4-20 mA	CP-21602	SURFACE	BU-216	UZT-21601B	COMBUSTIBLE GAS DETECTOR	RAC		#16	1 PAIR	CIC	300		214068-7604	
I2-UZT-21601B	ANALOG		4-20 mA	CP-21601	SURFACE	BU-216	CP-21602	COMBUSTIBLE GAS DETECTOR	RAC		#16	1 PAIR	CIC	300		214068-7604	
I3-UZT-21601B	POWER		24	CP-21602	SURFACE	BU-216	UZT-21601B	COMBUSTIBLE GAS DETECTOR	RAC		#14	2	RW90	600		214068-7602	

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PROJECT NAME: CARMON CREEK

CUSTOMER: SHELL

LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

TAG: 0735A-08030

SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

DWN BY: LS DATE: JAN 30/15 DWG #: 214068-7501

CHK BY: JS DATE: JAN 30/15

APP BY: - DATE: - PAGE: 2 OF 2 CAD: N/A REV: 1

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	AS-BUILT	LS	JS	-	NOV 09/15
0	ISSUED FOR CONSTRUCTION	JB	JS	-	SEP 21/15
C	ISSUED FOR INFORMATION	JP	JS	-	SEP 10/15
B	RE-ISSUED FOR APPROVAL	JP	JS	-	MAR 26/15
A	ISSUED FOR APPROVAL	LS	JS	-	JAN 30/15

CMT NG PRESSURE REDUCTION SKID PACKAGE
CABLE SCHEDULE SHEET 2



COLLEAUX ENGINEERING INC.

Shell PO 4512109130 -NG- CMT Package Instrument Data Index Rev 1

Tag Number	Instrument Type Description	P&ID	Equipment	Service Description	Specification Sheet Doc. Number	Furnished By	Installed By	Wired By
S-08070	Jonell Model JVC-3-8-1440-1-336-STD (Stock Vessel) Vessel Size: 219mm OD x 3405mm OAL x 9930 kpag design pressure x -45/50°C design temperature x 3.05mm CA Filter Element: Model JPMG-336-CE-R gas coalescer filter element CRN No.: T5967.213	CCK-4512109130-0735 -C01-00001-001	CMT	Coalescer Filter		Jonell	NATPRO	
H-08071	EXHEAT Rated Duty: 4.4 KW/ 600V / 60 HZ / 3 Phase Vessel Size: 168mm OD x 1726mm OAL x 9930kpag design pressure x -45/93°C design temperature x 1.6mm CA CRN No. :W8598.2	CCK-4512109130-0735 -C01-00001-001	CMT	Natural Gas Electric Heater		EXHEAT	NATPRO	
V-08069	Steelcraft 100 Gal Double Wall Steel Tank (Stock Tank) Size: 711mm OD x 1219mm long x atmospheric design pressure Designed & Fabricated: CAN/ULC-S601-07	CCK-4512109130-0735 -C01-00001-001	CMT	Condensate Storage Tank		Steelcraft	NATPRO	
V-08116	KingTool Mercaptan Gas Odorizer (Stock Vessel) Model: 3B Size: 406mmOD x 451mm S/S x 2068kpag design pressure x -45/66°C design temperature x 0mm CA CRN No.: L3956.52	CCK-4512109130-0735 -C01-00001-001	CMT	Mercaptan Gas Odorizer		Tansley Associates	NATPRO	
SDV-08070A	2" 600# RF full port ball valve, JAG FIG TB3-F20R06LH-S1-01 c/w Rotork Fig RH-060-045H/C2 Electric /Hydraulic Actuator, FC, 24VDC power supply	CCK-4512109130-0735 -C01-00001-001	CMT	Emergency Shut Down Valve		MRC	NATPRO	NATPRO
ZT-08070A	Contelec PL310-AA-KG-5K potentiometer conductive plastic resistance element, 5/10 kOhm nominal resistance, +/-20% resistance tolerance, max 0.5 W/40°C power rating, 360° (continuous) mechanical range, max 0.7Ncm Torque (IP54), -25/85°C operating temperature, -40/105°C storage temperature, IP54 protection class	CCK-4512109130-0735 -C01-00001-001	CMT	Actuator potentiometer conductive plastic resistance element		MRC	NATPRO	NATPRO
CV-08070A CV-08070B CV-08070C	Willis MC10A Inline Choke, 1-0.125" Tungsten Carbide Disc Trim, 1" 600# RF inlet/outlet connection	CCK-4512109130-0735 -C01-00001-001	CMT	Manual Choke Valve		Cameron	NATPRO	

PDI-08070A	Midwest Differential Pressure Indicator Model# 120-SA-10-OO-50, 0-345kpag range, dual scale	CCK-4512109130-0735 -C01-00001-001	CMT	Differential Pressure Indicator		Unified Valve	NATPRO	
PDI-08116A	Midwest Differential Pressure Indicator, Model# 120-SA-10-OO-05, 0-35kpag range, dual scale	CCK-4512109130-0735 -C01-00001-001	CMT	Differential Pressure Indicator		Unified Valve	NATPRO	
PSV-08070A	1" 600# RF x 2" 150# RF Farris relief valve Model 26DA13-120/LC, LCB body set @ 9930kpag (Basis: Fire)	CCK-4512109130-0735 -C01-00001-001	CMT	Pressure Safety Valve		Spartan Controls	NATPRO	
LI-08070A	Magtech Model #: L061CAC1M00355SD9A C14SD8F3B8CZF00355A0ZZ magnetic level gauge (min SG 0.61)	CCK-4512109130-0735 -C01-00001-001	CMT	Magnetic Level Gauge		Spartan Controls/ Magtech	NATPRO	
LI-08070B	Magtech Model #: L087CAC1M00355SD9A C14SD8F3B8CZF00355A0ZZ magnetic level gauge (min SG 0.87)	CCK-4512109130-0735 -C01-00001-001	CMT	Magnetic Level Gauge		Spartan Controls/ Magtech	NATPRO	
TZT-08071A / TW-08071A	Rosemount 3144PD1A1K6M5Q4 Smart Temperature Transmitter and Rosemount Temperature Sensor Model 0068N21C30N060E6 (SEE NOTE) c/w 1 1/2" 1500# RF tapered 316SST TW Calibration Range: -50 to 100°C NOTE: ORIGINAL EXTENSION LENGTH E= 3.0 INCHES WAS MODIFIED 3.385"	CCK-4512109130-0735 -C01-00001-001	CMT	Temperature Indicator Transmitter/THERMOWELL		Spartan Controls	NATPRO	NATPRO
PZT-08071A	Rosemount Smart PressureTransmitter Model # 2088G4S22A1M5K6P1Q4Q8, -14.7 TO 4000 PSI range WITH 3-VALVE MANIFOLD PARKER HPM6LS3DBBB-MD4-14299EHXJ Calibration range: 0-12,000 kpag	CCK-4512109130-0735 -C01-00001-001	CMT	Pressure Indicator Transmitter		Spartan Controls	NATPRO	NATPRO
PZT-08071B	Rosemount Smart PressureTransmitter Model # 2088G3S22A1M5K6P1Q4Q8, -14.7 TO 800 PSI range WITH 3-VALVE MANIFOLD PARKER HPM6LS3DBBB-MD4-14299EHXJ Calibration range: 0-5,515 kpag	CCK-4512109130-0735 -C01-00001-001	CMT	Pressure Indicator Transmitter		Spartan Controls	NATPRO	NATPRO
PZT-08071C	Rosemount Smart PressureTransmitter Model # 2088G3S22A1M5K6P1Q4Q8, -14.7 TO 800 PSI range WITH 3-VALVE MANIFOLD PARKER HPM6LS3DBBB-MD4-14299EHXJ Calibration range: 0-1,500 kpag	CCK-4512109130-0735 -C01-00001-001	CMT	Pressure Indicator Transmitter		Spartan Controls	NATPRO	NATPRO
PZT-08071D	Rosemount Smart PressureTransmitter Model # 2088G2S22A1M5K6P1Q4Q8, -14.7 TO 150 PSI range WITH 3-VALVE MANIFOLD PARKER HPM6LS3DBBB-MD4-14299EHXJ Calibration range: 0-1,000 kpag	CCK-4512109130-0735 -C01-00001-001	CMT	Pressure Indicator Transmitter		Spartan Controls	NATPRO	NATPRO
PSV-08071A	1 1/2" 900# RF x 2" 300# RF Farris relief valve Model# 26DA14-120/LC, LCB body set @ 9600kpag (Basis: Blocked Flow)	CCK-4512109130-0735 -C01-00001-001	CMT	Pressure Safety Valve		Spartan Controls	NATPRO	

PCV-08071A	1" 600# RF Fisher 627H pressure regulator, WCC body, 3/16" orifice SST nylon disk, 240-500# spring range, set @ 3348kpag	CCK-4512109130-0735 -C01-00001-001	CMT	Pressure Control Valve		Spartan Controls	NATPRO	
PCV-08071B	1" 300# RF Fisher 627 pressure regulator, WCC body, 1/8" orifice SST nylon disk, 70-150# spring range set @ 1034 kpag	CCK-4512109130-0735 -C01-00001-001	CMT	Pressure Control Valve		Spartan Controls	NATPRO	
PCV-08071C	1" 150# RF Fisher 627 pressure regulator, WCC body, 3/16" orifice SST nylon disk, 5-20# spring range, set 55kpag	CCK-4512109130-0735 -C01-00001-001	CMT	Pressure Control Valve		Spartan Controls	NATPRO	
PSV-08071B	1" 300# RFX 2" 150# RF Farris relief valve model 26DA12-120/LC , LCB body set @ 4137 kpag (Basis: Valve Failure)	CCK-4512109130-0735 -C01-00001-001	CMT	Pressure Safety Valve		Spartan Controls	NATPRO	
PSV-08071C	1" 150# RFX 2" 150# RF Farris relief valve model 26DA10-120/LC , LCB body set @ 1240 kpag (Basis: Valve Failure)	CCK-4512109130-0735 -C01-00001-001	CMT	Pressure Safety Valve		Spartan Controls	NATPRO	
PSV-08071D	1" 150# RFX 2" 150# RF Farris relief valve model 26DA10-120/LC, LCB body set @ 620 kpag (Basis: Valve Failure)	CCK-4512109130-0735 -C01-00001-001	CMT	Pressure Safety Valve		Spartan Controls	NATPRO	
TZT-08071B/ TW-08071B	Rosemount 3144PD1A1K6M5Q4 Smart Temperature Transmitter c/w Rosemount Temperature Sensor Model # 0068N21C30N050E6 (SEE NOTE) and 1 1/2" 300# RF tapered 316SST TW Calibration range: -50 to 100°C NOTE: ORIGINAL EXTENSION LENGTH E= 3.0 INCHES WAS MODIFIED TO 4.88"	CCK-4512109130-0735 -C01-00001-001	CMT	Temperature Indicator Transmitter/THERMOWELL		Spartan Controls	NATPRO	NATPRO
TT-08071A1 / TW-08071A1	Rosemount 3144PD1A1K6M5Q4 Smart Temperature Transmitter c/w Rosemount Temperature Sensor Model # 0068N21C30N050E6 (SEE NOTE) and 1 1/2" 300# RF tapered 316SST TW Calibration range: -50 to 100°C NOTE: ORIGINAL EXTENSION LENGTH E= 3.0 INCHES WAS MODIFIED TO 4.88"	CCK-4512109130-0735 -C01-00001-001	CMT	Temperature Indicator Transmitter/THERMOWELL		Spartan Controls	NATPRO	NATPRO
FE-08071A1 FT-08071A1	1/2"150# RF Coriolis Mass Flowmeter Model 83F15-EAAS6ANABBBA+Z1 Promass 83F15, DN15 1/2"; Calibration range: 0-2,000Sm3/day	CCK-4512109130-0735 -C01-00001-001	CMT	Flow Indicating Transmitter		Endress Hauser	NATPRO	NATPRO
PI-08070A	Wika Model 233.34 pressure gauge, 4 1/2" dial face, 0-10,000kpag range, dual scale, 1/2" bottom connection	CCK-4512109130-0735 -C01-00001-001	CMT	Pressure Gauge		Wika	NATPRO	
LI-08116A	KingTool Calibrated Level Gauge (supplied with KingTool Gas Odorizer)	CCK-4512109130-0735 -C01-00001-001	CMT	Level Gauge		Tansley Associates	NATPRO	
LI-08069A	2" NPT Krueger AT-A Glance Type D mechanical gauge	CCK-4512109130-0735 -C01-00001-001	CMT	Level Gauge		Steelcraft	NATPRO	

PSV-08116A	1" 150# RF x 2" 150# RF Farris relief valve Model 26DA10-120/LC , LCB body set 1827 kpag (Basis: Fire)	CCK-4512109130-0735 -C01-00001-001	CMT	Pressure Safety Valve		Spartan Controls	NATPRO	
YZT-21601A	Det-Tronics, Model: X3301A4N13W1 Multispectrum IR Flame Detector	CCK-4512109130-0735 -C01-00001-001	CMT	Flame Detector		Spartan Controls	NATPRO	NATPRO
UZT-21601A	Det-Tronics, Model: PIRECL Infrared Hydrocarbon Gas Detector PointWatch Eclipse/Det-Tronics Model:UD10A5N25T2, FlexVu Explosion Proof Universal Display unit	CCK-4512109130-0735 -C01-00001-001	CMT	LEL Detector/LEL Display		Spartan Controls	NATPRO	NATPRO
UZT-21601B	Det-Tronics, Model: PIRECL Infrared Hydrocarbon Gas Detector PointWatch Eclipse/Det-Tronics Model:UD10A5N25T2, FlexVu Explosion Proof Universal Display unit	CCK-4512109130-0735 -C01-00001-001	CMT	LEL Detector/LEL Display		Spartan Controls	NATPRO	NATPRO
YZT-21602A	Gentex, 8000/8003 series, Photoelctric open Area Smoke Detector Model #8240PY, PART# 908-1208-002	CCK-4512109130-0735 -C01-00001-001	CMT	Smoke Detector		Spartan Controls	NATPRO	NATPRO
TE-08071D	Temperature Sensors: -2 x tubesheet overtemperature sensing 3-WIRE Pt100RTD (Duplex). Terminated in tubesheet face -2 x element overtemperature sensing 3-WIRE Pt100RTD (Duplex). Strapped to element	CCK-4512109130-0735 -C01-00001-001	CMT	Electric Heater temperature sensors		EXHEAT	NATPRO	NATPRO
XAF-21601A	Federal Signal Model 302GCX-024 c/w die cast aluminum amplifier housing, 114dBA sound level on axis @ 10ft (3m) & Tone Module UTM with 32 switchable tones	CCK-4512109130-0735 -C01-00001-001	CMT	Horn		Westburn	NATPRO	NATPRO
XAF-21603A1	Federal Signal Model 191XL-024R, 60 FPM flashes per minute, 380mA maximum operating current, 24VDC operating voltage, 1.75A at 24VDC for 5 ms DC In-Rush current	CCK-4512109130-0735 -C01-00001-001	CMT	Red Beacon		Wetsburn	NATPRO	NATPRO
XAF-21603A2	Federal Signal Model 191XL-024R, 60 FPM flashes per minute, 380mA maximum operating current, 24VDC operating voltage, 1.75A at 24VDC for 5 ms DC In-Rush current	CCK-4512109130-0735 -C01-00001-001	CMT	Red Beacon		Westburn	NATPRO	NATPRO
XAF-21605A1	Federal Signal Model 191XL-024R, 60 FPM flashes per minute, 380mA maximum operating current, 24VDC operating voltage, 1.75A at 24VDC for 5 ms DC In-Rush current	CCK-4512109130-0735 -C01-00001-001	CMT	Red Beacon		Westburn	NATPRO	NATPRO

XAF-21605A2	Federal Signal Model 191XL-024R, 60 FPM flashes per minute, 380mA maximum operating current, 24VDC operating voltage, 1.75A at 24VDC for 5 ms DC In-Rush current	CCK-4512109130-0735 -C01-00001-001	CAMP	Red Beacon		Westburn	NATPRO	NATPRO
TT-21601A	Rosemount Model 3144PD1A1K6B5M5T1CNQ4HR7XAK1005 Smart Temperature Transmitter c/w Rosemount Temperature Sensor Model # 0068N11N00N030E6X8Q4XA Calibration range: -50 to 50°C	CCK-4512109130-0735 -C01-00001-001	CMT	Building Temperature Indicating Transmitter		Spartan Controls	NATPRO	NATPRO
HZS-21601A	Crouse-Hinds Model GHG43 control station, NEMA 4X, IP66 enclosure with formed-in-place gasket, UL/cUL certifications and compliances, Class 1 Div 2, Group A, B, C,D area classifications PUSHBUTTON # SGT-55-1-2-06	CCK-4512109130-0735 -C01-00001-001	CMT	ESD Button		Westburn	NATPRO	NATPRO
HZS-21602A	Crouse-Hinds Model GHG43 control station, NEMA 4X, IP66 enclosure with formed-in-place gasket, UL/cUL certifications and compliances, Class 1 Div 2, Group A, B, C,D area classifications PUSHBUTTON # SGT-55-1-2-06	CCK-4512109130-0735 -C01-00001-001	CMT	ESD Button		Westburn	NATPRO	NATPRO
HZS-21603A	Allen Bradley Model 800T-FX6D4 push button, NEMA 4,13 enclosure, standard mushroom head actuator, red color, 600 VAC/VDC voltage, 18-14 AWG wire size, -40 to 131 degree F temperature rating, minimum: 24V,24mA/maximum:10A AC/2.5 AMP DC contact rating	CCK-4512109130-0735 -C01-00001-001	CMT	Panel ESD Button		Allen Bradley	NATPRO	NATPRO

NATPRO				MANUAL CHOKE VALVE				
CLIENT: SHELL CANADA PROJECT: CARMON CREEK				REVISIONS			SHT # 1 OF 1	
				NO	BY	DATE	DESCRIPTION	Spec# :C600/LT
				0	ET	15-Sep-2015	For Approval	Job #: SLS338716
				1	ET	27-Oct-2015	Final Submission	Req # :3
								PO #:4512-109-130
				App'd by:				
				Chk'd by:				
1	Tag No:	CV-08070A/B/C		Fluid:	CONDY			
2	Service:	VESSEL DUMP CHOKE VALVE		P&ID:	338716-100			
3	Line Number:							
4	SERVICE CONDITIONS							
5		Units	Min	Norm	Max			
6	Flow Rate Liquid	m3/d	0.2	0.2	0.2			
7	Flow Rate Gas	Sm3/d	150	1540	1540			
8	Total Flow Rate	kg/hr						
9	Inlet Pressure	kPag	1200	2600	8500			
10	Outlet Pressure	kPag	0	140	160			
11	Inlet Temperature	°C	-5	5	40			
12	Op. Density Liquid/Gas	kg/m3						
13	Specific Gravity Liquid/Gas	SG	0.998/0.67	0.998/0.67	0/998/0.67			
14	Viscosity Liquid/Gas	cP						
15	Vapour Pressure	kPag						
16	Critical Pressure	kPa						
17	Required Cv (Max)		0.37	0.37	0.037			
18	Travel		48.80%	48.50%	43.80%			
19	Allowable/Predicted SPL	dBa	0	0	0			
20								
21	LINE			59	ACTUATOR			
22	Pipe Line Size & Sch. - In:	1" SCH XS		60	Type:	N/A		
23	-Out:	1 SCH XS		61	Manuf. & Model No:			
24	Pipe Line Insulation:	N/A		62	Size:	Effective Area:		
25	VALVE BODY/BONNET			63	On/Off:	Modulating:		
26	Type:	INLINE		64	Spring Action Open / Closed:	N/A		
27	Size:	1" ANSI Class: 600		65	Max. Allow. Pressure:			
28	Max. Press/Temp:	10,205 kPag -45°C / 38°C		66	Min. Req'd Pressure:			
29	Manuf:	CAMERON	Model: MC10A	67	Available Air Supply Pressure -			
30	Body/Bonnet Material:	A487-4C CAST CARBON STEEL		68	Max:	Min:		
31	Liner Material/ID:	N/A		69	Bench Range:			
32	End Conn. - In:	1" GR40 GRAYLOC		70	Actuator Orientation:	STEM HORIZONTAL		
33	- Out:	1" GR40 GRAYLOC		71	Handwheel Type:	N/A		
34	Flg Face Finish:	MFG STD		72	Air Failure Valve:			
35	End Ext/Material:	A350 LF2		73	Set @ :			
36	Flow Direction:	UNIDIRECTIONAL		74	POSITIONER			
37	Type of Bonnet:	N/R		75	Input Signal:	N/R		
38	Lub. & Iso Valve:	N/R		76	Type:	Tag No:		
39	Packing Material:	HNBR		77	Manuf. & Model No:			
40	Packing Type:	O-RING		78	On Incr. Signal Output Incr/Decr:			
41								
42	TRIM			79	Gauges:	Bypass:		
43	Type:	DISC TYPE		80	Cam Characteristic:			
44	Size:	2-0.125"	Rated Trav: N/A	81	SWITCHES			
45	Characteristic:	LINEAR N/A		83	Type:	N/R		
46	Balanced / Unbalanced:	N/A		84	Mfr. & Model No:			
47	Rated - Cv:	11.65	FL: N/A	85	Contacts/Rating:			
48			Xt: N/A	86	Actuation Points:			
49	Plug / Ball / Disc Material:	TUNGSTEN CARBIDE		87	Tag No:			
50	Seat Material:	N/A		88	AIRSET			
51	Cage / Guide Material:	N/A		89	Manuf. & Model No:	N/R		
52	Stem Material:	316 SS		90	Set Pressure:			
53								
54								
55	SPECIAL ACCESSORIES			91	Filter:	Gauge:		
56	NEC Class:	1, GP 'D', DIV 1		92	TESTS			
57								
58								
				94	Hydro Pressure:			
				95	ANSI / FCI Leakage Class:	IV		
				96				

NOTES:

1. All Instruments shall be identified with a hard stainless steel tag.



DIFFERENTIAL PRESSURE GAUGE SPECIFICATION

SHEET NO.	1	OF	1
SPEC. NO.	C600/LT		
JOB NO.	SLS338716		
REQ.	1	P.O	4512-109-130

CLIENT:	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
SHELL CANADA	0	For Approval	15-10-05	ET	ET	
LOCATION:	1	Revised as per customer request	15-10-27	ET	ET	
CARMON CREEK GAS PLANT						

1	Tag No.	PDI-08070A				
2	Service	SWEET NATURAL GAS				
3	Sour Service	NO				
4	Line / Vessel No.	S-08070				
5	P&ID No.	338716-100				
6	Line Size & Sch. & Spec:	-----	-----			
7	Design Press. / Temp.	10,205		38°C		

Operating Conditions

8	Fluid	State				Crit Temp Tc	°C
9	Amb. Temp. Min.	Max. (°C)	10	36	Atm Pres	101.3 kPaa	Crit Pres Pc
10			Units	Max	Norm	Min	Shut-Off
11	Pressure		kPag	8,500	2,600	1,200	Design Flow
12	Temperature		°C	40	5	-5	
13	Specific Gravity		Sp Gr	0.606	0.606	0.606	
14	Viscosity		cP	---	---	---	

Gauge

15	Type	PROCESS DIFFERENTIAL PRESSURE GAUGE				
16	Mounting	DIRECT				
17	Dial Size & Type	2 1/2" ROUND UNI-DIRECTIONAL DIAL C/W ENGINEERED PLASTIC DIAL CASE				
18	Seal Materials	VITON				
19	Case Material	ENGINEERED PLASTIC DIAL CASE				
20	Fill Fluid Material	SILICONE				
21	Ring Type	Ring Material	N/A			N/A
22	Blow Out Protection Location	N/A				
23	Lens Material	SHATTER RESISTANT ACRYLIC LENS				
24	Nominal Accuracy Required	2% + or -				
25	Element Type	Element Material	N/A			N/A
26	Body Material	316L SS c/w 316SS INTERNALS				
27	Connection Size and Type	1/4" FNPT				
28	Connection Location	BACK				
29	Adjustable Pointer	N/A				
30	Movement Material	N/A				
31	Movement Dampening	NONE				
32	Measurement Range (kPag)	0 - 345				

Options

33	Gauge Siphon	-----				
34	Gauge Siphon Material	-----				
35	Gauge Siphon Pressure/Temp. Rating	-----				
36	Gauge Siphon Manufacturer	-----				
37	Gauge Siphon Model Number	-----				
38	Gauge Snubber	-----				
39	Gauge Snubber Material	-----				
40	Gauge Snubber Pressure/Temp. Rating	-----				
41	Gauge Snubber Manufacturer	-----				
42	Gauge Snubber Model Number	-----				

Diaphragm Seal

43	Diaphragm Seal Type	-----				
44	Process Connection Size and Type	-----				
45	Diaphragm Material	-----				
46	Housing Material:	Top	Bottom	-----		
47	Fill Fluid Material	-----				
48	Design Pressure	Design Temperature	-----			-----
49	Connection to Gauge	-----				
50	Diaphragm Seal Manufacturer	-----				
51	Diaphragm Seal Model Number	-----				

Vendor

52	Vendor	UNIFIED VALVE				
53	Differential Pressure Gauge Manufacture	MID-WEST				
54	Differential Pressure Gauge Model No.	120-SA-10-00-50				
55	Canadian Registration Number	YES				

NOTES :



DIFFERENTIAL PRESSURE GAUGE SPECIFICATION

SHEET NO.	1	OF	1
SPEC. NO.	A150/LT		
JOB NO.	SLS338716		
REQ.	1	P.O	4512-109-130

CLIENT:	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
SHELL CANADA	0	For approval	15-10-05	ET	ET	
LOCATION:	1	Revised as per customer request	15-10-27	ET	ET	
CARMON CREEK						

1	Tag No.	PDI-08116A				
2	Service	SWEET NATURAL GAS				
3	Sour Service	NO				
4	Line / Vessel No.	2" FG-07990-80-A150LT-HC/ETR/CMT				
5	P&ID No.	338716-100				
6	Line Size & Sch. & Spec:	----	----			
7	Design Press. / Temp.	1965 kPag		38		

Operating Conditions

8	Fluid	State				Crit Temp Tc	°C
9	Amb. Temp. Min.	Max. (°C)	-43	27	Atm Pres	101.3 kPaa	Crit Pres Pc
10			Units	Max	Norm	Min	Shut-Off
11	Pressure		kPag	620	55	50	Design Flow
12	Temperature		°C	38	25	-10	
13	Specific Gravity		Sp Gr	0.65	0.65	---	
14	Viscosity		cP	---	---	---	

Gauge

15	Type	PROCESS DIFFERENTIAL PRESSURE GAUGE				
16	Mounting	DIRECT				
17	Dial Size & Type	2 1/2" ROUND UNI-DIRECTIONAL DIAL C/W ENGINEERED PLASTIC DIAL CASE				
18	Seal Materials	VITON				
19	Case Material	ENGINEERED PLASTIC DIAL CASE				
20	Fill Fluid Material	SILICONE				
21	Ring Type	Ring Material	N/A		N/A	
22	Blow Out Protection Location	N/A				
23	Lens Material	SHATTER RESISTANT ACRYLIC LENS				
24	Nominal Accuracy Required	2% +or -				
25	Element Type	Element Material	N/A		N/A	
26	Body Material	316L SS c/w 316SS internals				
27	Connection Size and Type	1/4" FNPT				
28	Connection Location	BACK				
29	Adjustable Pointer	N/A				
30	Movement Material	N/A				
31	Movement Dampening	NONE				
32	Measurement Range (kPag)	0 - 35				

Options

33	Gauge Siphon	----				
34	Gauge Siphon Material	----				
35	Gauge Siphon Pressure/Temp. Rating	----				
36	Gauge Siphon Manufacturer	----				
37	Gauge Siphon Model Number	----				
38	Gauge Snubber	----				
39	Gauge Snubber Material	----				
40	Gauge Snubber Pressure/Temp. Rating	----				
41	Gauge Snubber Manufacturer	----				
42	Gauge Snubber Model Number	----				

Diaphragm Seal

43	Diaphragm Seal Type	----				
44	Process Connection Size and Type	----				
45	Diaphragm Material	----				
46	Housing Material:	Top	Bottom	----		
47	Fill Fluid Material	----				
48	Design Pressure	Design Temperature	----			
49	Connection to Gauge	----				
50	Diaphragm Seal Manufacturer	----				
51	Diaphragm Seal Model Number	----				

Vendor

52	Vendor	UNIFIED VALVE				
53	Differential Pressure Gauge Manufacture	MID-WEST				
54	Differential Pressure Gauge Model No.	120-SA-10-00-05				
55	Canadian Registration Number	YES				

NOTES :



MAGNETIC LEVEL INDICATOR SPECIFICATION

SHEET NO.	1	OF	1
SPEC. NO.	C600/LT		
JOB NO.	SLS338716		
REQ.	1	P.O	4512-109-130

CLIENT: SHELL CANADA	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
	0	For Approval	5-Oct-15	ET	ET	
LOCATION: CARMON CREEK GAS PLANT	1	Revised as per customer request	27-Oct-15	ET	ET	

1	TAG NO.	LI-08070A
2	SERVICE	SWEET NATURAL GAS
3	SOUR SERVICE	
4	VESSEL NO.	S-08070
5	P&ID NO.	
6	ELECTRICAL AREA CLASSIFICATION	N/A
7	LINE SIZE & SCH & SPEC:	
8	DESIGN PRESS. / TEMP.	9930KPAG 38-c

Operating Conditions				
	Units	Min	Norm	Max
13	Pressure	kPag	1,200	2,600
14	Temperature	°C	-5	5
15	Specific Gravity (Minimum)	S.G.	0.61	0.61
16				
17				
18				
19				
20				

Magnetic Level Indicator				
24	Function	LEVEL INDICATOR		
25	Float Chamber	F061ABT IN A 2.5" S10 WITH A MINIMUM SG OF 0.61		
26	Mounting Style	STYLE C- CLOSED TOP; FLANGED BOTTOM WITH SIDE PROCESS CONNECTION		
27	Instrument Rating	600 ANSI B16.5		
28	Access Flange Type	RF WELD NECK		
29	Unit of Measure	METRIC (DEFAULT IN mm)		
30	Mounting Dimensions	355.6mm		
31	Chamber Material	316/316L (STANDARD)		
32	Side Conn Design	Side Conn Size	DRILL (1/2" HOLE) 3/4" 600#	
33	Side Conn Rating	Side Conn Type	600 ANSI B16.5 RF WELD NECK	
34	Connection Schedule	S40		
35	Connection Material	316/316L (STANDARD)		
36	Top Gauge	DOME CAP		
37	Top Size	Top Type	1/2" COUPLING-FNPT WITH PLUG	
38	Top Schedule	3000#		
39	Bottom Gauge	BLIND FLANGE		
40	Bottom Size	1/2"		
41	Bottom Type	SW TAPPED		
42	Bottom Schedule	DEFAULT		
43	Indicator	FLAG		
44	Measure Range	355.6mm		
45	Scale Unit	METRIC (5mm INCREMENTS)		
46	Enclosure Material	ANODIZED ALUMINUM HOUSING WITH GLASS		
47	Color	RED AND SILVER		
48	Indicator Mounting	STANDARD ORIENTATION (180° FROM PC'S)		
49	Max Pressure (Float)	15,858 kpag		
50	Max Temperature	100-F		
51				
Vendor				
52	Vendor / Manufacturer	SPARTAN CONTROLS/MAGTECH		
53	Model Number	L061CAC1M00355SD9AC14SD8F3B8CZF00355A0ZZ (SEE NOTE 2)		
54	Single or Dual Seal Certification	N/A		
55	CSA Approval	N/A		
56	Canadian Registration Number	CRN# OF1335.2		

NOTES :

- TAG NUMBER STAINLESS STEEL PLATE TO BE PROVIDED AND ATTACHED TO THE INSTRUMENT BY STAINLESS STEEL WIRE.
- FOR THE SELECTED FLOAT, THE FLOAT MAXIMUM OPERATING PRESSURE IS 15,858 kpag AND THE MAXIMUM PRESSURE FOR FLOAT CHAMBER IS 9931 kpag



MAGNETIC LEVEL INDICATOR SPECIFICATION

SHEET NO.	1	OF	1
SPEC. NO.	C600/LT		
JOB NO.	SLS338716		
REQ.	1	P.O	4512-109-130

CLIENT:	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
SHELL CANADA	0	For Approval	5-Oct-15	ET	ET	
LOCATION:	1	Revised as per customer request	27-Oct-15	ET	ET	
CARMON CREEK GAS PLANT						

1	TAG NO.	LI-08070B
2	SERVICE	SWEET NATURAL GAS
3	SOUR SERVICE	
4	VESSEL NO.	S-08070
5	P&ID NO.	
6	ELECTRICAL AREA CLASSIFICATION	N/A
7	LINE SIZE & SCH & SPEC:	
8	DESIGN PRESS. / TEMP.	9930KPAG 38-c

Operating Conditions				
	Units	Min	Norm	Max
13	Pressure	kPag	1,200	2,600
14	Temperature	°C	-5	5
15	Specific Gravity (Minimum)	S.G.	0.87	0.87
16				
17				
18				
19				
20				

Magnetic Level Indicator				
24	Function	LEVEL INDICATOR		
25	Float Chamber	F087ABT IN A 2.5" S10 WITH A MINIMUM SG OF 0.87		
26	Mounting Style	STYLE C- CLOSED TOP; FLANGED BOTTOM WITH SIDE PROCESS CONNECTION		
27	Instrument Rating	600 ANSI B16.5		
28	Access Flange Type	RF WELD NECK		
29	Unit of Measure	METRIC (DEFAULT IN mm)		
30	Mounting Dimensions	355.6mm		
31	Chamber Material	316/316L (STANDARD)		
32	Side Conn Design	Side Conn Size	DRILL (1/2" HOLE) 3/4" 600#	
33	Side Conn Rating	Side Conn Type	600 ANSI B16.5 RF WELD NECK	
34	Connection Schedule	S40		
35	Connection Material	316/316L (STANDARD)		
36	Top Gauge	DOME CAP		
37	Top Size	Top Type	1/2" COUPLING-FNPT WITH PLUG	
38	Top Schedule	3000#		
39	Bottom Gauge	BLIND FLANGE		
40	Bottom Size	1/2"		
41	Bottom Type	SW TAPPED		
42	Bottom Schedule	DEFAULT		
43	Indicator	FLAG		
44	Measure Range	355.6mm		
45	Scale Unit	METRIC (5mm INCREMENTS)		
46	Enclosure Material	ANODIZED ALUMINUM HOUSING WITH GLASS		
47	Color	RED AND SILVER		
48	Indicator Mounting	STANDARD ORIENTATION (180° FROM PC'S)		
49	Max Pressure (Float)	15,858 kpag		
50	Max Temperature	100-F		
51				
Vendor				
52	Vendor / Manufacturer	SPARTAN CONTROLS/MAGTECH		
53	Model Number	L087CAC1M00355SD9AC14SD8F3B8CZF00355A0ZZ (SEE NOTE 2)		
54	Single or Dual Seal Certification	N/A		
55	CSA Approval	N/A		
56	Canadian Registration Number	CRN# OF1335.2		

NOTES :

- 1 TAG NUMBER STAINLESS STEEL PLATE TO BE PROVIDED AND ATTACHED TO THE INSTRUMENT BY STAINLESS STEEL WIRE.
- 2 FOR THE SELECTED FLOAT, THE FLOAT MAXIMUM OPERATING PRESSURE IS 15,858 kpag AND THE MAXIMUM PRESSURE FOR FLOAT CHAMBER IS 9931 kpag



Level GAUGE SPECIFICATION

SHEET NO.	1	OF	1
SPEC. NO.	JPI-013		
JOB NO.	SLS338716		
REQ.	P.O 4512-109-130		

CLIENT: SHELL CANADA	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
	0	For Approval	Sep 15-15	ET	ET	
LOCATION: CARMON CREEK	1	Revised as per customer request	Oct 27-15	ET	ET	

1	Tag No.	LI-08069A				
2	Service	Condensate Tank Level Gauge				
3	Sour Service	NO				
4	Line / Vessel No.	V-08069				
5	P&ID No.	338716-100				
6	Line Size & Sch. & Spec:	2"	NPT			
7	Design Press. / Temp.	Atmospheric			-29 / 38°C	

Operating Conditions

8	Fluid	State	Natural Gas Mix			
9	Amb. Temp. Min.	Max. (°C)	10	35	Atm Pres	
10			Units	Max	Norm	Min
11	Pressure		kPaA	Atm Pres	Atm Pres	Atm Pres

Gauge

15	Type	Level Gauge				
16	Mounting	DIRECT				
17	Housing Material	2" NPT Aluminum bushing				
18	Rod Internal Material	Galvanized Steel Rods				
19	Site Tube Material	Plastic Cellulose acetate inner and outer calibration				
20	Float Material	High Density Polyethylene Plastic (HDPE)				
21	Max working Temp C	38				
22	Max Working Pressure	ATM				
32						

Vendor

33	Vendor	Steelcraft				
34	Level Gauge Manufacturer	Krueger				
35	Level Gauge Model No.	Direct Reading Gauge Type D				
36	Canadian Registration Number	N/A				

NOTES :

No available template were given, customized DS from existing Natpro templates



Level GAUGE SPECIFICATION

SHEET NO.	1	OF	1
SPEC. NO.	A150/LT		
JOB NO.	SLS338716		
REQ.	1	P.O	4512-109-130

CLIENT: SHELL CANADA	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
	0	For approval	June 3-15	ET	ET	
LOCATION: CARMON CREEK GAS PLANT	1	Revised as per customer request	Oct 27-15	ET	ET	

1	Tag No.	LI-08116A				
2	Service	MERCAPTAN ODORIZER LEVEL GAUGE				
3	Sour Service	NO				
4	Line / Vessel No.	V-08116A				
5	P&ID No.					
6	Line Size & Sch. & Spec:	1"	SCH 80			
7	Design Press. / Temp.	1965KPAG		-45 / 38°C		

Operating Conditions

8	Fluid	State	Natural Gas Mix			
9	Amb. Temp. Min.	Max. (°C)	-40	+35	Atm Pres	
10			Units	Max	Norm	Min
11	Pressure		kPaA	Atm Pres	Atm Pres	Atm Pres

Gauge

15	Type	Level Gauge				
16	Mounting	DIRECT				
17	Housing Material	1" NPT				
18	Rod Internal Material	N/A				
19	Site Tube Material	Tubular glass				
20	Float Material	N/A				
21	Max working Temp C	66°C				
22	Max Working Pressure	2068kpag				
32						

Vendor

33	Vendor	TANSLEY ASSOCIATES				
34	Level Gauge Manufacturer	KINGTOOL				
35	Level Gauge Model No.	Direct Reading Gauge Type D				
36	Canadian Registration Number	N/A				

NOTES :

No available template were given, customized DS from existing Natpro templates
 Mercaptan Odorizer level indicator scale is in lbs of odorant



PRESSURE SAFETY VALVE SPECIFICATION

SHEET NO.	1	OF	1
SPEC. NO.	C600/LT		
JOB NO.	338716		
REQ.	1	P.O	4512-109-130

CLIENT: SHELL CANADA	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
	0	For Approval	5-Oct-15	ET	ET	
	1	Revised as per customer request	27-Oct-15	ET	ET	
LOCATION: CARMON CREEK PROJECT						

1 Tag No.	P&ID No.	PSV-08070A		Natpro 338716-100
2 Vendor	Manufacturer	SPARTAN CONTROLS		FARRIS
3 Service	SWEET NATURAL GAS			
4 Sour Service	Cryogenic Service	NO		NO
5 Corrosive Service	NO			
6 Line No.	Vessel No.	2"FG-07985-80-C600/LT/CMT		S-08070
8 Size & Sch. & Spec:	In	Out	1" SCH 80	600#RF
9 Design Press. / Temp.	In	Out	10,205	38

Operating Conditions				
10 Amb. Temp. Min. (°C)	Max. (°C)	10		35
11 Atmospheric Pressure (kPaa)	101.33			
12 Fluid Type	Gas	GAS		
	Liquid			
	Vapor			
15 Required Capacity	Gas (Sm3/hour)			
	Liquid (Am3/hour)			
	Vapor (kg/hour)			
18 Vessel Exposed Surface Area (m2)	1.90			
19 Operating Pressure (kPag)	8500.00			
20 Back Pressure (kPag)	Constant	0.00		
	Variable	0.00		
	Built-Up	19.00		
	Total	19.00		
24 Norm/Op Temp (°C)	Relieving Temp (°C)	40		167.98
25 Molecular Wt.	Specific Gravity	17.58		0.60683
26 Viscosity (cP)	Density (kg/m3)			
27 Compressibility Factor (Z)	1			
28 Latent Heat of Vaporiz. (kJ/kg)				
29 Ratio of Specific Heats (Cp/Cv)	1.25			
30 Partial Pressure of H2S (MPa)	N/A			
31 Chloride Concentration (mg/L)	N/A			
32 PH	Mole Fraction - H2S	N/A		N/A

Basis of Selection				
33 Code	ASME SEC VIII			
34 Sizing Basis	FIRE CASE			
35 Set Pressure (kPag)	9,930			
36 Over Pressure %	Over Press. Factor	21.00		-----

Valve				
37 Model	26DA13-120/LC			
38 Conventional / Bellows / Pilot	CONVENTIONAL			
39 Pilot Control Type (Snap Acting or Modulating)	N/A			
40 Bonnet Type	BOLTED			
41 Nozzle Type (Full or Semi)	N/A			
42 Trim Type (Liquid or Vapor)	VAPOR			
43 Orifice Area	Calculated (ASME / API)	0.012513/0.011261		
44 (sq. in.)	Selected (ASME / API)	0.15/0.110		
45 Maximum Relieving Capacity	5,218 kg/hr			
46 Orifice Designation	D			
47 Connection (Size, Rating & Type)	Inlet	1" 600# R.F.		
	Outlet	2" 150# R.F.		
Materials				
50 Body and Bonnet	LCB (SA-352 GR. LCB)			
51 Nozzle	Seat and Disc	316 SS		316 SS
52 Resilient Seat Seal	Guide and Rings	N/A		316 SS
53 Spring	Bellows	CHROME ALLOY		N/A
54 Studs	Nuts	SA-193-B7		SA-194-2H

Options				
55 Cap: Screwed or Bolted	Screwed			
56 Lever: Plain or Packed	-----			
57 Test Gag	CRN	NO		YES, AB

NOTES :
 1. VENDOR TO PROVIDE STAINLESS STEEL TAG AFFIXED TO INSTRUMENT IDENTIFYING TAG NUMBER AND PURCHASE ORDER NUMBER.
 2. COMPLIES TO NACE MR0175-2002 IN PRIMARY ZONE
 3. NAME PLATE CAPACITY IS 106.8 M3/MIN



PRESSURE SAFETY VALVE SPECIFICATION

SHEET NO.	1	OF	1
SPEC. NO.	A150/LT		
JOB NO.	338716		
REQ.	1	P.O	4512-109-130

CLIENT:	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
SHELL CANADA	0	For approval	5-Oct-15	ET	ET	
	1	Revised as per customer request	27-Oct-15	ET	ET	
LOCATION: CARMON CREEK PROJECT						

1 Tag No.	P&ID No.	PSV-08071A		338716-100	
2 Vendor	Manufacturer	SPARTAN CONTROLS		FARRIS	
3 Service	SWEET NATURAL GAS				
4 Sour Service	Cryogenic Service	NO		NO	
5 Corrosive Service	NO				
6 Line No.	Vessel No.	2"FG-07987-80-D900/LT-HC/CMT		H-08071	
8 Size & Sch. & Spec:	In	Out	1 1/2" SCH 80	900#	2" SCH 80 300#RF
9 Design Press. / Temp.	In	Out	15,306	38	

Operating Conditions					
10 Amb. Temp. Min. (°C)	Max. (°C)	10		35	
11 Atmospheric Pressure (kPaa)	101.33				
12 Fluid Type	Gas	GAS			
13	Liquid				
14	Vapor				
15 Required Capacity	Gas (Sm3/day)	1,540			
16	Liquid (Am3/hour)				
17	Vapor (kg/hour)				
18 Vessel Exposed Surface Area (m2)	N/A				
19 Operating Pressure (kPag)	8500.00				
20 Back Pressure (kPag)	Constant	0.00			
21	Variable	0.00			
22	Built-Up	19.00			
23	Total	19.00			
24 Norm/Op Temp (°C)	Relieving Temp (°C)	61		80	
25 Molecular Wt.	Specific Gravity	17.58		0.60683	
26 Viscosity (cP)	Density (kg/m3)				
27 Compressibility Factor (Z)	1				
28 Latent Heat of Vaporiz. (kJ/kg)					
29 Ratio of Specific Heats (Cp/Cv)	1.25				
30 Partial Pressure of H2S (MPa)	N/A				
31 Chloride Concentration (mg/L)	N/A				
32 PH	Mole Fraction - H2S	N/A		N/A	

Basis of Selection					
33 Code	ASME SEC VIII				
34 Sizing Basis	BLOCKED FLOW				
35 Set Pressure (kPag)	9,600				
36 Over Pressure %	Over Press. Factor	10.00		----	

Valve					
37 Model	26DA14-120/LC				
38 Conventional / Bellows / Pilot	CONVENTIONAL				
39 Pilot Control Type (Snap Acting or Modulating)	N/A				
40 Bonnet Type	BOLTED				
41 Nozzle Type (Full or Semi)	N/A				
42 Trim Type (Liquid or Vapor)	VAPOR				
43 Orifice Area	Calculated (ASME / API)	0.001392/0.001253			
44 (sq. in.)	Selected (ASME / API)	0.150/0.110			
45 Maximum Relieving Capacity	165,974 Sm3/day				
46 Orifice Designation	D				
47 Connection (Size, Rating & Type)	Inlet	1 1/2" 900# R.F.			
48	Outlet	2" 300# R.F.			
49 Materials					
50 Body and Bonnet	LCB (SA-352 GR. LCB)				
51 Nozzle	Seat and Disc	316 SS		316 SS	
52 Resilient Seat Seal	Guide and Rings	N/A		316 SS	
53 Spring	Bellows	CHROME ALLOY		N/A	
54 Studs	Nuts	SA-193-B7		SA-194-2H	

Options					
55 Cap: Screwed or Bolted	Screwed				
56 Lever: Plain or Packed	----				
57 Test Gag	CRN	NO		YES, AB	

NOTES :

- VENDOR TO PROVIDE STAINLESS STEEL TAG AFFIXED TO INSTRUMENT IDENTIFYING TAG NUMBER AND PURCHASE ORDER NUMBER.
- COMPLIES TO NACE MR0175-2002 IN PRIMARY ZONE
- NAME PLATE CAPACITY AT 10% OVER PRESSURE IS 103.2 M3/MIN



PRESSURE SAFETY VALVE SPECIFICATION

SHEET NO.	1	OF	1
SPEC. NO.	A150/LT		
JOB NO.	338716		
REQ.	1	P.O	4512-109-130

CLIENT: SHELL CANADA	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
	0	For approval	5-Oct-15	ET	ET	
LOCATION: CARMON CREEK PROJECT	1	Revised as per customer request	27-Oct-15	ET	ET	

1 Tag No.	P&ID No.	PSV-08071B		338716-100	
2 Vendor	Manufacturer	SPARTAN CONTROLS		FARRIS	
3 Service	SWEET NATURAL GAS				
4 Sour Service	Cryogenic Service	NO		NO	
5 Corrosive Service	NO				
6 Line No.	Vessel No.	2"FG-07988-80-B300/LT-HC/CMT		N/A	
8 Size & Sch. & Spec:	In	Out	1" SCH 80	300#	2" SCH 80 150#RF
9 Design Press. / Temp.	In	Out	5102 kpag		38

Operating Conditions

10 Amb. Temp. Min. (°C)	Max. (°C)	10		35	
11 Atmospheric Pressure (kPaa)	101.33				
12 Fluid Type	Gas	GAS			
13	Liquid				
14	Vapor				
15 Required Capacity	Gas (Sm3/min)	35.719			
16	Liquid (Am3/hour)				
17	Vapor (kg/hour)				
18 Vessel Exposed Surface Area (m2)	N/A				
19 Operating Pressure (kPag)	3448.00				
20 Back Pressure (kPag)	Constant	0.00			
21	Variable	0.00			
22	Built-Up	44.00			
23	Total	44.00			
24 Norm/Op Temp (°C)	Relieving Temp (°C)	42		60	
25 Molecular Wt.	Specific Gravity	17.58		0.60683	
26 Viscosity (cP)	Density (kg/m3)				
27 Compressibility Factor (Z)	1				
28 Latent Heat of Vaporiz. (kJ/kg)					
29 Ratio of Specific Heats (Cp/Cv)	1.25				
30 Partial Pressure of H2S (MPa)	N/A				
31 Chloride Concentration (mg/L)	N/A				
32 PH	Mole Fraction - H2S	N/A		N/A	

Basis of Selection

33 Code	ASME SEC VIII				
34 Sizing Basis	VALVE FAILURE				
35 Set Pressure (kPag)	4,137				
36 Over Pressure %	Over Press. Factor	10.00		-----	

Valve

37 Model	26DA12-120/LC				
38 Conventional / Bellows / Pilot	CONVENTIONAL				
39 Pilot Control Type (Snap Acting or Modulating)	N/A				
40 Bonnet Type	BOLTED				
41 Nozzle Type (Full or Semi)	N/A				
42 Trim Type (Liquid or Vapor)	VAPOR				
43 Orifice Area	Calculated (ASME / API)	0.10347/0.093126			
44 (sq. in.)	Selected (ASME / API)	0.150/0.110			
45 Maximum Relieving Capacity	74565 Sm3/day				
46 Orifice Designation	D				
47 Connection (Size, Rating & Type)	Inlet	1" 300# RF			
	Outlet	2" 150# RF			
49 Materials					
50 Body and Bonnet	LCB (SA-352 GR. LCB)				
51 Nozzle	Seat and Disc	316 SS		316 SS	
52 Resilient Seat Seal	Guide and Rings	N/A			
53 Spring	Bellows	CHROME ALLOY			N/A
54 Studs	Nuts	SA-193-B7			SA-194-2H

Options

55 Cap: Screwed or Bolted	Screwed				
56 Lever: Plain or Packed	-----				
57 Test Gag	CRN	NO		YES, AB	

NOTES :

1. VENDOR TO PROVIDE STAINLESS STEEL TAG AFFIXED TO INSTRUMENT IDENTIFYING TAG NUMBER AND PURCHASE ORDER NUMBER.
2. COMPLIES TO NACE MR0175-2002 IN PRIMARY ZONE
3. NAME PLATE CAPACITY AT 10% OVER PRESSURE IS 45 M3/MIN



PRESSURE SAFETY VALVE SPECIFICATION

SHEET NO.	1	OF	1
SPEC. NO.	A150/LT		
JOB NO.	338716		
REQ.	1	P.O	4512-109-130

CLIENT:	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
SHELL CANADA	0	FOR APPROVAL	5-Oct-15	ET	ET	
	1	Revised as per customer request	27-Oct-15	ET	ET	
LOCATION: CARMON CREEK PROJECT						

1 Tag No.	P&ID No.	PSV-08071C		338716-100
2 Vendor	Manufacturer	SPARTAN CONTROLS		FARRIS
3 Service	SWEET NATURAL GAS			
4 Sour Service	Cryogenic Service	NO		NO
5 Corrosive Service	NO			
6 Line No.	Vessel No.	2"FG-07989-80-A150/LT-HC/CMP		N/A
8 Size & Sch. & Spec:	In	Out	1" SCH 80	150#
9 Design Press. / Temp.	In	Out	1965 kpag	38

Operating Conditions				
10 Amb. Temp. Min. (°C)	Max. (°C)	10		35
11 Atmospheric Pressure (kPaa)	101.33			
12 Fluid Type	Gas	GAS		
13	Liquid			
14	Vapor			
15 Required Capacity	Gas (Sm3/day)	5,949		
16	Liquid (Am3/hour)			
17	Vapor (kg/hour)			
18 Vessel Exposed Surface Area (m2)	N/A			
19 Operating Pressure (kPag)	1034.00			
20 Back Pressure (kPag)	Constant	0.00		
21	Variable	0.00		
22	Built-Up	35.00		
23	Total	35.00		
24 Norm/Op Temp (°C)	Relieving Temp (°C)	39.2		58
25 Molecular Wt.	Specific Gravity	17.58		0.60683
26 Viscosity (cP)	Density (kg/m3)			
27 Compressibility Factor (Z)	1			
28 Latent Heat of Vaporiz. (kJ/kg)				
29 Ratio of Specific Heats (Cp/Cv)	1.25			
30 Partial Pressure of H2S (MPa)	N/A			
31 Chloride Concentration (mg/L)	N/A			
32 PH	Mole Fraction - H2S	N/A		N/A

Basis of Selection				
33 Code	ASME SEC VIII			
34 Sizing Basis	VALVE FAILURE			
35 Set Pressure (kPag)	1,240			
36 Over Pressure %	Over Press. Factor	10.00		-----

Valve				
37 Model	26DA10-120/LC			
38 Conventional / Bellows / Pilot	CONVENTIONAL			
39 Pilot Control Type (Snap Acting or Modulating)	N/A			
40 Bonnet Type	BOLTED			
41 Nozzle Type (Full or Semi)	N/A			
42 Trim Type (Liquid or Vapor)	VAPOR			
43 Orifice Area	Calculated (ASME / API)	0.037879/0.034091		
44 (sq. in.)	Selected (ASME / API)	0.150/0.110		
45 Maximum Relieving Capacity	23,558 Sm3/day			
46 Orifice Designation	D			
47 Connection (Size, Rating & Type)	Inlet	1" 150# RF		
48	Outlet	2" 150# RF		
49 Materials				
50 Body and Bonnet	LCB (SA-352 GR. LCB)			
51 Nozzle	Seat and Disc	316 SS		316 SS
52 Resilient Seat Seal	Guide and Rings	N/A		316 SS
53 Spring	Bellows	CHROME ALLOY		N/A
54 Studs	Nuts	SA-193-B7		SA-194-2H

Options				
55 Cap: Screwed or Bolted	Screwed			
56 Lever: Plain or Packed	-----			
57 Test Gag	CRN	NO		YES, AB

NOTES :

- VENDOR TO PROVIDE STAINLESS STEEL TAG AFFIXED TO INSTRUMENT IDENTIFYING TAG NUMBER AND PURCHASE ORDER NUMBER.
- COMPLIES TO NACE MR0175-2002 IN PRIMARY ZONE
- NAME PLATE CAPACITY AT 10% OVER PRESSURE IS 14.2 M3/MIN



PRESSURE SAFETY VALVE SPECIFICATION

SHEET NO.	1	OF	1
SPEC. NO.	A150/LT		
JOB NO.	338716		
REQ.	1	P.O	4512-109-130

CLIENT:	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
SHELL CANADA	0	For Approval	10/05/15	ET	ET	
	1	Revised as per customer request	10/27/15	ET	ET	
LOCATION: CARMON CREEK PROJECT						

1 Tag No.	P&ID No.	PSV-08071D		338716-100
2 Vendor	Manufacturer	SPARTAN CONTROLS		FARRIS
3 Service	SWEET NATURAL GAS			
4 Sour Service	Cryogenic Service	NO		NO
5 Corrosive Service	NO			
6 Line No.	Vessel No.	2"FG-07990-80-A150/LT-HC/ETR/CMT		N/A
8 Size & Sch. & Spec:	In	Out	1" SCH 80	150#
9 Design Press. / Temp.	In	Out	1965 kpag	38

Operating Conditions				
10 Amb. Temp. Min. (°C)	Max. (°C)	10		35
11 Atmospheric Pressure (kPaa)	101.33			
12 Fluid Type	Gas	GAS		
13	Liquid			
14	Vapor			
15 Required Capacity	Gas (Sm3/day)	4,341		
16	Liquid (Am3/hour)			
17	Vapor (kg/hour)			
18 Vessel Exposed Surface Area (m2)	N/A			
19 Operating Pressure (kPag)	55.00			
20 Back Pressure (kPag)	Constant	0.00		
21	Variable	0.00		
22	Built-Up	19.00		
23	Total	19.00		
24 Norm/Op Temp (°C)	Relieving Temp (°C)	34.4		53
25 Molecular Wt.	Specific Gravity	17.58		0.6068
26 Viscosity (cP)	Density (kg/m3)			
27 Compressibility Factor (Z)	1			
28 Latent Heat of Vaporiz. (kJ/kg)				
29 Ratio of Specific Heats (Cp/Cv)	1.25			
30 Partial Pressure of H2S (MPa)	N/A			
31 Chloride Concentration (mg/L)	N/A			
32 PH	Mole Fraction - H2S	N/A		N/A

Basis of Selection				
33 Code	ASME SEC VIII			
34 Sizing Basis	VALVE FAILURE			
35 Set Pressure (kPag)	620			
36 Over Pressure %	Over Press. Factor	10.00		----

Valve				
37 Model	26DA10-120/LC			
38 Conventional / Bellows / Pilot	CONVENTIONAL			
39 Pilot Control Type (Snap Acting or Modulating)	N/A			
40 Bonnet Type	BOLTED			
41 Nozzle Type (Full or Semi)	N/A			
42 Trim Type (Liquid or Vapor)	VAPOR			
43 Orifice Area	Calculated (ASME / API)	0.051314/0.046182		
44 (sq. in.)	Selected (ASME / API)	0.150/0.110		
45 Maximum Relieving Capacity	12,690 Sm3/day			
46 Orifice Designation	D			
47 Connection (Size, Rating & Type)	Inlet	1" 150# RF		
48	Outlet	2" 150# RF		
49 Materials				
50 Body and Bonnet	LCB (SA-352 GR. LCB)			
51 Nozzle	Seat and Disc	316 SS		316 SS
52 Resilient Seat Seal	Guide and Rings	N/A		316 SS
53 Spring	Bellows	CHROME ALLOY		N/A
54 Studs	Nuts	SA-193-B7		SA-194-2H

Options				
55 Cap: Screwed or Bolted	Screwed			
56 Lever: Plain or Packed	----			
57 Test Gag	CRN	NO		YES, AB

NOTES :

- VENDOR TO PROVIDE STAINLESS STEEL TAG AFFIXED TO INSTRUMENT IDENTIFYING TAG NUMBER AND PURCHASE ORDER NUMBER.
- COMPLIES TO NACE MR0175-2002 IN PRIMARY ZONE
- NAME PLATE CAPACITY AT 10% OVER PRESSURE IS 7.5 M3/MIN



PRESSURE SAFETY VALVE SPECIFICATION

SHEET NO.	1	OF	1
SPEC. NO.	A150/LT		
JOB NO.	338716		
REQ.	1	P.O	4512-109-130

CLIENT:	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
SHELL CANADA	0	For Approval	5-Oct-15	ET	ET	
	1	Revised as per customer request	27-Oct-15	ET	ET	
LOCATION: CARMON CREEK PROJECT						

1 Tag No.	P&ID No.	PSV-08116A		338716-100	
2 Vendor	Manufacturer	SPARTAN CONTROLS		FARRIS	
3 Service		SWEET NATURAL GAS + MERCAPTAN			
4 Sour Service	Cryogenic Service	NO	NO		
5 Corrosive Service		NO			
6 Line No.	Vessel No.			V-08116	
8 Size & Sch. & Spec:		In	Out	1" SCH 80	150#RF
9 Design Press. / Temp.		In	Out	1965kpag	38

Operating Conditions					
10	Amb. Temp. Min. (°C)	Max. (°C)	-43		27
11	Atmospheric Pressure (kPaa)		101.33		
12	Fluid Type	Gas	GAS		
13	Fluid Type	Liquid			
14		Vapor			
15		Gas (kg/hr)	269.52		
16	Required Capacity	Liquid (Am3/hour)			
17		Vapor (kg/hour)			
18		Vessel Exposed Surface Area (m2)	0.864		
19	Operating Pressure (kPag)		55.00		
20	Back Pressure (kPag)	Constant	0.00		
21		Variable	0.00		
22		Built-Up	19.00		
23		Total	19.00		
24	Norm/Op Temp (°C)	Relieving Temp (°C)	34.4		176.67
25	Molecular Wt.	Specific Gravity	48.1		1.6603
26	Viscosity (cP)	Density (kg/m3)			
27	Compressibility Factor (Z)		1		
28	Latent Heat of Vaporiz. (kJ/kg)				
29	Ratio of Specific Heats (Cp/Cv)		1.1988		
30	Partial Pressure of H2S (MPa)		N/A		
31	Chloride Concentration (mg/L)		N/A		
32	PH	Mole Fraction - H2S	N/A		N/A

Basis of Selection					
33	Code	ASME SEC VIII			
34	Sizing Basis	FIRE CASE			
35	Set Pressure (kPag)	1,827			
36	Over Pressure %	Over Press. Factor	21.00	-----	

Valve					
37	Model	26DA10-120/LC			
38	Conventional / Bellows / Pilot	CONVENTIONAL			
39	Pilot Control Type (Snap Acting or Modulating)	N/A			
40	Bonnet Type	BOLTED			
41	Nozzle Type (Full or Semi)	N/A			
42	Trim Type (Liquid or Vapor)	VAPOR			
43	Orifice Area	Calculated (ASME / API)	0.025161/0.022645		
44	(sq. in.)	Selected (ASME / API)	0.15/0.11		
45	Maximum Relieving Capacity		1606.8 kg/hr		
46	Orifice Designation		D		
47	Connection (Size, Rating & Type)	Inlet	1" 150# R.F.		
48		Outlet	2" 150# R.F.		
49	Materials				
50	Body and Bonnet	LCB (SA-352 GR. LCB)			
51	Nozzle	Seat and Disc	316 SS		316 SS
52	Resilient Seat Seal	Guide and Rings	N/A		316 SS
53	Spring	Bellows	CHROME ALLOY		N/A
54	Studs	Nuts	SA-193-B7		SA-194-2H

Options					
55	Cap: Screwed or Bolted	Screwed			
56	Lever: Plain or Packed	-----			
57	Test Gag	CRN	NO	YES, AB	

NOTES :

- VENDOR TO PROVIDE STAINLESS STEEL TAG AFFIXED TO INSTRUMENT IDENTIFYING TAG NUMBER AND PURCHASE ORDER NUMBER.
- COMPLIES TO NACE MR0175-2002 IN PRIMARY ZONE
- NAME PLATE CAPACITY AT 10% OVER PRESSURE IS 722 SCFM



REGULATORS SPECIFICATION

SHEET NO.	1	OF	1
SPEC. NO.	C600/LT		
JOB NO.	SLS338716		
REQ.	1	P.O	4512-109-130

CLIENT:	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
SHELL CANADA	0	For Approval	27-Oct-15	ET	ET	
LOCATION:						
CARMON CREEK GAS PLANT						

1 Tag No.	P&ID No.	PCV-08071A	338716-100
2 Vendor	Manufacturer	Spartan Controls	Fisher
3 Service	Sour Service	Sweet Natural Gas	
4 Line / Vessel No.	Line Insulation	2" FG-07987-80-D900/LT-HC/CMT	1H
5 Line Size & Sch. & Spec:	In	Out	2" SCH 80

Operating Conditions

6 Fluid	Sizing Basis					Crit Temp Tc	°C
7 Amb. Temp. Min.	Max. °C	10	35	Atm Pres	101.3	kPaa	Crit Pres Pc
8 Flow Rate (Volumetric flow)	Units	Min	Normal	Max	Shut-Off	Design Flow	
9 Inlet Pressure	kPag	150	1,540	1,540	---	---	
10 Outlet Pressure	kPag	1,200	2,600	8,500	---	---	
11 Inlet Temperature	°C	3,348	3,348	3,348	---	---	
12 Spec Wt / Spec Grav / Mol Wt	Mol Wt	30.9	37.8	61	---	---	
13 Visc. (cP) / Spec Heats Ratio k (Cp/Cv)	cP / -	17.58	17.58	17.58	---	---	
14 Vapor Pressure Pv / Density / Compr. Z	kg / m3 / -	1	1	1	---	---	
15 Required Coefficient	Cv	---	---	---	---	---	
16 Travel	% Open	---	---	---	---	---	
17 Allowable / Predicted SPL	dBA	---	---	---	---	---	
18 Max Press & Temp	Flow @ 100% Open	kPag / °C	---	---	---	---	

Valve Body

Actuator

20 Type	ANSI Class	1	600# RF	55 Type	Diaphragm	Pressure Reducing
21 Size	Max Pres (kPag)	10,205	38	56 Materials	Spring Case	Neoprene (CR)
22 Manufacturer	Model	Fisher	627H	57 Diaphragm Case	Spring	Steel
23 Body	Bolting	WCC	N/A	58 Spring	Spring Range	Plated Steel
24 Materials	Flange	WCC		59 Set Point	Spring #	240-500 psig
25 O-Ring	Nitrite (NBR)			60 Spring #	Color	485.5693 psig (3348 kpag)
26 End Conn Inlet	Outlet	1"	1	61 Color		10B3076X012
27 Flange Face Finish	Manufacturer's Standard			62		Yellow
28				63		
29				64		
30				65		
31				66		
32				67		
33				68		
34				69		

Trim

Positioner

35 Orifice Size	Disk	3/16" (4.76mm)	Nylon (PA)	70 Type	Incr Signal Output	Incr/Decr
36 Materials	Seat	Stainless Steel	Stainless Steel	71 Manufacturer	Gauges	Bypass
37 Rated Cv	Stem	Stainless Steel	Stainless Steel	72 Cam Characteristic	Split Range	
38 Wide Open Cg		0.93	29	73		
39				74		
40				75		

Purchase

45 Manufacturer	Model	Fisher	627H	76 Type	Tag No	-----
46				77 Mfr	Model	-----
47				78 Quantity		-----
48				79 Contacts / Rating		-----
49				80 Actuation Points		-----

Air Set

50	Mfr	Model	81 Mfr	Model	82 Set Pressure (kpag)	83 Filter	Gauge
51			81				
52			82				
53			83				

Tests

54	84 Hydro Pressure (kPag)	85 ANSI / FCI Leakage Class	86 Hydro Test / Function Test	87 Canadian Registration Number

NOTES :



REGULATORS SPECIFICATION

SHEET NO.	1	OF	1
SPEC. NO.	B300/LT		
JOB NO.	SLS338716		
REQ.	1	P.O	4512-109-130

CLIENT:	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
SHELL CANADA	0	For Approval	27-Oct-15	ET	ET	
LOCATION:						
CARMON CREEK GAS PLANT						

1 Tag No.	P&ID No.	PCV-08071B	338716-100
2 Vendor	Manufacturer	Spartan Controls	Fisher
3 Service	Sour Service	Sweet Natural Gas	
4 Line / Vessel No.	Line Insulation	2" FG-07988-80-B300/LT-HC/CMT	1H
5 Line Size & Sch. & Spec:	In	Out	2" SCH 80

Operating Conditions

6 Fluid	Sizing Basis				Crit Temp Tc	°C
7 Amb. Temp. Min.	Max. °C	10	35	Atm Pres	101.3 kPaa	Crit Pres Pc
8 Flow Rate (Volumetric flow)	Units	Min	Normal	Max	Shut-Off	Design Flow
9 Inlet Pressure	kPag	150	1,540	1,540		
10 Outlet Pressure	kPag	1,200	3,348	4,137	---	
11 Inlet Temperature	°C	1,034	1,034	1,034	---	
12 Spec Wt / Spec Grav / Mol Wt	Mol Wt	30.9	37.8	61	---	
13 Visc. (cP) / Spec Heats Ratio k (Cp/Cv)	cP / -	17.58	17.58	17.58	---	
14 Vapor Pressure Pv / Density / Compr. Z	kg / m3 / -	1	1	1	---	
15 Required Coefficient	Cv				---	
16 Travel	% Open				---	
17 Allowable / Predicted SPL	dBA				---	
18 Max Press & Temp	Flow @ 100% Open	kPag / °C				

Valve Body

Actuator

20 Type	ANSI Class	Direct Operated	300# RF	55 Type	Pressure Reducing
21 Size	1"			56	Nitrile (NBR)
22 Max Pres (kPag)	Max Temp (°C)	5,102	38	57 Materials	Spring Case
23 Manufacturer	Model	Fisher	627	58	Diaphragm Case
24	Body	WCC		59	Spring
25 Materials	Bolting	N/A		60	Spring Range
26	Flange	WCC		61	Set Point
27	O-Ring	Nitrile (NBR)		62	Spring #
28 End Conn Inlet	Outlet	1"	1	63	Color
29 Flange Face Finish		Manufacturer's Standard		64	
30				65	
31				66	
32				67	
33				68	
34				69	

Trim

Positioner

35	Orifice Size	1/8" (3mm)	70 Type	71 Manufacturer	Model
36			72	Incr Signal Output	Incr/Decr
37	Materials	Disk	Nylon (PA)	73 Gauges	Bypass
38		Seat	Stainless Steel	74	Cam Characteristic
39		Stem	Stainless Steel	75	Split Range
40	Rated Cv		0.43		
41	Wide Open Cg		12.5		

Purchase

45 Manufacturer	Model	Fisher	627	79	Contacts / Rating
46				80	Actuation Points
47					
48				81	Mfr
49				82	Set Pressure (kpag)
50				83	Filter
51					Gauge
52					
53					
54					

NOTES :



REGULATORS SPECIFICATION

SHEET NO.	1	OF	1
SPEC. NO.	A150/LT		
JOB NO.	SLS338716		
REQ.	1	P.O	4512-109-130

CLIENT:	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
SHELL CANADA	0	For Approval	27-Oct-15	ET	ET	
LOCATION:						
CARMON CREEK GAS PLANT						

1 Tag No.	P&ID No.	PCV-08071C	338716-100
2 Vendor	Manufacturer	Spartan Controls	Fisher
3 Service	Sour Service	Sweet Natural Gas	
4 Line / Vessel No.	Line Insulation	2" FG-07989-80-A150/LT-HC/CMT	1H
5 Line Size & Sch. & Spec:	In	Out	2" SCH 80

Operating Conditions

6 Fluid	Sizing Basis				Crit Temp Tc	°C
7 Amb. Temp. Min.	Max. °C	10	35	Atm Pres	101.3 kPaa	Crit Pres Pc
8 Flow Rate	Units	Min	Normal	Max	Shut-Off	Design Flow
9 Inlet Pressure	Sm3/day	150	1,540	1,540		
10 Outlet Pressure	kPag	1,034	1,034	1,240	---	
11 Inlet Temperature	°C	55	55	55	---	
12 Spec Wt / Spec Grav / Mol Wt	Mol Wt	30.9	37.8	61	---	
13 Visc. (cP) / Spec Heats Ratio k (Cp/Cv)	cP / -	17.58	17.58	17.58	---	
14 Vapor Pressure Pv / Density / Compr. Z	kg / m3 / -	1	1	1	---	
15 Required Coefficient	Cv				---	
16 Travel	% Open				---	
17 Allowable / Predicted SPL	dBA				---	
18 Max Press & Temp	Flow @ 100% Open	kPag / °C				

Valve Body

Actuator

20 Type	ANSI Class	Direct Operated	1"	150# RF	55 Type	Pressure Reducing
21 Size	Max Pres (kPag)	Max Temp (°C)	1,965	38	56 Materials	Nitrile (NBR)
22 Manufacturer	Model	Fisher	627	57 Diaphragm	Spring Case	Steel
23 Materials	Body	WCC		58 Diaphragm Case	Spring	Plated Steel
24 Bolting	N/A			59 Spring Range		5-20 psig
25 Flange	WCC			60 Set Point		7.9768 psig (55 kpag)
26 O-Ring	Nitrile (NBR)			61 Spring #		10B3076X012
27 End Conn Inlet	Outlet	1"	1	62 Color		Yellow
28 Flange Face Finish	Manufacturer's Standard			63		
29				64		
30				65		
31				66		
32				67		
33				68		
34				69		

Trim

Positioner

35 Orifice Size	Disk	3/16" (4.76mm)	Nylon (PA)	70 Type	Manufacturer	Model
36 Materials	Seat	Stainless Steel		71	Incr Signal Output	Incr/Decr
37 Rated Cv	Stem	Stainless Steel		72 Gauges	Bypass	
38 Wide Open Cg		0.93		73 Cam Characteristic		
39		29		74 Split Range		

Purchase

45 Manufacturer	Model	Fisher	627	75 Switches	Type	Tag No
46				76	Mfr	Model
47				77	Quantity	
48				78	Contacts / Rating	
49				79	Actuation Points	
50				80		
51				81	Air Set	
52				82	Mfr	Model
53				83	Set Pressure (kpag)	
54				84	Filter	Gauge

Tests

51	84	Hydro Pressure (kPag)	
52	85	ANSI / FCI Leakage Class	
53	86	Hydro Test / Function Test	
54	87	Canadian Registration Number	

NOTES :



TEMPERATURE TRANSMITTER SPECIFICATION

SHEET NO. 1 OF 1
 SPEC. NO.
 JOB NO. 338716
 REQ. 1 P.O 4512-109-130

CLIENT:	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
SHELL CANADA	0	For Approval	15-Oct-15	ET	ET	
LOCATION:	1	Revised as per customer request	27-Oct-15	ET	ET	
CARMON CREEK GAS PLANT						

1	Tag No.	P&ID No.	TZT 08071A	338716-100
2	Service	Sour Service	SWEET NATURAL GAS	
3	Line / Vessel No.	2" FG-07987-80-D900/LT-HC/CMT		
4	Electrical Area Classification	CLASS 1 DIV 1		
5	Line Size & Sch. & Spec:	2" SCH 80	1500#	
6	Design Press. / Temp.	15,307 kPag	38C	

Operating Conditions

7	Fluid	NATURAL GAS				Crit Temp Tc	°C
8	Amb. Temp. Min.	Max. (°C)	10	35	Atm Pres	101.3 kPaa	Crit Pres Pc
9			Units	Max	Norm	Min	Shut-Off
10	Flow Rate		m3/day	1,540	1,540	150	Design Flow
11	Pressure		kPag	9,600	2,600	1,200	-
12	Temperature		°C	72.6	61	31	-
13	Mol. Weight			17.58	17.58	17.58	-
14	Density		kg/M3	0.742	0.742	0.742	-
15	Specific Gravity		S.G	0.606	0.606	0.606	-
16	Viscosity		cP	0.0100	0.0100	0.0100	-
17	Supercomp. Factor			-	-	-	-
18	Spec Heats Ratio k (Cp/Cv)			-	-	-	-

Transmitter

19	Indicator Scale (LCD)	Output Signal Range	REQUIRED	4-20 mA + HART
20	Accuracy	±0.02% of span (Applies to HART/4-20 mA devices)		
21	Calibrated Range	Adjustable Range	-50 TO 100°C	-200 TO 850°C
22	Power Supply	Failure Output	10.5 - 42.4 VDC	---
23	Ambient Temperature Limit	-40 TO 85°C		
24	Housing Material	Conduit Connection	ALUMINUM	1/2" NPT
25	Enclosure Material	Rating	---	---
26	Area Classification	CSA IS, FISCO Division 2 and Explosion-proof combo (includes standard IS, FISCO for fieldbus units)		
27	Mounting	---		

RTD

28	Type (Ice Point Resistance)	100 OHMS		
29	Coefficient	Construction	0.00385 OHM / OHM / °C	SINGLE 4-WIRE RTD
30	Temperature Range	-50 TO 400°C		
31	Sensor Diameter	6.35 mm (1/4")		
32	Sheath Material	316 SST		
33	Stem Length - "X"	203mm		
34	Assembly Type	SPRING LOADED FITTING, NIPPLE UNION		
35	Assembly Length - "A"	289mm		
36	Assembly Material	SST		
37	Enclosure Head Material			
38	Terminal Block Material	INTEGRAL WITH TRANSMITTER		
39	Conduit Connection Size			
40	Electrical Area Classification	CSA IS, FISCO Division 2 and Explosion-proof combo (includes standard IS, FISCO for fieldbus units)		

Thermowell

41	Tag No.	TW-08071A		
42	Process Connection	Size	Rating	1 1/2" 1500#
43	Thermowell Style	Thermowell Material	Tapered	316 SST
44	Element Connection	12mm		
45	Overall Length - "U" + "H"	mm	190	
46	Head Length - "H"	mm	38	
47	Insertion Length - "U"	mm	152	
48	Shielded Length	mm	124	
49	Bore Size	mm	7	
50	Lag Extension - "T"	mm	57	
51	Root Diameter - "Q"	mm	27	
52	Tip Diameter - "B"	mm	19	
53	Tip Thickness - "t"	mm	6	

Vendor

54	Vendor	Manufacturer	NATPRO	ROSEMOUNT
55	Transmitter Model No.	3144PD1A1K6M5Q4		
56	RTD Model No.	0068N21C30N060E6 (SEE NOTE 5)		
57	Thermowell Model No.	CUSTOM MADE FROM MAC-WELD (REFER TO WAKE FREQUENCY ANALYSIS SHEET FOR DETAILS)		
58	CSA Approval	CRN	REQUIRED	REQUIRED FOR AB

NOTES :

- VENDOR TO PROVIDE STAINLESS STEEL TAG AFFIXED TO INSTRUMENT IDENTIFYING TAG NUMBER AND PURCHASE ORDER NUMBER.
- ALL THERMOWELLS WILL HAVE HYDROSTATIC TESTING & FULL PENETRATION WELDS.
- THERMOWELLS TO HAVE TAG NUMBER AND AB CRN STAMPED ON BODY.
- TRANSMITTERS TO BE FACTORY CALIBRATED.
- ORIGINAL EXTENSION LENGTH E = 3.0 INCHES WAS MODIFIED TO 3.385"

WAKE FREQUENCY ANALYSIS

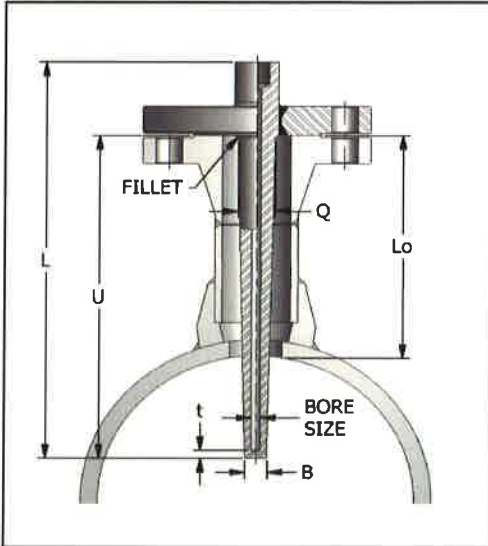
In accordance with ASME PTC-19.3-TW-2010

Report Information

Customer: Unified Valve Group
 Tag Numbers: TW-08071A

Analyst: JOANNA
 Reference #: 1211390-Rev.2B

Date : 10/13/2015



Process Operating Conditions

Process Fluids:	Natural Gas
Max Temperature (T):	141 °F
Max Pressure (P):	1233 psi
Fluid Velocity (v):	2.26 ft/s
Fluid Density:	33 lb/ft ³
Fluid Viscosity:	0.0141 centipoise

Thermowell Material Properties

Density (Pm):	0.29 lb/in ³
Elastic Modulus, E(T):	28115384.6153846 psi
Allowable Stress (S) / Fatigue Limit (Sf):	20000 psi/9100 psi

Stress (Support Plane)

In-Line Reson. Velocity(VIR):	18.77 m/s	Von Mises Stress (Root):	136.69 psi
Bending Stress at VIR (So,max)	69147.7 psi		
Peak oscill. bending stress (So,max)	0.94 psi		

Frequency

Frequency Limit:	0.40	Reynolds # (Re):	491951
Frequency must be below:	338.46 [Hz]	Strouhal # (Ns):	0.2109
Installed Natural Freq (fnc):	846.15 [Hz]	Scruton # (Nsc):	0.07
Strouhal Frequency (fs):	7.63 [Hz]	Freq Ratio (fs/fnc)	0.01

Pressure

Allowable Stem Pressure(Pc):	8242.41psi
Allowable Tip Pressure(Pt):	142202.47psi

Thermowell Rating

	Status	Value
Oscillating Stress (psi)	PASS	0.94
Steady-State Stress (psi)	PASS	1312.605
Pressure (psi)	PASS	1233
Frequency (Hz)	PASS	7.63

Thermowell Configuration

Process Connection:	Flanged FP Weld
Stem Style:	Tapered
Thermowell Material:	316
Flange Size l Rating:	1-1/2" 1500#
Flange Facing:	Raised Face
Flange Material:	316
Bore Size:	0.26"
Overall Length (L):	8.25"
Unsupported Length (U):	6"
Shielded Length (Lo):	4.905"
Root Diameter (Q):	1.06"
Tip Diameter (B):	0.75"
Tip Thickness (t):	0.25"
Fillet (Root):	0.188"

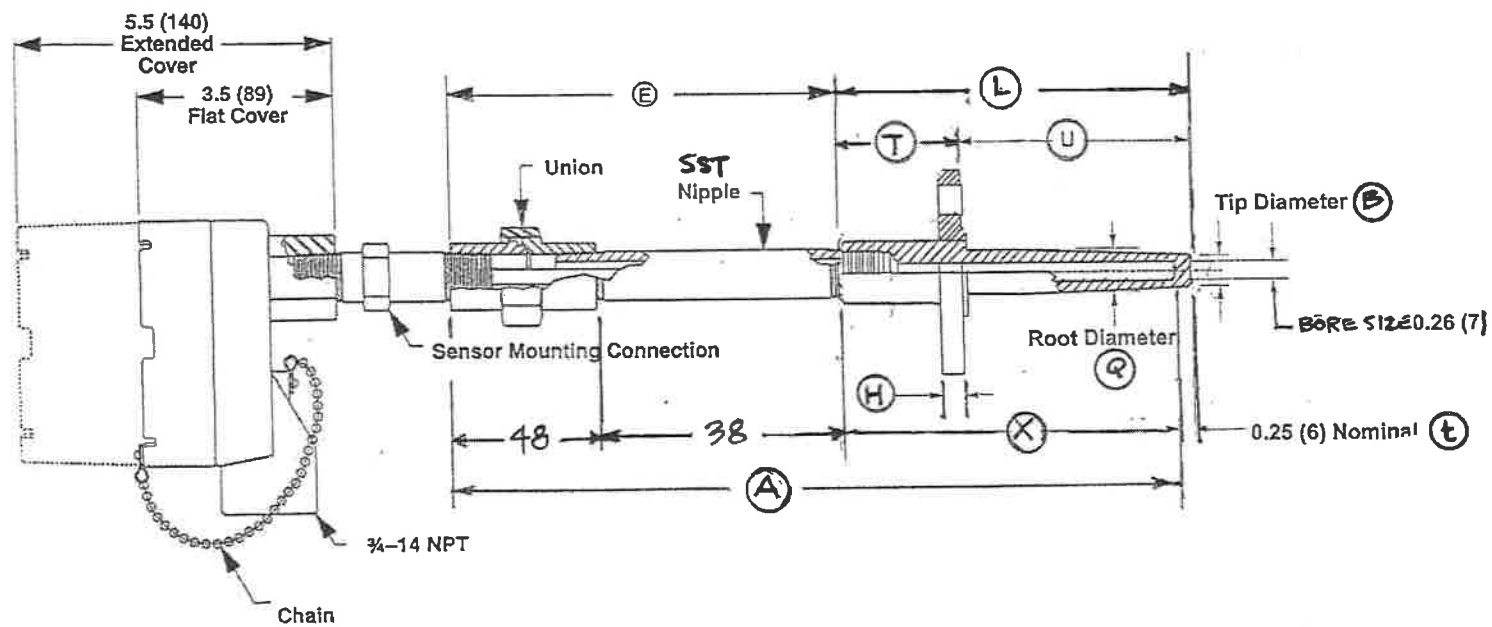
The thermowell design has PASSED the wake frequency calculation

"These well design calculations are based on the ASME PTC 19.3 TW-2010 formulas. The results of these calculations should only be used as a guide for thermowell design. Mac-Weld does not guarantee the performance of a specific well design obtained from the use of these calculations".

This calculation is only valid when the thermowell is manufactured and supplied by Mac-Weld Machining Ltd.

TW-08071A

SENSOR INSTALLED IN CONNECTION HEAD (FLAT COVER)
WITH UNION AND NIPPLE EXTENSION AND THERMOWELL





TEMPERATURE TRANSMITTER SPECIFICATION

SHEET NO. 1 OF 1
 SPEC. NO. A150/LT
 JOB NO. 338716
 REQ. 1 P.O 4512-109-130

CLIENT:	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
SHELL CANADA	0	FOR APPROVAL	15-Oct-15	ET	ET	
LOCATION:	1	Revised as per customer request	27-Oct-15	ET	ET	
CARMON CREEK GAS PLANT						

1 Tag No.	P&ID No.	TZT-08071B	338716-100
2 Service	Sour Service	SWEET NATURAL GAS	
3 Line / Vessel No.	2" FG-07990-80-A150/LT-HC/ETR/CMT		
4 Electrical Area Classification	CLASS 1 DIV 1		
5 Line Size & Sch. & Spec:	2" SCH 80	150#	
6 Design Press. / Temp.	1965 kPag		38C

Operating Conditions							
7 Fluid	SWEET NATURAL GAS					Crit Temp Tc	°C
8 Amb. Temp. Min.	Max. (°C)	10	35	Atm Pres	101.3 kPaa	Crit Pres Pc	kPaa
9		Units	Max	Norm	Min	Shut-Off	Design Flow
10 Flow Rate		m3/day	1,540	1,540	150	-	-
11 Pressure		kPag	620	55	0	-	-
12 Temperature		°C	61	25	-10	-	-
13 Mol. Weight			17.58	17.58	17.58	-	-
14 Density		kg/M3	0.742	0.742	0.742	-	-
15 Specific Gravity		S.G	0.606	0.606	0.606	-	-
16 Viscosity		cP	0.0100	0.0100	0.0100	-	-
17 Supercomp. Factor			-	-	-	-	-
18 Spec Heats Ratio k (Cp/Cv)			-	-	-	-	-

Transmitter			
19 Indicator Scale (LCD)	Output Signal Range	REQUIRED	4-20 mA + HART
20 Accuracy	±0.02% of span (Applies to HART/4-20 mA devices)		
21 Calibrated Range	Adjustable Range	-50 TO 100°C	-200 TO 850°C
22 Power Supply	Failure Output	10.5 - 42.4 VDC	---
23 Ambient Temperature Limit	-40 TO 85°C		
24 Housing Material	Conduit Connection	ALUMINUM	1/2" NPT
25 Enclosure Material	Rating	---	---
26 Area Classification	CSA IS, FISCO Division 2 and Explosion-proof combo (includes standard IS, FISCO for fieldbus units)		
27 Mounting	---		

RTD			
28 Type (Ice Point Resistance)	100 OHMS		
29 Coefficient	Construction	0.00385 OHM / OHM / °C	SINGLE 4-WIRE RTD
30 Temperature Range	-50 TO 400°C		
31 Sensor Diameter	6mm		
32 Sheath Material	316 SST		
33 Stem Length - "X"	178mm		
34 Assembly Type	SPRING LOADED FITTING, NIPPLE UNION		
35 Assembly Length - "A"	302mm		
36 Assembly Material	SST		
37 Enclosure Head Material			
38 Terminal Block Material	INTEGRAL WITH TRANSMITTER		
39 Conduit Connection Size			
40 Electrical Area Classification	CSA IS, FISCO Division 2 and Explosion-proof combo (includes standard IS, FISCO for fieldbus units)		

Thermowell			
41 Tag No.	TW-08071B		
42 Process Connection	Size	Rating	1 1/2" 300# RF
43 Thermowell Style	Thermowell Material	TAPERED 316 SS	
44 Element Connection	12mm		
45 Overall Length - "U" + "H"	mm	148	
46 Head Length - "H"	mm	21	
47 Insertion Length - "U"	mm	127	
48 Shielded Length	mm	104	
49 Bore Size	mm	7	
50 Lag Extension - "T"	mm	57	
51 Root Diameter - "Q"	mm	27	
52 Tip Diameter - "B"	mm	19	
53 Tip Thickness - "t"	mm	6	

Vendor			
54 Vendor	Manufacturer	SPARTAN CONTROLS	ROSEMOUNT
55 Transmitter Model No.	3144PD1A1K6M5Q4		
56 RTD Model No.	0068N21C30N050E6 (SEE NOTE 5)		
57 Thermowell Model No.	CUSTOM MADE FROM MAC-WELD (REFER TO WAKE FREQUENCY ANALYSIS SHEET FOR DETAILS)		
58 CSA Approval	CRN	YES	REQUIRED FOR AB

NOTES :

- VENDOR TO PROVIDE STAINLESS STEEL TAG AFFIXED TO INSTRUMENT IDENTIFYING TAG NUMBER AND PURCHASE ORDER NUMBER.
- ALL THERMOWELLS WILL HAVE HYDROSTATIC TESTING & FULL PENETRATION WELDS.
- THERMOWELLS TO HAVE TAG NUMBER AND AB CRN STAMPED ON BODY.
- TRANSMITTERS TO BE FACTORY CALIBRATED.
- ORIGINAL EXTENSION LENGTH E= 3.0 INCHES WAS MODIFIED TO 4.88"

WAKE FREQUENCY ANALYSIS

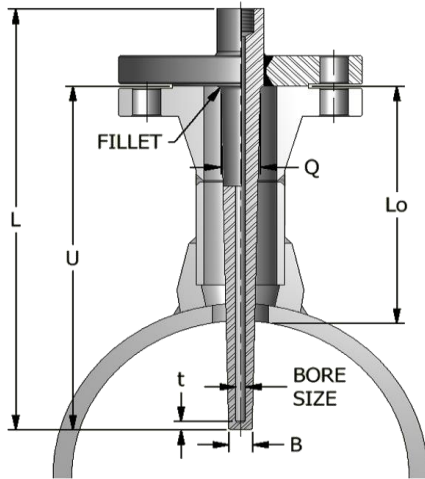
In accordance with ASME PTC-19.3-TW-2010

Report Information

Customer: Unified Valve Group
 Tag Numbers: TW-08071B

Analyst: JOANNA
 Reference #: 1211390-Rev. 3

Date : 10/22/2015



Process Operating Conditions

Process Fluids:	Natural Gas
Max Temperature (T):	77 °F
Max Pressure (P):	90 psi
Fluid Velocity (v):	21.3 ft/s
Fluid Density:	33 lb/ft ³
Fluid Viscosity:	0.011 centipoise

Thermowell Material Properties

Density (Pm):	0.29 lb/in ³
Elastic Modulus, E(T):	28115384.6153846 psi
Allowable Stress (S) / Fatigue Limit (Sf):	20000 psi/9100 psi

Stress (Support Plane)

In-Line Reson. Velocity (VIR):	51.63 m/s	Von Mises Stress (Root):	63.17 psi
Bending Stress at VIR (So.max)	362215.57 psi		
Peak oscill. bending stress (So.max)	57.82 psi		

Frequency

Frequency Limit:	0.40	Reynolds # (Re):	6E+06
Frequency must be below:	476.93 [Hz]	Strouhal # (Ns):	0.22
Installed Natural Freq (fnc):	1192.32 [Hz]	Scruton # (Nsc):	0.07
Strouhal Frequency (fs):	74.98 [Hz]	Freq Ratio (fs/fnc)	0.06

Pressure

Allowable Stem Pressure (Pc):	8242.41 psi
Allowable Tip Pressure (Pt):	142202.47 psi

Thermowell Rating

	Status	Value
Oscillating Stress (psi)	PASS	57.81
Steady-State Stress (psi)	PASS	158.104
Pressure (psi)	PASS	90
Frequency (Hz)	PASS	74.98

Thermowell Configuration

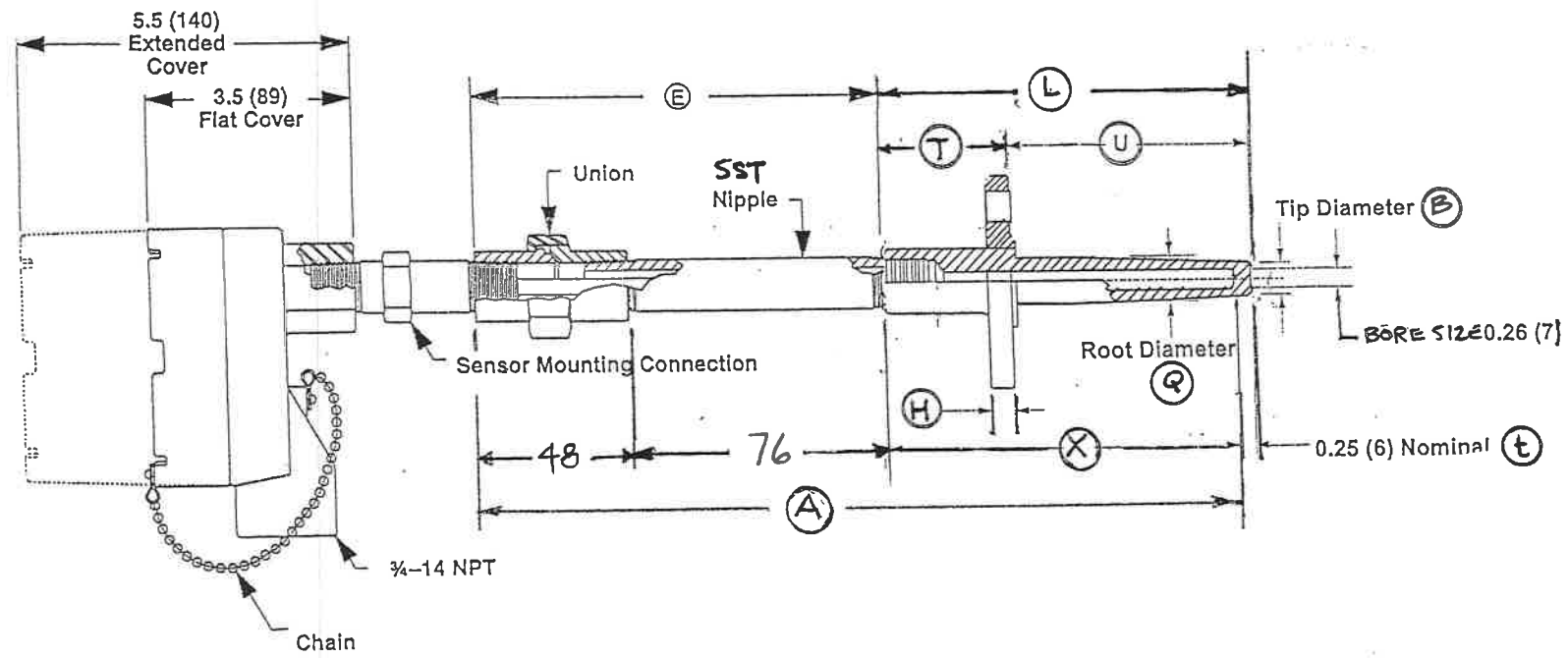
Process Connection:	Flanged FP Weld
Stem Style:	Tapered
Thermowell Material:	316
Flange Size l Rating:	1-1/2" 300#
Flange Facing:	Raised Face
Flange Material:	316
Bore Size:	0.26"
Overall Length (L):	7.25"
Unsupported Length (U):	5"
Shielded Length (Lo):	4.091"
Root Diameter (Q):	1.06"
Tip Diameter (B):	0.75"
Tip Thickness (t):	0.25"
Fillet (Root):	0.188"

The thermowell design has PASSED the wake frequency calculation

"These well design calculations are based on the ASME PTC 19.3 TW-2010 formulas. The results of these calculations should only be used as a guide for thermowell design. Mac-Weld does not guarantee the performance of a specific well design obtained from the use of these calculations".

This calculation is only valid when the thermowell is manufactured and supplied by Mac-Weld Machining Ltd.

SENSOR INSTALLED IN CONNECTION HEAD (FLAT COVER)
WITH UNION AND NIPPLE EXTENSION AND THERMOWELL





TEMPERATURE TRANSMITTER SPECIFICATION

SHEET NO.	1	OF	1
SPEC. NO.	A150/LT		
JOB NO.	338716		
REQ.	1	P.O	4512-109-130

CLIENT:	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
SHELL CANADA	0	For Approval	15-Oct-15	ET	ET	
LOCATION:	1	Revised as per customer request	27-Oct-15	ET	ET	
CARMON CREEK GAS PLANT						

1	Tag No.	P&ID No.	TT- 08071A1	338716-100
2	Service	Sour Service	SWEET NATURAL GAS	
3	Line / Vessel No.	2" FG-07990-80-A150/LT-HC/ETR/CMT		
4	Electrical Area Classification	CLASS 1 DIV 1		
5	Line Size & Sch. & Spec:	2" SCH 80	150#	
6	Design Press. / Temp.	1965 kPag		38C

Operating Conditions							
7	Fluid	SWEET NATURAL GAS				Crit Temp Tc	°C
8	Amb. Temp. Min.	Max. (°C)	10	35	Atm Pres	101.3 kPaa	Crit Pres Pc
9			Units	Max	Norm	Min	Shut-Off
10	Flow Rate		m3/day	1,540	1,540	150	Design Flow
11	Pressure		kPag	620	55	0	-
12	Temperature		°C	61	25	-10	-
13	Mol. Weight			17.58	17.58	17.58	-
14	Density		kg/M3	0.742	0.742	0.742	-
15	Specific Gravity		S.G	0.606	0.606	0.606	-
16	Viscosity		cP	0.0100	0.0100	0.0100	-
17	Supercomp. Factor			-	-	-	-
18	Spec Heats Ratio k (Cp/Cv)			-	-	-	-

Transmitter			
19	Indicator Scale (LCD)	Output Signal Range	REQUIRED
20	Accuracy	±0.02% of span (Applies to HART/4-20 mA devices)	
21	Calibrated Range	Adjustable Range	-50 TO 100°C
22	Power Supply	Failure Output	10.5 - 42.4 VDC
23	Ambient Temperature Limit	-40 TO 85°C	
24	Housing Material	Conduit Connection	ALUMINUM
25	Enclosure Material	Rating	---
26	Area Classification	CSA IS, FISCO Division 2 and Explosion-proof combo (includes standard IS, FISCO for fieldbus units)	
27	Mounting	---	

RTD			
28	Type (Ice Point Resistance)	100 OHMS	
29	Coefficient	Construction	0.00385 OHM / OHM / °C
30	Temperature Range	-50 TO 400°C	
31	Sensor Diameter	6mm	
32	Sheath Material	316 SST	
33	Stem Length - "X"	178mm	
34	Assembly Type	SPRING LOADED FITTING, NIPPLE UNION	
35	Assembly Length - "A"	302mm	
36	Assembly Material	SST	
37	Enclosure Head Material		
38	Terminal Block Material	INTEGRAL WITH TRANSMITTER	
39	Conduit Connection Size		
40	Electrical Area Classification	CSA IS, FISCO Division 2 and Explosion-proof combo (includes standard IS, FISCO for fieldbus units)	

Thermowell			
41	Tag No.	TW-08071A1	
42	Process Connection	Size	Rating
43	Thermowell Style	Thermowell Material	
44	Element Connection	12mm	
45	Overall Length - "U" + "H"	mm	148
46	Head Length - "H"	mm	21
47	Insertion Length - "U"	mm	127
48	Shielded Length	mm	104
49	Bore Size	mm	7
50	Lag Extension - "T"	mm	57
51	Root Diameter - "Q"	mm	27
52	Tip Diameter - "B"	mm	19
53	Tip Thickness - "t"	mm	6

Vendor			
54	Vendor	Manufacturer	
55	Transmitter Model No.	3144PD1A1K6M5Q4	
56	RTD Model No.	0068N21C30N050E6 (SEE NOTE 5)	
57	Thermowell Model No.	CUSTOM MADE FROM MAC-WELD (REFER TO WAKE FREQUENCY ANALYSIS SHEET FOR DETAILS)	
58	CSA Approval	CRN	
		YES	REQUIRED FOR AB

NOTES :

- VENDOR TO PROVIDE STAINLESS STEEL TAG AFFIXED TO INSTRUMENT IDENTIFYING TAG NUMBER AND PURCHASE ORDER NUMBER.
- ALL THERMOWELLS WILL HAVE HYDROSTATIC TESTING & FULL PENETRATION WELDS.
- THERMOWELLS TO HAVE TAG NUMBER AND AB CRN STAMPED ON BODY.
- TRANSMITTERS TO BE FACTORY CALIBRATED.
- ORIGINAL EXTENSION LENGTH E= 3.0 INCHES WAS MODIFIED TO 4.88"

WAKE FREQUENCY ANALYSIS

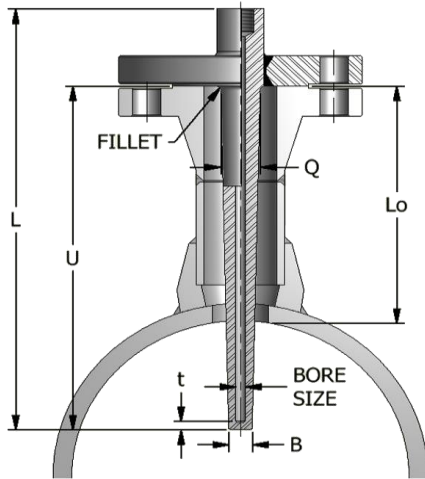
In accordance with ASME PTC-19.3-TW-2010

Report Information

Customer: Unified Valve Group
 Tag Numbers: TW-08071A1

Analyst: JOANNA
 Reference #: 1211390-Rev. 3

Date: 10/22/2015



Process Operating Conditions

Process Fluids:	Natural Gas
Max Temperature (T):	77 °F
Max Pressure (P):	90 psi
Fluid Velocity (v):	21.3 ft/s
Fluid Density:	33 lb/ft ³
Fluid Viscosity:	0.011 centipoise

Thermowell Material Properties

Density (Pm):	0.29 lb/in ³
Elastic Modulus, E(T):	28115384.6153846 psi
Allowable Stress (S) / Fatigue Limit (Sf):	20000 psi/9100 psi

Stress (Support Plane)

In-Line Reson. Velocity (VIR):	51.63 m/s	Von Mises Stress (Root):	63.17 psi
Bending Stress at VIR (So.max)	362215.57 psi		
Peak oscill. bending stress (So.max)	57.82 psi		

Frequency

Frequency Limit:	0.40	Reynolds # (Re):	6E+06
Frequency must be below:	476.93 [Hz]	Strouhal # (Ns):	0.22
Installed Natural Freq (fnc):	1192.32 [Hz]	Scruton # (Nsc):	0.07
Strouhal Frequency (fs):	74.98 [Hz]	Freq Ratio (fs/fnc)	0.06

Pressure

Allowable Stem Pressure (Pc):	8242.41 psi
Allowable Tip Pressure (Pt):	142202.47 psi

Thermowell Rating

	Status	Value
Oscillating Stress (psi)	PASS	57.81
Steady-State Stress (psi)	PASS	158.104
Pressure (psi)	PASS	90
Frequency (Hz)	PASS	74.98

Thermowell Configuration

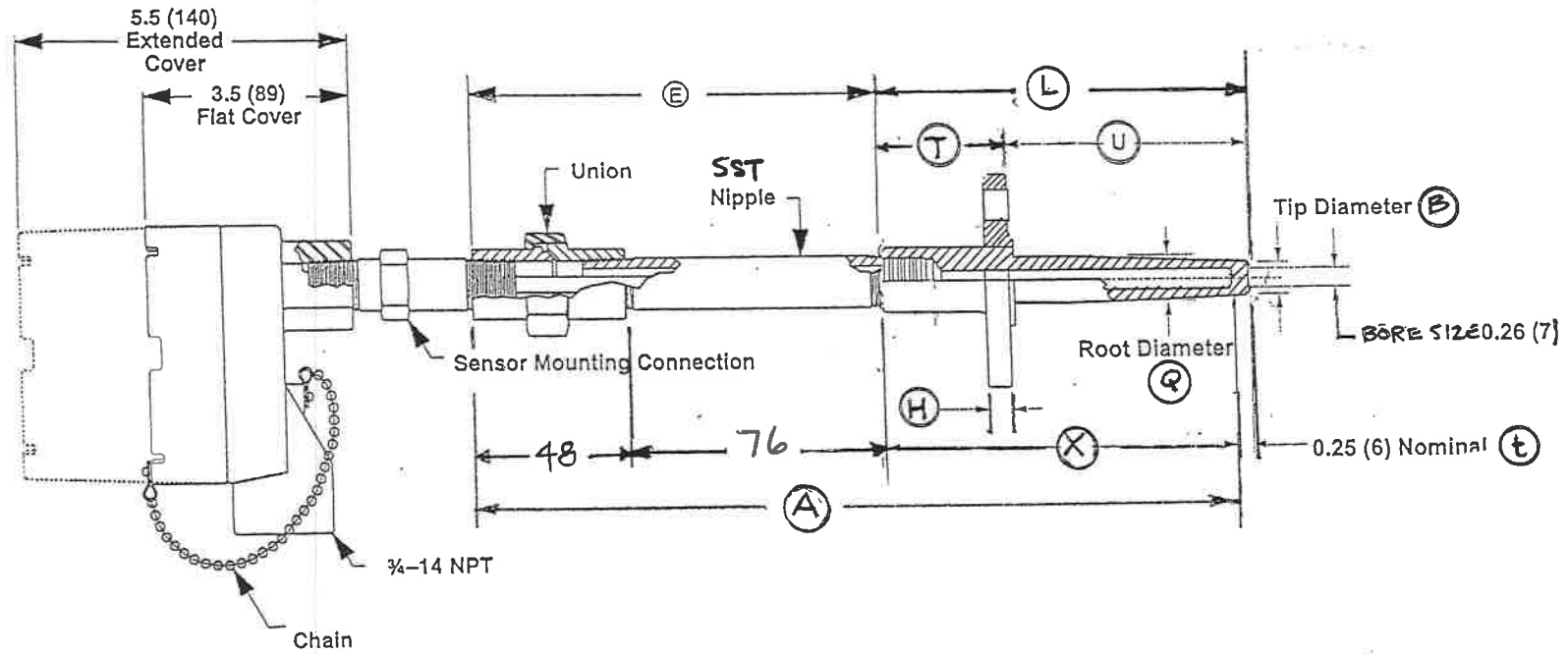
Process Connection:	Flanged FP Weld
Stem Style:	Tapered
Thermowell Material:	316
Flange Size l Rating:	1-1/2" 300#
Flange Facing:	Raised Face
Flange Material:	316
Bore Size:	0.26"
Overall Length (L):	7.25"
Unsupported Length (U):	5"
Shielded Length (Lo):	4.091"
Root Diameter (Q):	1.06"
Tip Diameter (B):	0.75"
Tip Thickness (t):	0.25"
Fillet (Root):	0.188"

The thermowell design has PASSED the wake frequency calculation

"These well design calculations are based on the ASME PTC 19.3 TW-2010 formulas. The results of these calculations should only be used as a guide for thermowell design. Mac-Weld does not guarantee the performance of a specific well design obtained from the use of these calculations".

This calculation is only valid when the thermowell is manufactured and supplied by Mac-Weld Machining Ltd.

SENSOR INSTALLED IN CONNECTION HEAD (FLAT COVER)
WITH UNION AND NIPPLE EXTENSION AND THERMOWELL





PRESSURE TRANSMITTER SPECIFICATION

SHEET NO.	1	OF	1
SPEC. NO.	D900/LT		
JOB NO.	338716		
REQ.	1	P.O	4512-109-130

CLIENT:	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
SHELL CANADA	0	For Approval	5-Oct-15	ET	ET	
LOCATION:	1	Revised as per customer request	27-Oct-15	ET	ET	
CARMON CREEK GAS PLANT						

1	Tag No.	PZT-08071A				
2	Service	Sweet Natural Gas				
3	Sour Service	No				
4	Line / Vessel No.	2"-FG-07987-80-D900/LT-HC-CMT				
5	P&ID No.	338716-100				
6	Electrical Area Classification	CLASS 1 DIV 1				
7	Line Size & Sch. & Spec:	2" SCH 80	1500#			
8	Design Press. / Temp.	15,307 kPag		38C		

Operating Conditions							
9	Fluid	State	SWEET NATURAL GAS				VAPOR
10	Amb. Temp. Min.	Max. (°C)	10				35
11	Atmospheric Pressure (kPa)		101.3				
12		Units	Max	Norm	Min	Shut-Off	Design Flow
13	Pressure	kPag	9,600	2,600	1,200	-	-
14	Temperature	°C	61	37.8	-10.0	-	-
15	Density	kg/m ³	17.58	17.58	17.6	-	-
16	Specific Gravity	S.G.	0.606	0.606	0.606	-	-
17	Viscosity	csT	0.0001	0.0001	0.0001	-	-

Body							
18	Body/Flange Material	Rating	STAINLESS STEEL				---
19	Bolts Type	---					
20	Wetted O-Ring Material	PTFE					
21	Design Pressure	Temperature					

Transmitter							
22	Function	GAUGE PRESSURE					
23	Indicator Scale (LCD)	REQUIRED					
24	Output Signal Range	4-20 mA + HART					
25	Accuracy	+/- 0.075% OF SPAN					
26	Calibrated Range	Flow Range	0-12,000 kpag (0-1,740 PSIG)				
27	Adjustable Range	(-)14.7 - 4000 PSI					
28	Conduit Connection	1/2" FNPT					
29	Power Supply	10.5 - 36 V DC					
30	Failure Output	---					
31	Ambient Temperature Limit	-40 TO 85 °C					
32	Housing Material	ALUMINUM					
33	Enclosure Material	Rating	---				
34	Area Classification	CSA Explosion-Proof, Dust Ignition-proof, Intrinsically Safe, Division 2					
35	Single or Dual Seal Certification	DUAL SEAL CERTIFIED AS PER ANSI/ISA 12.27.01					

Element							
36	Element Type	DIAPHRAGM					
37	Material	316L SST					
38	Fill Fluid	SILICONE					
39	Fill Fluid Temperature Range	-40 TO 121 °C					
40	Process Connection	1/2-14 FNPT					

Manifold							
52	Type	HI-PRO MONOFLANGE 3- VALVE MANIFOLD					
53	Body Material	Packing	316L SST				GRAPHITE
54	Process Connection	Mounting	3/4" SW (c/w 5mm bore),1500#				
55	Design Pressure	Temperature	6000 PSI				
56	Manufacturer	Model Number	PARKER				HPM6LS3DBBB-MD4-14299EHXJ

Vendor							
51	Vendor	SPARTAN CONTROLS					
52	Manufacturer	ROSEMOUNT					
53	Model Number	2088G4S22A1M5K6P1Q4Q8					
54	CSA Approval	REQUIRED					
55	Canadian Registration Number	YES					

NOTES :

- VENDOR TO PROVIDE STAINLESS STEEL TAG AFFIXED TO INSTRUMENT IDENTIFYING TAG NUMBER AND PURCHASE ORDER NUMBER.
- TRANSMITTERS TO BE FACTORY CALIBRATED.
- ALBERTA CRN IS REQUIRED FOR BOTH TRANSMITTER AND MANIFOLD.



PRESSURE TRANSMITTER SPECIFICATION

SHEET NO.	1	OF	1
SPEC. NO.	B300/LT		
JOB NO.	338716		
REQ.	1	P.O	4512-109-130

CLIENT:	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
SHELL CANADA	0	For Approval	5-Oct-15	ET	ET	
LOCATION:	1	Revised as per customer request	27-Oct-15	ET	ET	
CARMON CREEK GAS PLANT						

1	Tag No.	PZT-08071B				
2	Service	Sweet Natural Gas				
3	Sour Service	No				
4	Line / Vessel No.	2" FG-07988-80-B300/LT-HC/CMT				
5	P&ID No.	338716-100				
6	Electrical Area Classification	CLASS 1 DIV 1				
7	Line Size & Sch. & Spec:	2" SCH 80	300#			
8	Design Press. / Temp.	5102 kpag		38C		

Operating Conditions							
9	Fluid	State	SWEET NATURAL GAS				VAPOR
10	Amb. Temp. Min.	Max. (°C)	10				35
11	Atmospheric Pressure (kPa)		101.3				
12		Units	Max	Norm	Min	Shut-Off	Design Flow
13	Pressure	kPag	4,137	3,348	0	-	-
14	Temperature	°C	61	41.8	-10.0	-	-
15	Density	kg/m ³	17.58	17.58	17.58	-	-
16	Specific Gravity	S.G.	0.606	0.606	0.606	-	-
17	Viscosity	csT	0.0001	0.0001	0.0001	-	-

Body							
18	Body/Flange Material	Rating	STAINLESS STEEL				---
19	Bolts Type	---					
20	Wetted O-Ring Material	PTFE					
21	Design Pressure	Temperature					

Transmitter							
22	Function	GAUGE PRESSURE					
23	Indicator Scale (LCD)	REQUIRED					
24	Output Signal Range	4-20 mA + HART					
25	Accuracy	+/- 0.075% OF SPAN					
26	Calibrated Range	Flow Range	0-5515 kpag (0-800 psig)				
27	Adjustable Range	(-)14.7 - 800PSI					
28	Conduit Connection	1/2" FNPT					
29	Power Supply	10.5 - 36 V DC					
30	Failure Output	---					
31	Ambient Temperature Limit	-40 TO 85 °C					
32	Housing Material	ALUMINUM					
33	Enclosure Material	Rating	---				
34	Area Classification	CSA Explosion-Proof, Dust Ignition-proof, Intrinsically Safe, Division 2					
35	Single or Dual Seal Certification	DUAL SEAL CERTIFIED AS PER ANSI/ISA 12.27.01					

Element							
36	Element Type	DIAPHRAGM					
37	Material	316L SST					
38	Fill Fluid	SILICONE					
39	Fill Fluid Temperature Range	-40 TO 121 °C					
40	Process Connection	1/2-14 FNPT					

Manifold							
52	Type	HI-PRO MONOFLANGE 3 VALVE MANIFOLD					
53	Body Material	Packing	316L SST				GRAPHITE
54	Process Connection	Mounting	3/4" SW (c/w 5mm bore), 600#				
55	Design Pressure	Temperature	6000 PSI				
56	Manufacturer	Model Number	PARKER				
			HPM6LS3DBBB-MD4-14299EHXJ				

Vendor							
51	Vendor	SPARTAN CONTROLS					
52	Manufacturer	ROSEMOUNT					
53	Model Number	2088G3S22A1M5K6P1Q4Q8					
54	CSA Approval	CSA Explosion-Proof					
55	Canadian Registration Number	YES, AB					

NOTES :

- VENDOR TO PROVIDE STAINLESS STEEL TAG AFFIXED TO INSTRUMENT IDENTIFYING TAG NUMBER AND PURCHASE ORDER NUMBER.
- TRANSMITTERS TO BE FACTORY CALIBRATED.
- ALBERTA CRN IS REQUIRED FOR BOTH TRANSMITTER AND MANIFOLD.



PRESSURE TRANSMITTER SPECIFICATION

SHEET NO.	1	OF	1
SPEC. NO.	A150		
JOB NO.	338716		
REQ.	1	P.O	4512-109-130

CLIENT:	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
SHELL CANADA	0	For Approval	5-Oct-15	ET	ET	
LOCATION:	1	Revised as per customer request	26-Oct-15	ET	ET	
CARMON CREEK GAS PLANT						

1	Tag No.	PZT-08071C				
2	Service	Sweet Natural Gas				
3	Sour Service	No				
4	Line / Vessel No.	2" FG-07989-80-A150/LT-HC/CMT				
5	P&ID No.	338716-100				
6	Electrical Area Classification	CLASS 1 DIV 1				
7	Line Size & Sch. & Spec:	2" SCH 80	150#			
8	Design Press. / Temp.	1965		38C		

Operating Conditions							
9	Fluid	State	SWEET NATURAL GAS			VAPOR	
10	Amb. Temp. Min.	Max. (°C)	10			35	
11	Atmospheric Pressure (kPa)		101.3				
12			Units	Max	Norm	Min	Shut-Off
13	Pressure		kPag	1,240	1,034	0	-
14	Temperature		°C	61	30.9	-10.0	-
15	Density		kg/m ³	17.58	17.58	17.58	-
16	Specific Gravity		S.G.	0.606	0.606	0.606	-
17	Viscosity		csT	0.0001	0.0001	0.0001	-

Body							
18	Body/Flange Material	Rating	STAINLESS STEEL			---	
19	Bolts Type		---				
20	Wetted O-Ring Material		PTFE				
21	Design Pressure	Temperature					

Transmitter							
22	Function	GAUGE PRESSURE					
23	Indicator Scale (LCD)	REQUIRED					
24	Output Signal Range	4-20 mA + HART					
25	Accuracy	+/- 0.075% OF SPAN					
26	Calibrated Range	Flow Range	0-1500 kpag (218 psig)				
27	Adjustable Range	(-)14.7 - 800PSI					
28	Conduit Connection	1/2" FNPT					
29	Power Supply	10.5 - 36 V DC					
30	Failure Output	---					
31	Ambient Temperature Limit	-40 TO 85 °C					
32	Housing Material	ALUMINUM					
33	Enclosure Material	Rating	---				
34	Area Classification	CSA Explosion-Proof, Dust Ignition-proof, Intrinsically Safe, Division 2					
35	Single or Dual Seal Certification	DUAL SEAL CERTIFIED AS PER ANSI/ISA 12.27.01					

Element							
36	Element Type	DIAPHRAGM					
37	Material	316L SST					
38	Fill Fluid	SILICONE					
39	Fill Fluid Temperature Range	-40 TO 121 °C					
40	Process Connection	1/2"-14 FNPT					

Manifold							
52	Type	HI-PRO MONOFLANGE 3 VALVE MANIFOLD					
53	Body Material	Packing	316L SST			GRAPHITE	
54	Process Connection	Mounting	3/4" SW (c/w 5mm bore), 300#			---	
55	Design Pressure	Temperature	6000 PSI			180C	
56	Manufacturer	Model Number	PARKER			HPM6LS3DBBB-MD4-14299EHXJ	

Vendor							
51	Vendor	SPARTAN CONTROLS					
52	Manufacturer	ROSEMOUNT					
53	Model Number	2088G3S22A1M5K6P1Q4Q8					
54	CSA Approval	CSA Explosion-Proof					
55	Canadian Registration Number	YES, AB					

NOTES :

1. VENDOR TO PROVIDE STAINLESS STEEL TAG AFFIXED TO INSTRUMENT IDENTIFYING TAG NUMBER AND PURCHASE ORDER NUMBER.
2. TRANSMITTERS TO BE FACTORY CALIBRATED.
3. ALBERTA CRN IS REQUIRED FOR BOTH TRANSMITTER AND MANIFOLD.



PRESSURE TRANSMITTER SPECIFICATION

SHEET NO. 1 OF 1
 SPEC. NO. D900/LT
 JOB NO. 338716
 REQ. 1 P.O. 4512-109-130

CLIENT:	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
SHELL CANADA	0	For Approval	5-Oct-15	ET	ET	
LOCATION:	1	Revised as per customer request	27-Oct-15	ET	ET	
CARMON CREEK GAS PLANT						

1	Tag No.	PZT-08071D				
2	Service	Sweet Natural Gas				
3	Sour Service	No				
4	Line / Vessel No.	2" FG-07990-80-A150/LT-HC/ETR/CMT				
5	P&ID No.	338716-100				
6	Electrical Area Classification	CLASS 1 DIV 1				
7	Line Size & Sch. & Spec:	2" SCH 80	150#			
8	Design Press. / Temp.	1965		38C		

Operating Conditions							
9	Fluid	State	SWEET NATURAL GAS				VAPOR
10	Amb. Temp. Min.	Max. (°C)	10				35
11	Atmospheric Pressure (kPa)		101.3				
12		Units	Max	Norm	Min	Shut-Off	Design Flow
13	Pressure	kPag	620	55	0	-	-
14	Temperature	°C	61	25	-10	-	-
15	Density	kg/m ³	17.58	17.58	17.6	-	-
16	Specific Gravity	S.G.	0.606	0.606	0.61	-	-
17	Viscosity	csT	0.0001	0.0001	0.001	-	-

Body							
18	Body/Flange Material	Rating	STAINLESS STEEL				---
19	Bolts Type	---					
20	Wetted O-Ring Material	PTFE					
21	Design Pressure	Temperature					

Transmitter							
22	Function	GAUGE PRESSURE					
23	Indicator Scale (LCD)	REQUIRED					
24	Output Signal Range	4-20 mA + HART					
25	Accuracy	+/- 0.075% OF SPAN					
26	Calibrated Range	Flow Range	0-1000kpag (0-145 psig)				
27	Adjustable Range	(-)14.7 - 150PSI					
28	Conduit Connection	1/2" FNPT					
29	Power Supply	10.5 - 36 V DC					
30	Failure Output	---					
31	Ambient Temperature Limit	-40 TO 85 °C					
32	Housing Material	ALUMINUM					
33	Enclosure Material	Rating	---				
34	Area Classification	CSA Explosion-Proof, Dust Ignition-proof, Intrinsically Safe, Division 2					
35	Single or Dual Seal Certification	DUAL SEAL CERTIFIED AS PER ANSI/ISA 12.27.01					

Element							
36	Element Type	DIAPHRAGM					
37	Material	316L SST					
38	Fill Fluid	SILICONE					
39	Fill Fluid Temperature Range	-40 TO 121 °C					
40	Process Connection	1/2"-14 FNPT					

Manifold							
52	Type	HI-PRO MONOFLANGE 3 VALVE MANIFOLD					
53	Body Material	Packing	316L SST				GRAPHITE
54	Process Connection	Mounting	3/4" SW (c/w 5mm bore), 300#				
55	Design Pressure	Temperature	6000 PSI				
56	Manufacturer	Model Number	PARKER				HPM6LS3DBBB-MD4-14299EHXJ

Vendor							
51	Vendor	SPARTAN CONTROLS					
52	Manufacturer	ROSEMOUNT					
53	Model Number	2088G2S22A1M5K6P1Q4Q8					
54	CSA Approval	CSA Explosion-Proof					
55	Canadian Registration Number	YES, AB					

NOTES :
 1. VENDOR TO PROVIDE STAINLESS STEEL TAG AFFIXED TO INSTRUMENT IDENTIFYING TAG NUMBER AND PURCHASE ORDER NUMBER.
 2. TRANSMITTERS TO BE FACTORY CALIBRATED.
 3. ALBERTA CRN IS REQUIRED FOR BOTH TRANSMITTER AND MANIFOLD.

RESPONSIBLE ORGANIZATION				CORIOLIS FLOW METER w/ TRANSMITTER Device Specification				SPECIFICATION IDENTIFICATIONS						
1	CLIENT: SHELL			TAG NO.: FE-08071A1/FT-08071A1				6	SHEET NO.			1 of 1		
2	LOCATION: Carmon Creek							7	Latest revision			1	Date	10/27/15
3	Creek Gas Plant							8	Issue status			Rev per customer request		
4	JOB NO. SLS338716							9	P.O. 4512-109-130					
5								10						
FLOWMETER BODY					PROCESS DATA									
11	Body type		Dual- tube,vent		FLUID				GAS					
12	End conn nominal size		1/2"	Rating	CL 150, flange ANSI B16.5	Flow Rate (Sm3/d)	Min	Norm	Max	150	1540	1540		
13	Threaded Cable Entry		1/2"NPT	Style		Pressure (kpag)	Min	Norm	Max	0	55	620		
14	Seal type		No internal seals			Temperature (°C)	Min	Norm	Max	-10	25	61		
15	Mounting hardware		N/A			Operating S.G.	Min	Norm	Max	0.606	0.606	0.606		
16	Body wetted material		316L stainless steel			Viscosity (cP)	Min	Norm	Max	0.01	0.01	0.01		
17	Flowrate Range (Sm3/day)		2,000			Reynolds No.	Min	Norm	Max	8697	89290	89290		
18	Calibrated Range (Sm3/day)		0-42,624											
19	(measurement converted from 48.37lb/min)					Standard Density (kg/Sm3)				0.742				
20	Acc. Inst's Range (Sm3/day)		0-210,243			Molecular Weight				17.58				
21	SENSING ELEMENT													
22	Sensor type		Mass.-Coriolis											
23	Sensor wetted material		316L											
24	Fill fluid material					PIPE DATA								
25	Accuracy		0.35%			Line Size				2" (60mm)				
26	Repeatability		0.25%			Pipe Schedule				SCH 80				
27	CONNECTION HEAD					Pipe Material				SA-333-6				
28	Housing type		Compact IP67			Pipe Insulation				Mineral wool				
29	Enclosure type no/class		NEMA Type 4X Enclosure			Insulation Thickness				1" (25.4mm)				
30	Signal termination type		NPT			Pipe ID				1.939" (49mm)				
31	Cert/Approval type		CSA XP			Line Orientation				Horizontal				
32	Enclosure material		Die-cast aluminium			Line Number				2" FG-07990-80-A150/LT- HC/ETR/CMT				
33	TRANSMITTER OR COMPUTER													
34	Housing type		compact											
35	Measurement compensation		±0.05% ±											
36	Output signal type		4-20 mA SIL HART + Frequency											
37	Enclosure type no/class		NEMA Type 4X Enclosure											
38	Span-Zero adjustment		±0.10% ±											
39	Characteristic curve													
40	Digital communication std		HART											
41	Signal power source		4-20mA											
42	Failsafe style		NAMUR NE43											
43	Integral indicator style		LCD display, 4-line + touch control											
44	Signal termination type													
45	Cert/Approval type		XP FM Cl. 1 Div 1/CSA Cl. 1 Div 1, A,B,C,D + Zone 1											
46	Mounting location/type		compact											
47	Calibration type													
48	Failure/Diagnostic action		Yes											
49	Enclosure material		Die-cast aluminium											
50	Electrical Area Class		CSA XP											
51	PHYSICAL DATA													
52	Estimated weight											12kg		
53	Face-to-face dimension											404mm		
54	Overall height											266mm		
55	Removal clearance													
56	Signal conn nominal size											Style		
57	Mfr reference dwg													
58	Device CRN#											OF14903.52		
CALIBRATIONS AND TEST				INPUT OR TEST				OUTPUT OR SCALE						
110	TAG NO/FUNCTIONAL IDENT		MEAS/SIGNAL/TEST		LRV	URV	UNIT	LRV	URV					
111			Flow rate-Analog output											
112			Mass flow-Analog output											
113			Meas-Analog output											
114			Meas-Freq output 1											
115			Meas-Freq output 2											
116			Measurement-Scale											
117			Temp-Digital output											
118			Meas-Digital output											
119			Density-Digital output											
120			Test pressure											
121														
COMPONENT IDENTIFICATION				MODEL NUMBER										
122	COMPONENT TYPE		MANUFACTURER											
123	Coriolis flow meter		Endress Hauser		83F15-EAAS6ANABBBA+									
124														
125														
126														
127														
Rev	Date	Revision Description		By	CHK'D	APPR.	REMARKS							
0	10/05/2015	For Approval		ET	ET									
1	10/27/2015	Revised as per customer request		ET	ET									



TEMPERATURE TRANSMITTER SPECIFICATION

SHEET NO.	1	OF	1
SPEC. NO.	A150/LT		
JOB NO.	338716		
REQ.	1	P.O	4512-109-130

CLIENT:	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
SHELL CANADA	0	For Approval	15-Oct-15	ET	ET	
LOCATION:	1	Revised as per customer request	27-Oct-15	ET	ET	
CARMON CREEK GAS PLANT						

1 Tag No.	P&ID No.	TT-21601A	338716-100
2 Service	Sour Service	BUILDING TEMPERATURE	
3 Line / Vessel No.			No
4 Electrical Area Classification	CLASS 1 DIV 1		
5 Line Size & Sch. & Spec:			
6 Design Press. / Temp.	38C		

Operating Conditions

7 Fluid							Crit Temp Tc	°C
8 Amb. Temp. Min.	Max. (°C)	10	35	Atm Pres	101.3	kPaa	Crit Pres Pc	kPaa
9		Units	Max	Norm	Min		Shut-Off	Design Flow
10 Flow Rate		m3/day					-	-
11 Pressure		kPag					-	-
12 Temperature		°C					-	-
13 Mol. Weight							-	-
14 Density		kg/M3					-	-
15 Specific Gravity		S.G					-	-
16 Viscosity		csT					-	-
17 Supercomp. Factor			-	-	-		-	-
18 Spec Heats Ratio k (Cp/Cv)			-	-	-		-	-

Transmitter

19 Indicator Scale (LCD)	Output Signal Range	REQUIRED	4-20 mA + HART
20 Accuracy	±0.02% of span (Applies to HART/4-20 mA devices)		
21 Calibrated Range	Adjustable Range	-50 to 50 C	
22 Power Supply	Failure Output	10.5 - 42.4 VDC	
23 Ambient Temperature Limit	-40 TO 85°C		
24 Housing Material	Conduit Connection	ALUMINUM	1/2-14NPT
25 Enclosure Material	Rating	---	---
26 Area Classification	CSA IS, FISCO Division 2 and Explosion-proof combo (includes standard IS, FISCO for fieldbus units)		
27 Mounting			

RTD

28 Type (Ice Point Resistance)	100 OHMS		
29 Coefficient	Construction	0.00385 OHM / OHM / °C	
30 Temperature Range	-50 TO 400°C		
31 Sensor Diameter	6mm		
32 Sheath Material	316 SST		
33 Stem Length - "L"	76mm		
34 Assembly Type			
35 Assembly Length - "A"			
36 Assembly Material			
37 Enclosure Head Material			
38 Terminal Block Material	INTEGRAL WITH TRANSMITTER		
39 Conduit Connection Size			
40 Electrical Area Classification	CSA IS, FISCO Division 2 and Explosion-proof combo (includes standard IS, FISCO for fieldbus units)		

Thermowell

41 Tag No.			
42 Process Connection	Size	Rating	
43 Thermowell Style	Thermowell Material		
44 Element Connection			
45 Overall Length - "U" + "H"	mm		
46 Head Length - "H"	mm		
47 Insertion Length - "U"	mm		
48 Shielded Length	mm		
49 Bore - "B"	mm		
50 Lag Extension - "T"	mm		
51 Root Diameter - "Q"	mm		
52 Tip Diameter - "V"	mm		
53 Tip Thickness - "Tt"	mm		

Vendor

54 Vendor	Manufacturer	SPARTAN CONTROLS	ROSEMOUNT
55 Transmitter Model No.	3144PD1A1K6B5M5T1CNQ4HR7XAK1005		
56 RTD Model No.	0068N11N00N030E6X8Q4XA		
57 Thermowell Model No.	N/A		
58 CSA Approval	CRN	YES	REQUIRED FOR AB

NOTES :

1. VENDOR TO PROVIDE STAINLESS STEEL TAG AFFIXED TO INSTRUMENT IDENTIFYING TAG NUMBER AND PURCHASE ORDER NUMBER.
2. --
3. --
4. TRANSMITTERS TO BE FACTORY CALIBRATED.



PRESSURE GAUGE SPECIFICATION

SHEET NO.	1	OF	1
SPEC. NO.	C600/LT		
JOB NO.	SLS338716		
REQ.	1	P.O	4512-109-130

CLIENT:	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
SHELL CANADA	0	For Approval	15-09-06	ET	ET	
LOCATION:	1	Revised as per customer request	27-10-06	ET	ET	
CARMON CREEK GAS PLANT						

1 Tag No.	PI-08070A				
2 Service	SWEET NATURAL GAS				
3 Sour Service					
4 Line / Vessel No.	S-08070				
5 P&ID No.	338716-100				
6 Line Size & Sch. & Spec:	-----				
7 Design Press. / Temp.	10,205 kPag			38°C	

Operating Conditions							
8 Fluid	State				Crit Temp Tc	°C	
9 Amb. Temp. Min.	Max. (°C)	10	35	Atm Pres	101.3 kPaa	Crit Pres Pc	°C
		Units	Max	Norm	Min	Shut-Off	Design Flow
11 Pressure		kPag	8,500	2,600	1,200		
12 Temperature		°C	40	5	-5		
13 Specific Gravity		Sp Gr	0.606	0.606	0.606		
14 Viscosity		cP	---	---	---		

Gauge							
15 Type	PROCESS GAUGE						
16 Mounting	DIRECT						
17 Dial Size	4 1/2"						
18 Dial Color	WHITE ALUMINUM WITH BLACK LETTERING						
19 Case Material	BLACK FIBERGLASS-REINFORCED THERMOPLASTIC						
20 Fill Fluid Material	GLYCERINE						
21 Ring Type	Ring Material	THREADED					THERMOPLASTIC
22 Blow Out Protection Location	BACK						
23 Lens Material	CLEAR ACRYLIC WITH BUNA N GASKET						
24 Nominal Accuracy Required	+/- 1% OF SPAN						
25 Element Type	Element Material	BOURDON TUBE					316 SS
26 Socket Material	316 SS						
27 Connection Size and Type	1/2" MNPT						
28 Connection Location	BOTTOM						
29 Adjustable Pointer	YES						
30 Movement Material	316 SS						
31 Movement Dampening	NONE						
32 Measurement Range (kPag)	0 - 10,000						

Options							
33 Gauge Siphon	-----						
34 Gauge Siphon Material	-----						
35 Gauge Siphon Pressure/Temp. Rating	-----						
36 Gauge Siphon Manufacturer	-----						
37 Gauge Siphon Model Number	-----						
38 Gauge Snubber	-----						
39 Gauge Snubber Material	-----						
40 Gauge Snubber Pressure/Temp. Rating	-----						
41 Gauge Snubber Manufacturer	-----						
42 Gauge Snubber Model Number	-----						

Diaphragm Seal							
43 Diaphragm Seal Type	-----						
44 Process Connection Size and Type	-----						
45 Diaphragm Material	-----						
46 Housing Material: Top Bottom	-----					-----	
47 Fill Fluid Material	-----						
48 Design Pressure Design Temperature	-----					-----	
49 Connection to Gauge	-----						
50 Diaphragm Seal Manufacturer	-----						
51 Diaphragm Seal Model Number	-----						

Vendor							
52 Vendor	WIKA						
53 Pressure Gauge Manufacturer	WIKA						
54 Pressure Gauge Model No.	233.34						
55 Canadian Registration Number	OF02026.2C						

NOTES :



TEMPERATURE TRANSMITTER SPECIFICATION

SHEET NO.	1	OF	1
SPEC. NO.	D900/LT		
JOB NO.	338716		
REQ.	1	P.O	4512-109-130

CLIENT:	REV	DESCRIPTION	DATE	BY	CHK'D	APPR.
SHELL CANADA	0	FOR APPROVAL	15-Sep-15	ET	ET	
LOCATION:	1	Revised as per customer request	27-Oct-15	ET	ET	
CARMON CREEK GAS PLANT						

1 Tag No.	P&ID No.	TE-08071D	338716-100
2 Service	Sour Service	SWEET NATURAL GAS	
3 Line / Vessel No.	H-08071		
4 Electrical Area Classification			
5 Line Size & Sch. & Spec:			
6 Design Press. / Temp.	10205		38

Operating Conditions								
7 Fluid		NATURAL GAS				Crit Temp Tc		°C
8 Amb. Temp. Min.	Max. (°C)	10	35	Atm Pres	101.3	kPaa	Crit Pres Pc	kPaa
9	Units	Max	Norm	Min				Design Flow
10 Flow Rate	m3/day	1,540	1,540	150				-
11 Pressure	kPag	8,500	2,600	1,200				-
12 Temperature	°C	40	5	-5				-
13 Mol. Weight		17.58	17.58	17.58				-
14 Density	kg/M3	0.742	0.742	0.742				-
15 Specific Gravity	S.G	0.606	0.606	0.606				-
16 Viscosity	csT	0.0001	0.0001	0.0001				-
17 Supercomp. Factor		-	-	-				-
18 Spec Heats Ratio k (Cp/Cv)		-	-	-				-

Transmitter			
19 Indicator Scale (LCD)	Output Signal Range		
20 Accuracy			
21 Calibrated Range	Adjustable Range		
22 Power Supply	Failure Output		
23 Ambient Temperature Limit			
24 Housing Material	Conduit Connection		
25 Enclosure Material	Rating		
26 Area Classification			
27 Mounting			

RTD'S			
28 Type (Ice Point Resistance)			
29 Coefficient	Construction		DUFLEX 3-WIRE Pt100 RTD TERMINATED IN BEIGE KLIPPON SAK22.5 TERMINALS
30 Temperature Range	Flange Protection: -50C to 195C/ Element Overtemperature: -50C to 142C		
31 Sensor Diameter	6.35 mm (1/4") PT100 BSEN 60751		
32 Sheath Material	316 SST		
33 Stem Length - "L"	(1)-500mm LONG (flange protection)/(1)- 4500mm LONG (element overtemperature devices)		
34 Assembly Type			
35 Assembly Length - "A"			
36 Assembly Material	1996 CLASS B (MINERAL INSULATED) SST GRADE 316, 3- WIRE		
37 Enclosure Head Material			
38 Terminal Block Material			
39 Conduit Connection Size			
40 Electrical Area Classification	Ex e II T3 TO CAN/CSA-E79-0-95 7 CAN/CSA-E79-7-95, CLASS 1, DIV 2, GROUPS A,B,C&D,T3 CERTIFICATE No: LR110035-1X (ISES/V)		


Thermowell			
41 Tag No.			
42 Process Connector	Size	Rating	
43 Thermowell Style	Thermowell Material		
44 Element Connection			
45 Overall Length - "U" + "H"	mm		
46 Head Length - "H"	mm		
47 Insertion Length - "U"	mm		
48 Shielded Length	mm		
49 Bore - "B"	mm		
50 Lag Extension - "T"	mm		
51 Root Diameter - "Q"	mm		
52 Tip Diameter - "V"	mm		
53 Tip Thickness - "Tt"	mm		

Vendor			
54 Vendor	Manufacturer	EXHEAT	
55 Transmitter Model No.			
56 RTD Model No.			
57 Thermowell Model No.			
58 CSA Approval	CRN		

NOTES :

GENERAL	1	P&ID Number	Tag Number	338716-100	YZT-21601A
	2	Service	0735A-08030 CARMON CREEK GAS PLANT		
	3	Application	CMT NG PRESSURE REDUCTION SKID PACKAGE		
	4	Line Number	Equipment Number	---	0735A-08030
	5	Area Classification	Location	CLASS 1 ZONE 2	CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1&2
	6	Ambient Temperature Range	-40°C TO 38°C		
	7				
	8				
	9				
PROCESS CONDITIONS	10	Gas Components	NATURAL GAS		
	11	Mole Weight or Specific Gravity			
	12	Distance From Source			
	13	Humidity			
	14	Vibration			
	15	Location			
	16				
DETECTOR	17	Model	MULTISPECTRUM IR FLAME DETECTOR X3301		
	19	Enclosure	ALUMINUM		
	20	Mounting	WALL MOUNT BRACKET		
	21	Sensor Type	IR FLAME DETECTOR		
	22	Detection Range	12.2-64m		
	23	Field of Vision	90 DEG HORIZONTAL BY 75 DEG VERTICAL, AT A MINIMUM 70% OF THE ON-AXIS DETECTION DISTANCE		
	24	Sensitivity			
	25	UV Wavelength			
	26	IR Radiation			
MONITOR/ TRANSMITTER	27	Model	MULTISPECTRUM IR FLAME DETECTOR X3301		
	28	Enclosure	ALUMINUM		
	29	Mounting	MOUNTING ARM AND COLLAR ATTACHMENT		
	30	Type			
	31	Typical Response Time	2-14SEC		
	32	Minimum Response Time	2 SEC		
	33	Calibration			
	34	Analog Output	0-20mA		
	35	Power Supply	24VDC NOMINAL (18 V DC MINIMUM - 30 V DC MAXIMUM)		
	36	Local Indication	TRI-COLOR LED		
	37	Alarm Relay	FIRE ALARM/FAULT/AUXILIARY RELAYS		
	38	Calibrated Range	0 TO 20mA		
	39				
OPTIONS	40	Calibration/Test Kit	NO		
	41	Optical Air Guard	NO		
	42	Swivel Elbow	YES		
	43	Mounting Bracket	YES		
	44				
	45				
PURCHASE	47	Manufacturer	DET-TRONICS		
	48	Model	X3301A4N13W1		
	49	Purchase Order Number			
	50	Price			
	51	Serial Number			

Notes:

				INSTRUMENT SPECIFICATION				
				FLAME DETECTOR				
1	ET	10/27/2015	Revised as per customer request	Instr. Chk	Process Chk	Appr.		
0	ET	09/15/2015	For approval	ET	ET		Sheet 1	
No.	By	Date	Description	Code:	Dwg. No.:	338716-100	1	

AUTOMATIC

Protect•IR®**Multispectrum IR Flame Detector****X3301**

Shown with Q9033A
 Aluminum Swivel Mount

DESCRIPTION

The Protect•IR® Multispectrum IR Flame Detector is the future generation detector for performance and technology. The detector utilizes multi-patented* signal processing algorithms supported by an embedded 32-bit microprocessor to provide continuous protection in the presence of false alarm sources and environments with infrared radiation present. It is suitable for indoor

and outdoor applications that require the highest level of false alarm rejection and fire detection performance. The detector is available in aluminum or 316 stainless steel for installation in the harshest environments. The Protect•IR has a detection range to n-Heptane of 210 feet, and a solid cone of vision for methane. The detector features standard fire alarm, fault and auxiliary relays, with an isolated 0 to 20 mA output model with optional HART communication.

The X3301 provides superior performance in applications that are at the extremes, and where background infrared radiation is a normal condition:

- Hangars
- Offshore production platforms
- Offshore production ships
- Refineries
- Production facilities
- Loading racks
- Compressor stations
- Turbine enclosures
- Airport water curtains.

*X3301 technology advancements are covered under the following U.S. Patents: 5,995,008, 5,804,825 and 5,850,182.

FEATURES AND BENEFITS**Protect•IR TECHNOLOGY FEATURES**

- FM 3260 (2000).
- EN 54-10 Certified (VdS).
- ATEX Directive compliant.
- Certified performance to multiple fuel types.
- EQP models available.
- Extended detection range.
- New standard set for cone of vision.
- HART models available.
- Maximum false alarm rejection.
- Reliable flame detection with modulated IR background.
- Microprocessor controlled heated optics.
- Calibrated automatic optical check for each sensor eliminates need for testing with external test lamp.
- RFI and EMC Directive compliant.
- Event logging with time and date stamp.
- International certifications.
- Integral wiring compartment for ease of installation.
- Solar resistance.

BENEFITS

- Single detector for multiple fuels.
- Low cost of coverage.
- Ability to detect smaller fires earlier.
- Solid cone of vision to 100 feet for methane.
- Better detection zoning capability.
- Best combination of flame detection and false alarm rejection.
- Low maintenance costs.
- Reliable fault diagnostics.
- Suitable for heavy industrial applications.
- Explosion/flame proof (Ex d) or increased safety installations (Ex d e) in hazardous locations.
- Easily retrofitted.

SPECIFICATIONS

Operating Voltage 24 Vdc. Operating range is 18 to 30 Vdc.

Power Consumption 4 watts minimum (without heater), 17 watts at 30 Vdc with EOL resistor installed and heater on maximum.

Relays Contacts rated 5 amperes at 30 Vdc.
Fire Alarm: — Form C (NO and NC contacts)
 — normally de-energized
 — latching/non-latching.
Fault: — Form A (NO contacts)
 — normally energized
 — latching/non-latching.
Auxiliary: — Form C (NO and NC contacts)
 — normally energized/de-energized
 — latching/non-latching.

Current Output (Optional) 0–20 mA, with a maximum loop resistance of 500 ohms from 18–19.9 Vdc, 600 ohms from 20–30 Vdc.

Temperature Range Operating: –40°F to +167°F (–40°C to +75°C).
Storage: –67°F to +185°F (–55°C to +85°C).
 Hazardous location ratings from –55°C to +125°C available on flameproof model.

Humidity Range 0 to 95% relative humidity, can withstand 100% condensing humidity for short periods of time.

Wiring 14 AWG (2.08 mm²) or 16 AWG (1.31 mm²) shielded cable is recommended.

Enclosure Material Copper-free aluminum or 316 stainless steel.

Response Characteristics

	Fuel	Size	Distance Ft (m)	Average Response Time (seconds)***
Very High Sensitivity	n-Heptane	1 x 1 foot	210 (64)*	11
	n-Heptane**	1 x 1 foot	210 (64)*	6
	n-Heptane	1 x 1 foot	100 (30.5)	3
	n-Heptane	6 in. x 6 in.	80 (24.4)	3
	Isopropanol	6 in. x 6 in.	70 (21.3)	4
	Diesel**	1 x 1 foot	150 (45.7)*	14
	Ethanol	1 x 1 foot	210 (64)	11
	Methanol	6 in. x 6 in.	40 (12.2)	3
	Methanol	1 x 1 foot	150 (45.7)*	18
	Methanol**	1 x 1 foot	150 (45.7)*	7
	Methane	30 inch plume	100 (30.5)	3
	JP-5**	1 x 1 foot	150 (45.7)*	2
	JP-5**	2 x 2 feet	210 (64)*	4
	JP-5**	2 x 2 feet	100 (30.5)	2
Medium Sensitivity	Office Paper 0.5 lb.	19" x 19" x 8"	100 (30.5)	4
	Corrugated Panel	18" x 36"	100 (30.5)	8
	n-Heptane	1 x 1 foot	100 (30.5)	12
	n-Heptane	1 x 1 foot	50 (15.2)	2
	Diesel**	1 x 1 foot	70 (21.3)	4
	Ethanol	1 x 1 foot	85 (25.9)	13
	Methanol	1 x 1 foot	70 (21.3)	10
	Methane	30 inch plume	65 (19.8)	3
Methane	30 inch plume	55 (16.8)	2	
JP-5**	2 x 2 feet	100 (30.5)	3	
Office Paper 0.5 lb.	19" x 19" x 8"	50 (15.2)	6	
Corrugated Panel	18" x 36"	50 (15.2)	2	

* Outdoor test condition.
 ** 10 second pre-burn from ignition.
 *** Add 2 seconds for EQP Model.

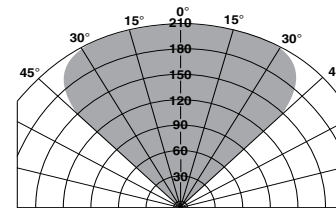
Conduit Entry Size 3/4 inch NPT or 25 mm.

Warranty 5 years.

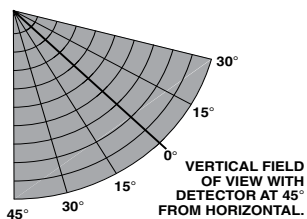
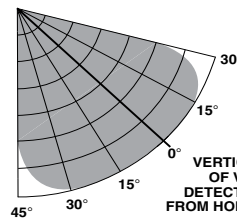
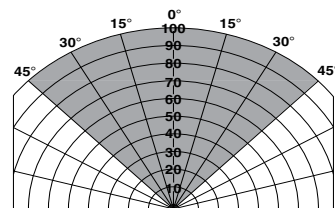
Shipping Weight (Approximate) Aluminum: 6 pounds (2.75 kg).
Stainless Steel: 10 pounds (4.5 kg).

Field of View 90° horizontal by 75° vertical, at a minimum of 70% of the on-axis detection distance.

Field of View at Indicated Distance in Feet for n-Heptane



Field of View at Indicated Distance in Feet for Methane



Certification



Class I, Div. 1, Groups B, C & D (T4A);
 Class II, Div. 1, Groups E, F & G (T4A);
 Class I, Div. 2, Groups A, B, C & D (T3C);
 Class II, Div. 2, Groups F & G (T3C);
 Class III.
 Enclosure NEMA/Type 4X.

DNV

Type Approval Certificate Number A-11022.

Lloyd's Register

Type Approval Certificate Number 09/00027.



IECEx Certificate of Conformity

IECEx ULD 06.0017X
 Ex d e IIC T5-T6 Gb
 T6 (T_{amb} = –50°C to +60°C).
 T5 (T_{amb} = –50°C to +75°C).
 IP66.

– or –

Ex d IIC T4-T6 Gb
 T6 (T_{amb} = –55°C to +60°C).
 T5 (T_{amb} = –55°C to +75°C).
 T4 (T_{amb} = –55°C to +125°C).
 IP66.

Increased Safety Model

CE 0539 Ex II 2 G
 II 2 D
 Ex d e IIC T5–T6 Gb
 Ex tb IIIC T130°C
 T6 (T_{amb} –50°C to +60°C)
 T5 (T_{amb} –50°C to +75°C)
 IP66/IP67.

Flameproof Model

CE 0539 Ex II 2 G
 II 2 D
 Ex d e IIC T4–T6 Gb
 Ex tb IIIC T130°C
 T6 (T_{amb} –55°C to +60°C)
 T5 (T_{amb} –55°C to +75°C)
 T4 (T_{amb} –55°C to +125°C)
 IP66/IP67.



IEC 61508

Certified SIL 2 Capable.
 Certification DET 070417 C001
 Applies to specific models –
 Refer to the SIL 2 Certified
 X3301 Safety manual (95-8582).

Specifications subject to change without notice.

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Detector Electronics Corporation

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 Operator: (952) 941-5665 or (800) 765-FIRE
 Customer Service: (952) 946-6491 • Fax (952) 829-8750
 http://www.det-tronics.com • E-mail: det-tronics@det-tronics.com

GENERAL	1	P&ID Number	Tag Number	338716-100	YZT-21602A	
	2	Service		0735A-08030 CARMON CREEK GAS PLANT		
	3	Application		CMT NG PRESSURE REDUCTION SKID PACKAGE		
	4	Line Number	Equipment Number	---	0735A-08030	
	5	Area Classification	Location	CLASS 1 ZONE 2	CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1&2	
	6	Ambient Temperature Range		-40°C TO 38°C		
	7					
	8					
	9					
PROCESS CONDITIONS	10	Gas Components		NA		
	11	Mole Weight or Specific Gravity		NA		
	12	Distance From Source		NA		
	13	Humidity		NA		
	14	Vibration		NA		
	15	Location		NON HAZARDOUS		
	16					
DETECTOR	17					
	18	Model		NA		
	19	Enclosure		NA		
	20	Mounting		NA		
	21	Sensor Type		NA		
	22	Detection Range		NA		
	23	Field of Vision		NA		
	24	Sensitivity		2.5% NOMINAL		
MONITOR/ TRANSMITTER	25	UV Wavelength		NA		
	26	IR Radiation		NA		
	27	Model				
	28	Enclosure		GENERAL PURPOSE		
	29	Mounting		CEILING MOUNT		
	30	Type		PHOTO ELECTRIC SMOKE DETECTOR		
	31	Typical Response Time		NA		
	32	Minimum Response Time		NA		
	33	Calibration		NA		
	34	Analog Output		NA		
	35	Power Supply		24VDC NOMINAL (OPERATING VOLTAGE 18 TO 30 V DC)		
36	Local Indication		YES			
37	Alarm Relay		1 FORM A & 1 FORM C RESISTIVE			
38	Calibrated Range		NA TO			
39						
OPTIONS	40	Calibration/Test Kit		NA		
	41	Optical Air Guard		NA		
	42	Swivel Elbow		NA		
	43	Mounting Bracket		DTB-MISC-GEN 8240PY / KIT# SMOKE-MOUNT-C		
	44					
	45					
PURCHASE	46					
	47	Manufacturer		GENTEX		
	48	Model		8240PY PART# 908-1208-002		
	49	Purchase Order Number				
50	Price					
51	Serial Number		NA			
Notes:						
				INSTRUMENT SPECIFICATION		
				SMOKE DETECTOR		
1	ET	10/27/2015	Revised as per customer request	Instr. Chk	Process Chk	Appr.
0	ET	10/15/2015	For Approval	ET	ET	
No.	By	Date	Description	Code:	Dwg No.	338716-100
				Sheet	1	
				Rev		1



CLIENT: SHELL
LOCATION: CARMON CREEK GAS PLANT
JOB #: 338715 (CAMP)
TAG #: YTZ-21502A
REF DWG: 338715-100 REV10
AREA CLASSIFICATION: NON HAZARDOUS

Photoelectric Open Area Smoke Detector

4-Wire Detectors for 24 VDC
and 120 VAC Fire Alarm Systems

Applications

The Gentex 8000/8003 Series of photoelectric detectors is specifically designed for commercial, industrial, and institutional applications, including hotels, motels, dormitories, and other multi-family dwellings. Gentex offers a full range of detectors that are compatible with 4-wire control panels from leading manufacturers. The 8000/8003 Series is engineered to provide outstanding performance wherever reliable fire protection is required.

The Gentex 8000/8003 Series provides an exclusive patented three position test feature that simulates a 0.85% and a 3.5% actual smoke condition, in full compliance with NFPA 72 and UL 268 Standards. The test feature has the capability to let you know when maintenance is required.

A standard Form A dry contact for connection to the system initiating circuit and an auxiliary Form C dry contact are provided on all models. Other options include reverse/local 90dBA solid-state piezo horns and 135°F fixed temperature self-restoring integral or isolated thermals to meet your specific requirements.

The 8003 Series provides the temporal 3 evacuation tone as a standard feature. When testing the 8003 Series it may take up to 16 seconds longer to go in or out of alarm.

Standard Features

- 2 Year Warranty from Date of Purchase
- Functional Test Switch — Patented Three Position Test
- Nominal 2.5% Sensitivity
- 5-to-1 Signal-to-Noise Ratio
- Pulsing LED Sensing Chamber
- Fully Insect Screened
- Form A/Form C Dry Contacts
- Solid-State LED Condition Indicator



8000/8003 Series

Approvals



This symbol on the product's nameplate means it is Listed by UNDERWRITERS LABORATORIES, INC.

- Americans with Disabilities Act (ADA)
- BS+A/MEA #928-84-SA
- CSFM Listings (7272-0569:102)
- MSFM Listing #1929
- NFPA 72
- UL 268

- Quick-Disconnect Wiring Harness
- Mounting Hardware Adapts to Standard Junction Boxes
- Dust Cover to Prevent Contamination During Installation
- Protective High Air Velocity Gasket
- On Site Maintenance Washing Program
- Suitable for release device service
- Horn Frequency 3100 Hz (Nominal)

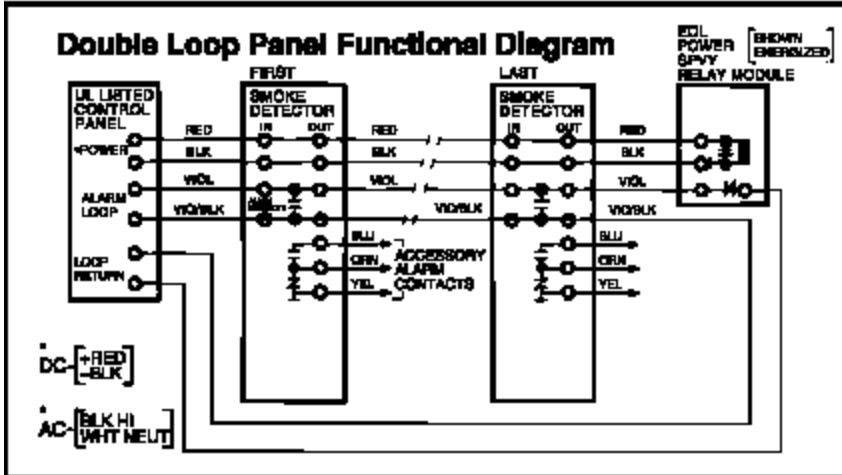
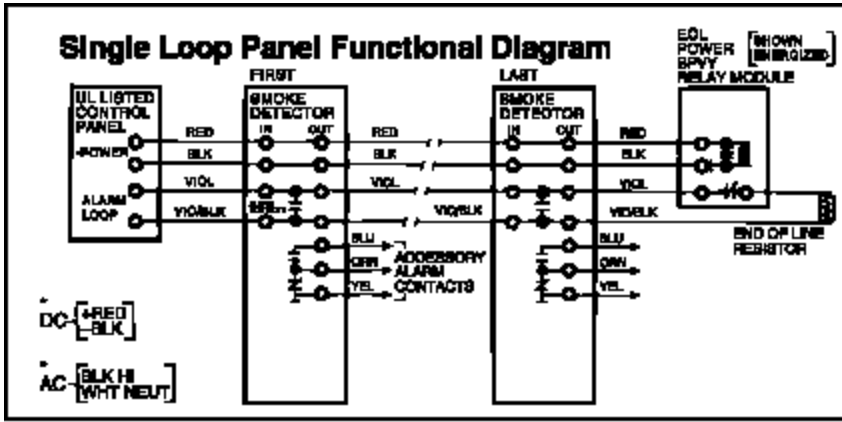
**8000 Series - 4 Wire Photoelectric System Detectors
24 VDC and 120 VAC**

Model Number	Part Number	Voltage	Reverse/ Local 90dBA Piezo	Integral 135°F Thermal	Isolated 135° Thermal	Non- Latching Circuit "Y"
8240	908-1201	24 VDC				
8240Y	908-1207	24 VDC				•
8240T	908-1203	24 VDC		•		
8240P	908-1202	24 VDC	•			
8240PT	908-1205	24 VDC	•	•		
8240PTY	908-1209	24 VDC	•	•		•
8240PY	908-1208	24 VDC	•			•
8240PH	908-1206	24 VDC	•		•	
8240PHY	908-1210	24 VDC	•		•	•
8100	908-1233	120 VAC				
8100Y	908-1239	120 VAC				•
8100T	908-1234	120 VAC		•		
8100P	908-1236	120 VAC	• (Local)			
8100PY	908-1240	120 VAC	• (Local)			•

**8003 Series - 4 Wire w/Temporal 3 Sounder Photoelectric System
Detectors 24 VDC and 120 VAC**

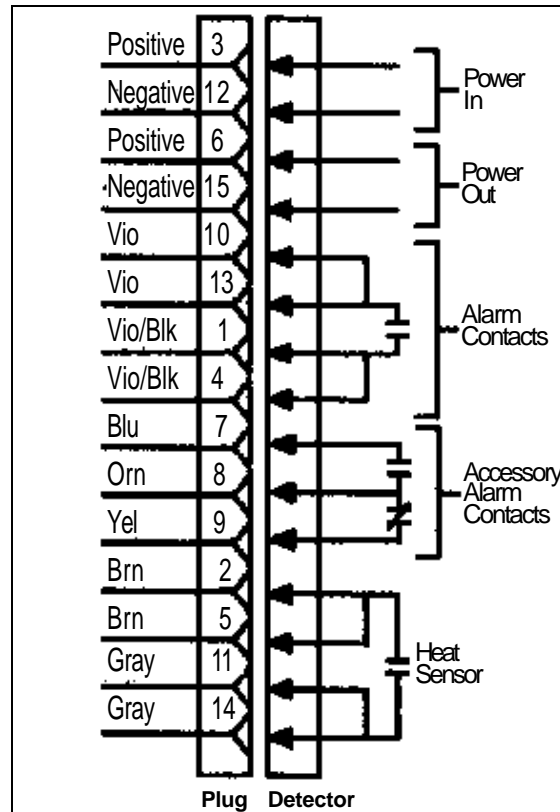
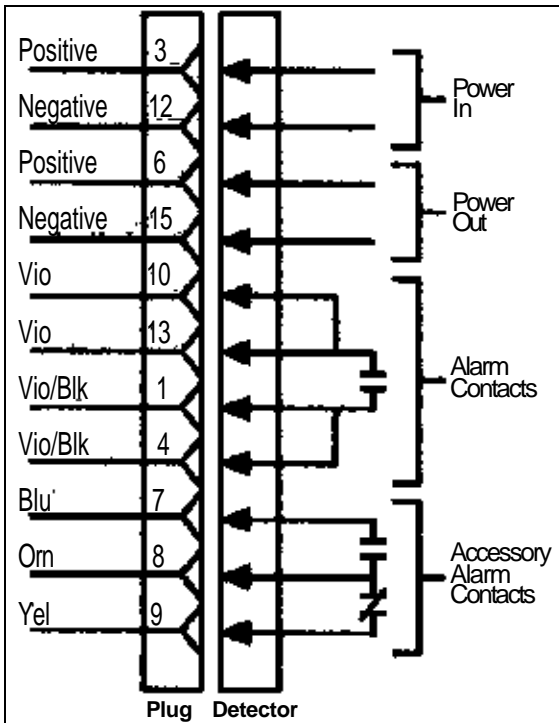
Model Number	Part Number	Voltage	Reverse/ Local 90dBA Piezo	Integral 135°F Thermal	Isolated 135° Thermal	Non- Latching Circuit "Y"
8243P	908-1211	24 VDC	•			
8243PT	908-1212	24 VDC	•	•		
8243PTY	908-1215	24 VDC	•	•		•
8243PY	908-1214	24 VDC	•			•
8243PH	908-1213	24 VDC	•		•	
8243PHY	908-1216	24 VDC	•		•	•
8103P	908-1243	120 VAC	• (local)			
8103PY	908-1246	120 VAC	• (local)			•

Wiring Diagrams



Detector Wiring Diagram

for "H" — Isolated Thermal



NOTE: Supervision of power is necessary and is accomplished by installing an End of Line Relay Assembly. The EOL Relay Assembly contacts are closed when energized and are wired in series with the alarm loop. Power failure or a break in the power loop de-energizes the EOL Relay, causing the relay contacts to open. This results in a trouble signal at the control panel.

Electrical Specifications

Model Numbers	8240	8100
Operating Voltage Nominal:	24 VDC	120 VAC
Range Min:	18 VDC	110 VAC
Max:	30 VDC	130 VAC
Frequency	-	60HZ
Current Consumption at Nominal Operating Voltage (Milliamperes):		
Standby	6mA	70mA
Alarm	60mA	70mA
Note: For "P" Option (Horn), Alarm Current Consumption is unchanged.		
Sensitivity	2.5% Nominal	
Alarm Contacts	1 Form A -N.O. (Resistive) 1 Amp at 24 VDC 0.6A at 125 VAC	
Auxiliary	1 Form C -N.O. (Resistive) 1 Amp at 24 VDC 0.5A at 120 VAC	
Temperature	40°-100°F. (4.4°C-38°C)	
Humidity	10%-93% Relative Humidity	
Size	Diameter: 6 1/2 OD (5 3/4 in. at ceiling) Depth: 2 5/8 in.	

Architect & Engineering Specifications

The Photoelectric Smoke Detector shall be a Gentex Model _____ and shall operate on the photoelectric light scattering principle and shall be listed by Underwriter's Laboratories, Inc., the State of California Fire Marshal and the Bureau of Standards and Appeals (NYC).

The smoke detector shall contain an infrared LED light source and a light sensing photodiode. These components shall be positioned such that when smoke particles enter the sensing area, light from the LED reflects onto the photodiode. When the amount of light reflected onto the photodiode reaches a predetermined level, the detector shall latch into alarm.

The smoke detector shall contain a test knob that, when in TEST 1 Position, scatters the detector's LED light source to the equivalent of a nominal .85% actual smoke condition, when in Test 2 position the detector shall simulate an equivalent of a nominal 3.5% actual smoke condition. Test feature shall indicate when maintenance is required without the need of additional equipment. A magnetic switch closure or other switch closure, or smoke generating equipment which does not scatter the light beam or test sensitivity is not sufficient.

The smoke detector shall be able to contain an optional internal 90dBA horn (at 10 feet) which emits an intermittent tone when the detector alarms. Also have the provision of reverse polarity operation. The horn shall have the capability of being self-restoring.

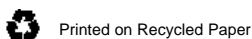
The smoke detector shall be able to provide a self-restoring integral/isolated heat sensor set to alarm at 135°F fixed temperature.

The smoke detector shall be provided from the manufacturer with all internal wiring (power in, power out and alarm contacts have 2 wires, auxiliary relay contacts have 1 wire) leading into a plug-in terminal socket for ease of field installation. Screws are not acceptable since they make service more difficult. The manufacturer shall further supply the field wiring harness with plug connector for connection to insulated wire connectors. The smoke detector shall mount to a 2" x 3" switch box or 4" octagon junction box using a standard bracket that does not have to be purchased separately. The smoke detector shall be listed for wall or ceiling mounting.



Fire Protection Products:
10985 Chicago Dr., Box 310, Zeeland, MI 49464
616/392-7195 1-800/436-8391 FAX: 616/392-4219

Gentex corporation reserves the right to make changes to the product data sheets at their discretion.



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CSFM Listing

7272-0569:102

All are suitable for releasing
device service.

GENERAL	1	P&ID Number	Tag Number	338716-100	UZT-21601A
	2	Service	0735A-08030 CARMON CREEK GAS PLANT		
	3	Application	CMT NG PRESSURE REDUCTION SKID PACKAGE		
	4	Line Number	Equipment Number	---	0735A-08030
	5	Area Classification	Location	CLASS 1 ZONE 2	CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1&2
	6	Ambient Temperature Range	-40°C TO 38°C		
	7				
	8				
	9				
PROCESS CONDITIONS	10	Gas Components	NATURAL GAS		
	11	Mole Weight or Specific Gravity			
	12	Distance From Source			
	13	Humidity			
	14	Vibration			
	15	Location			
	16				
DETECTOR	18	Model	PIRECL (INFRARED HYDROCARBON GAS DETECTOR)		
	19	Enclosure	STAINLESS STEEL EXPLOSION PROOF		
	20	Mounting	BUILT-IN MOUNT BRACKET		
	21	Sensor Type	INFRARED LEL DETECTOR		
	22	Detection Range	0-100% LFL STANDARD (METHANE)		
	23	Field of Vision	NA		
	24	Sensitivity	NA		
	25	UV Wavelength	NA		
MONITOR/ TRANSMITTER	26	IR Radiation			
	27	Model	UD10A5N25T2 (UNIVERSAL DISPLAY UNIT)		
	28	Enclosure	ALUMINUM		
	29	Mounting	BUILT-IN WALL MOUNT BRACKET		
	30	Type	EXPLOSION PROOF		
	31	Typical Response Time			
	32	Minimum Response Time			
	33	Instrument Range	0-100%		
	34	Analog Output	4-20mA		
	35	Power Supply	24VDC NOMINAL (OPERATING VOLTAGE 18 TO 30 V DC)		
	36	Local Indication	BACKLIT LCD DISPLAY		
37	Alarm Relay	THREE ALARM RELAYS & 1 FAULT RELAY			
38	Calibrated Range	0-100%			
39					
OPTIONS	40	Calibration/Test Kit	NO		
	41	Optical Air Guard	NO		
	42	Swivel Elbow	YES		
	43	Mounting Bracket	YES		
	44				
	45				
PURCHASE	46				
	47	Manufacturer	DET-TRONICS		
	48	Model	PIRECL/UD10		
	49	Purchase Order Number			
50	Price				
51	Serial Number				

Notes:

				INSTRUMENT SPECIFICATION			
				LEL DETECTOR			
1	ET	10/27/2015	Revised as per customer request	Instr. Chk	Process Chk	Appr.	
0	ET	09/15/2015	For Approval	ET	ET		Sheet 1
No.	By	Date	Description	Code:	Dwg. No.	338716-100	REV 1

**FlexVu® Explosion-Proof
Universal Display Unit
Model UD10**

CLIENT: SHELL
 LOCATION: CARMON CREEK GAS PLANT
 JOB #: 338715 (CAMP)
 TAG #: UZT-21501A
 REF DWG: 338715-100 REV10
 AREA CLASSIFICATION:
 CLASS 1 ZONE 2



DESCRIPTION

The FlexVu® Model UD10 is recommended for applications that require a gas detector with digital readout of detected gas levels as well as analog 4-20 mA output with HART, relay contacts, and Modbus RS485 (FOUNDATION™ Fieldbus option available). The UD10 Universal Display Unit is designed for use with Det-Tronics gas detectors such as GT3000, PIR9400, PIRECL, OPECL, C706x*, Model 505/CGS, CGS** or NTMOS, as well as generic linear 4-20 mA sensors. The display unit is designed and approved as a 'stand alone' device and performs all the functions of a gas controller.

Gas concentration and unit of measurement are indicated on a digital display. The display unit provides a linear isolated/non-isolated 4-20 mA DC output signal (with HART) that corresponds to the detected gas concentration.

All electronics are enclosed in an explosion-proof aluminum or stainless steel housing. The display unit is used with a single detector that may be either coupled directly to the UD10, or remotely located using a sensor termination box. The UD10 features non-intrusive calibration. A magnet is used to perform calibration as well as to navigate the UD10's internal menu.

The UD10 Universal Display can be used with various 4-20 mA gas detection devices, with or without HART. The unit provides display, output and control capabilities for the gas detector.

The UD10 utilizes the following I/O:

- Signal Inputs: 4-20 mA loop from the sensing device
- User Inputs: Magnetic switches (4) on the display panel
HART communication (handheld field communicator or AMS)
FOUNDATION™ Fieldbus (if selected)
- Signal Outputs: 4-20 mA output loop with HART
Modbus RS485 or FOUNDATION™ Fieldbus
Three alarm relays and one fault relay
- Visible Outputs: Backlit LCD display
HART slave interface via HART communicator.

FEATURES AND BENEFITS

- Universal design supports multiple Det-Tronics sensors or generic linear 4-20 mA sensors.
- Local digital LCD display continuously indicates gas level, gas type, and units measured.
- Backlit and heated display.
- Non-intrusive calibration quickly performed by one person.
- Rugged construction approved for use in classified hazardous areas.
- Linear isolated/non-isolated 4-20 mA output with HART.
- Non-intrusive menu allows device configuration without de-classifying the hazardous area.
- Internal magnetic switches provide a non-intrusive user interface.
- Smart capabilities with access to sensor information and measurement range.
- Event logs: Calibration with date and time stamp.
- Fault logs: Detector fault, Low power and General fault.
- Alarm logs: High gas alarm, Low gas alarm and Aux alarm.

* C7065E O₂ detector is not supported.

** Requires the use of a CGS Interface Board. See Instruction Manual 95-8661 for details.

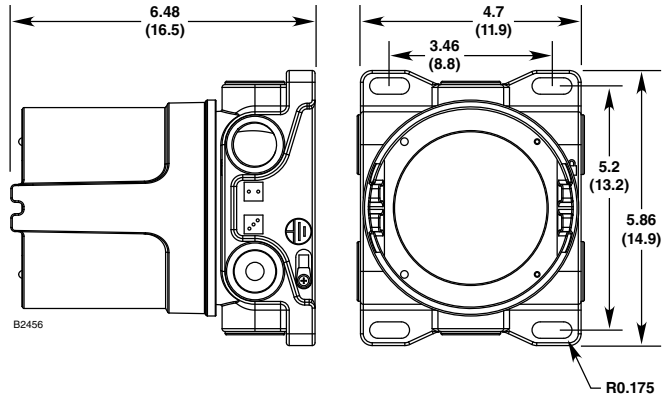
SPECIFICATIONS

Operating Voltage	24 Vdc nominal, operating range is 18 to 30 Vdc.
Operating Power	Standard model, with heater and backlight off: No alarm: 1.5 watts @ 24 Vdc. Alarm: 3 watts @ 24 Vdc (20 mA current output, and all 3 alarm relays energized.) Backlight on: 0.5 watt additional. Heater on: 3.5 watts additional. CGS model: Add 4 watts with CGS interface board and CGS sensor installed. Maximum power in alarm, with heater and backlight on: 7 watts @ 30 Vdc (Standard model) 11 watts @ 30 Vdc (CGS model) NOTES: – Heater turns on when the internal temperature drops below –10°C. Heater function can be disabled to save power. – Appropriate relays will be activated when a fault or alarm occurs.
Current Output	Linear isolated 4-20 mA output with HART. Maximum loop resistance 600 ohms at 18 to 30 Vdc.
Relay Contacts	Three Alarm Relays: Form C, 5 amperes at 30 Vdc. Selectable energized/de-energized. Selectable latching/non-latching. One Fault Relay: Form C, 5 amperes at 30 Vdc. Normally energized for no fault condition with power applied.
Operating Temperature	–55°C to +75°C.
Storage Temperature	–55°C to +75°C.
Humidity Range	5 to 95% RH (Det-Tronics verified).
Wiring Terminals	14 to 18 AWG wire can be used.
Conduit Entries	3/4" NPT or M25.
Enclosure Material	Epoxy coated aluminum or 316 stainless steel.
Shipping Weight	Aluminum: 4.15 pounds (1.88 kilograms). Stainless Steel: 10.5 pounds (4.76 kilograms).
Warranty	12 months from date of installation or 18 months from date of shipment, whichever occurs first.
Electro-Magnetic Compatibility	EMC Directive 2004/108/EC EN55011 (Emissions) EN50270 (Immunity).

Refer to Instruction Manual 95-8661 for in-depth information regarding the FlexVu UD10 Universal Display Unit.

Dimensions

Dimensions shown in inches (centimeters).



Certification



FM: Class I, Div. 1, Groups B, C & D (T5);
 Class I, Div. 2, Groups B, C & D (T4);
 Class I, Zone 1/2 AEx d IIC (T5);
 Class II/III, Div. 1/2, Groups E, F & G.
 Tamb –55°C to +75°C
 NEMA/Type 4X, IP66
 Conduit seal not required.

Performance verified in accordance with:
 ANSI/ISA-92.00.01
 ANSI/ISA-12.13.01 (CGS excluded)
 FM 6310/6320
 ANSI/ISA-12.13.04/FM 6325

CSA: CSA 08 2029512.
 Class I, Div. 1, Groups B, C & D (T5);
 Class I, Div. 2, Groups B, C & D (T4);
 Class II/III, Div. 1/2, Groups E, F & G.
 (Tamb = –55°C to +75°C)
 Type 4X
 Conduit seal not required.
 Performance verified in accordance with:
 CSA C22.2 #152.

ATEX: 0539 II 2 G
 Ex d IIC T5
 Tamb –55°C to +75°C
 FM08ATEX0042X
 IP66
 Performance verified in accordance with:
 EN 60079-29-1 and EN 50241-1/-2.

IECEX: Ex d IIC T5 Gb
 Tamb –55°C to +75°C
 IECEX FMG 08.0010X
 IP66
 Performance verified in accordance with:
 IEC 60079-29-1.



Specifications subject to change without notice.

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<http://www.det-tronics.com> • E-mail: det-tronics@det-tronics.com

CLIENT: SHELL
 LOCATION: CARMON CREEK GAS PLANT
 JOB #: 338715 (CAMP)
 TAG #: UZT-21501A
 REF DWG: 338715-100 REV10
 AREA CLASSIFICATION: CLASS1 ZONE2

Infrared Hydrocarbon Gas Detector PointWatch Eclipse® Model PIRECL



DESCRIPTION



The Pointwatch Eclipse® Model PIRECL is a diffusion-based, infrared combustible gas detector that provides continuous, fixed monitoring of flammable hydrocarbon gases from 0 to 100% Lower Flammable Limit (LFL). Standard device outputs include an electrically isolated 4-20 mA signal with HART communication protocol, and RS-485 serial communication. Serial communication protocols supported include MODBUS and ASCII. An optional relay output board with two programmable alarm relay outputs and one fault relay output is available.

supported include MODBUS and ASCII. An optional relay output board with two programmable alarm relay outputs and one fault relay output is available.

Ideally suited for protection of challenging on/offshore oil and gas facilities and other downstream hydrocarbon applications, the PointWatch Eclipse is globally certified for use in Class I, Divisions 1 and 2, and Zones 1 and 2 hazardous areas. In addition, the stainless steel construction, sapphire optics, and modular design all combine to deliver industrial grade hardness along with easy installation and the lowest cost of ownership available.

The PointWatch Eclipse is capable of detecting hundreds of flammable hydrocarbon gases and vapors. The Eclipse is performance certified to methane, propane, ethylene, and butane, and is shipped from the factory set and calibrated to one of these gases. Numerous additional operating parameters are programmable via digital communication or the optional hand-held communicator.



FEATURES AND BENEFITS

- Superior optics protection system.
- No undisclosed failure modes.
- SIL 2 model certified to IEC 61508 by exida®
- Routine calibration not required.
- Explosion-proof, stainless steel housing with tethered weather protection baffle.
- Integral wiring compartment eliminates need for external junction boxes.
- Built-in tri-color LED eliminates need for external display module.
- Built-in optional relay package eliminates need for external relay output module.
- EQP models available.
- Non-interfering HART communication capability.
- Optional Intrinsically Safe HART communication port
- Optional hand-held HART communicator enables field configuration and calibration.
- Heated sapphire optics deliver long-lasting, high performance detection capability.
- Immune to damage from exposure to constant background gases or to high gas concentrations.
- FM, CSA, DNV/MED, DEMKO and CE (including ATEX 94/9/EC) certifications.
- Certified to FM/CSA Div. 1 and DEMKO Ex d, e protection standards for maximum versatility.
- Gas performance verification by FM/CSA/DEMKO.
- Factory set and calibrated to methane, propane, ethylene, or butane.

SPECIFICATIONS

Input Voltage	24 Vdc nominal. Operating range is 18 to 32 Vdc. Ripple cannot exceed 0.5 volt P-P.
Power Consumption	4.0 watts nominal @ 24 Vdc 7.5 watts maximum @ 24 Vdc 10 watts maximum @ 32 Vdc.
Short Circuit Current	Isc: 5.4 amperes. Isc (fuse): 3.1 amperes. Power Supply Max Voltage: Um = 250V.
Warmup Time	Two minutes from cold power-up to normal mode; 1 hour minimum recommended.
Current Output Relays (Opt.)	Linear 4-20 mA (current source/sink, isolated/ non-isolated) rated at 600 ohms maximum loop resistance @ 24 Vdc operating voltage.
Temperature Range	Operating: -40°C to +75°C (-40°F to +167°F). Storage: -55°C to +85°C (-67°F to +185°F).
Humidity	0 to 99% R.H. (Det-Tronics verified). 5 to 95% R.H. (FM/CSA/DEMKO verified).
Detection Range	0 to 100% LFL standard. Other ranges are configurable.
Detectable Gases	Most flammable hydrocarbon vapors are detectable. Eclipse is performance certified to methane, propane, ethylene, and butane, and is shipped from the factory set and calibrated to one of these gases. For detection of other gases, configuration using HART, MODBUS, or EQP system software, and device calibration are required.
Device Configuration	Configuration parameters include tag number, measurement range, signal processing algorithm, alarm levels, and other selectable parameters.
Response Time in Sec. (With Methane Applied and Baffle Installed)	T50 T60 T90 With Hydrophobic Filter: 4.4 4.8 8.2 Testing based on EN 60079-29-1. See manual 95-8526 for other gases and other performance standards.
Alarm Setpoint Range	Low Alarm: 5 to 60% LFL High Alarm: 5 to 60% LFL. Note: Low alarm range for EQP model is 5-40% LFL.
Accuracy	±3% from 0 to 50% LFL, ±5% from 51 to 100% LFL.
Self-Diagnostic Test	All critical tests performed once per second.
Detector Housing Material	316 stainless steel (CF8M).
Conduit Entry Options	Two entries, 3/4 inch NPT or 25 mm.
Wiring Terminals	Field wiring screw terminals are UL/CSA rated for up to 14 AWG wire, and are DIN/VDE rated for 2.5 mm ² wire.
Shipping Weight (Approximate)	11.5 pounds (5.2 kg).
Dimensions	L = 9.3 in, W = 5.2 in, H = 4.6 in.

Certifications

FM & CSA:	Class I, Div. 1, Groups B, C & D (T4) with intrinsically safe output for HART communication in accordance with control drawing 007283-001. Class I, Div. 2, Groups A, B, C & D (T3C). Performance certified to Methane, Propane, Ethylene, & Butane in accordance with FM 6310/6320, ANSI/ISA 12.13.01, and CSA C22.2 No. 152. Tamb = -40°C to +75°C. Acidic atmospheres excluded. Conduit seal not required.
CE:	Conforms to: Low Voltage Directive: 2006/95/EC, EMC Directive: 2004/108/EC, ATEX Directive: 94/9/EC.
IEC:	IECEX ULD 04.0002X Ex de IIC T4-T5 Gb -- OR -- Ex de [ib] IIC T4-T5 Gb (with HART communication port) T5 (Tamb -50°C to +40°C) T4 (Tamb -50°C to +75°C) -- OR -- IECEX ULD 04.0002X Ex d IIC T4-T5 Gb -- OR -- Ex d [ib] IIC T4-T5 Gb (with HART communication port) T5 (Tamb -55°C to +40°C) T4 (Tamb -55°C to +75°C) IP66/IP67.
ATEX:	CE 0539 Ex II 2 G Ex de IIC T4-T5 Gb -- OR -- Ex de [ib] IIC T4-T5 Gb (with HART communication port) DEMKO 01 ATEX 129485X. (Performance certified to Methane, Propane, Ethylene, & Butane in accordance with EN 60079-29-1.) T5 (Tamb -50°C to +40°C) T4 (Tamb -50°C to +75°C) -- OR -- CE 0539 Ex II 2 G Ex d IIC T4-T5 Gb -- OR -- Ex d [ib] IIC T4-T5 Gb (with HART communication port) DEMKO 01 ATEX 129485X. (Performance certified to Methane, Propane, Ethylene, & Butane in accordance with EN 60079-29-1.) T5 (Tamb -55°C to +40°C) T4 (Tamb -55°C to +75°C) IP66/IP67.
DNV:	Certificate No. A-11023
MED:	Certificate No. MED-B-5866 Certificate No. MED-D-1508
SIL:	All Safety-Certified PIRECL models are certified compliant to: IEC61508: 2000 SIL 2 certified.

Specifications subject to change without notice.

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Customer Service: (952) 946-6491 • Fax (952) 829-8750

http://www.det-tronics.com • E-mail: det-tronics@det-tronics.com

GENERAL	1	P&ID Number	Tag Number	338716-100	UZT-21601B
	2	Service	0735A-08030 CARMON CREEK GAS PLANT		
	3	Application	CMT NG PRESSURE REDUCTION SKID PACKAGE		
	4	Line Number	Equipment Number	---	0735A-08030
	5	Area Classification	Location	CLASS 1 ZONE 2	CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1&2
	6	Ambient Temperature Range	-40°C TO 38°C		
	7				
	8				
	9				
PROCESS CONDITIONS	10	Gas Components	NATURAL GAS		
	11	Mole Weight or Specific Gravity			
	12	Distance From Source			
	13	Humidity			
	14	Vibration			
	15	Location			
	16				
DETECTOR	18	Model	PIRECL (INFRARED HYDROCARBON GAS DETECTOR)		
	19	Enclosure	STAINLESS STEEL EXPLOSION PROOF		
	20	Mounting	BUILT-IN MOUNT BRACKET		
	21	Sensor Type	INFRARED LEL DETECTOR		
	22	Detection Range	0-100% LFL STANDARD (METHANE)		
	23	Field of Vision	NA		
	24	Sensitivity	NA		
	25	UV Wavelength	NA		
MONITOR/ TRANSMITTER	26	IR Radiation			
	27	Model	UD10A5N25T2 (UNIVERSAL DISPLAY UNIT)		
	28	Enclosure	ALUMINUM		
	29	Mounting	BUILT-IN WALL MOUNT BRACKET		
	30	Type	EXPLOSION PROOF		
	31	Typical Response Time			
	32	Minimum Response Time			
	33	Instrument Range	0-100%		
	34	Analog Output	4-20mA		
	35	Power Supply	24VDC NOMINAL (OPERATING VOLTAGE 18 TO 30 V DC)		
	36	Local Indication	BACKLIT LCD DISPLAY		
37	Alarm Relay	THREE ALARM RELAYS & 1 FAULT RELAY			
38	Calibrated Range	0-100%			
39					
OPTIONS	40	Calibration/Test Kit	NO		
	41	Optical Air Guard	NO		
	42	Swivel Elbow	YES		
	43	Mounting Bracket	YES		
	44				
	45				
PURCHASE	46				
	47	Manufacturer	DET-TRONICS		
	48	Model	PIRECL/UD10		
	49	Purchase Order Number			
50	Price				
51	Serial Number				
Notes:					

				INSTRUMENT SPECIFICATION				
				LEL DETECTOR				
1	ET	10/25/2015	Revised as per customer request	Instr. Chk	Process Chk	Appr.		
0	ET	09/15/2015	For Approval	ET	ET		Sheet 1	
No.	By	Date	Description	Code:	Dwg. No.	338716-100	REV 1	

**FlexVu® Explosion-Proof
Universal Display Unit
Model UD10**

CLIENT: SHELL
LOCATION: CARMON CREEK GAS PLANT
JOB #: 338715 (CAMP)
TAG #:UZT-21501B
REF DWG: 338715-100 REV10
AREA CLASSIFICATION:
CLASS1 ZONE2



DESCRIPTION

The FlexVu® Model UD10 is recommended for applications that require a gas detector with digital readout of detected gas levels as well as analog 4-20 mA output with HART, relay contacts, and Modbus RS485 (FOUNDATION™ Fieldbus option available). The UD10 Universal Display Unit is designed for use with Det-Tronics gas detectors such as GT3000, PIR9400, PIRECL, OPECL, C706x*, Model 505/CGS, CGS** or NTMOS, as well as generic linear 4-20 mA sensors. The display unit is designed and approved as a 'stand alone' device and performs all the functions of a gas controller.

Gas concentration and unit of measurement are indicated on a digital display. The display unit provides a linear isolated/non-isolated 4-20 mA DC output signal (with HART) that corresponds to the detected gas concentration.

All electronics are enclosed in an explosion-proof aluminum or stainless steel housing. The display unit is used with a single detector that may be either coupled directly to the UD10, or remotely located using a sensor termination box. The UD10 features non-intrusive calibration. A magnet is used to perform calibration as well as to navigate the UD10's internal menu.

The UD10 Universal Display can be used with various 4-20 mA gas detection devices, with or without HART. The unit provides display, output and control capabilities for the gas detector.

The UD10 utilizes the following I/O:

- Signal Inputs: 4-20 mA loop from the sensing device
- User Inputs: Magnetic switches (4) on the display panel
HART communication (handheld field communicator or AMS)
FOUNDATION™ Fieldbus (if selected)
- Signal Outputs: 4-20 mA output loop with HART
Modbus RS485 or FOUNDATION™ Fieldbus
Three alarm relays and one fault relay
- Visible Outputs: Backlit LCD display
HART slave interface via HART communicator.

FEATURES AND BENEFITS

- Universal design supports multiple Det-Tronics sensors or generic linear 4-20 mA sensors.
- Local digital LCD display continuously indicates gas level, gas type, and units measured.
- Backlit and heated display.
- Non-intrusive calibration quickly performed by one person.
- Rugged construction approved for use in classified hazardous areas.
- Linear isolated/non-isolated 4-20 mA output with HART.
- Non-intrusive menu allows device configuration without de-classifying the hazardous area.
- Internal magnetic switches provide a non-intrusive user interface.
- Smart capabilities with access to sensor information and measurement range.
- Event logs: Calibration with date and time stamp.
- Fault logs: Detector fault, Low power and General fault.
- Alarm logs: High gas alarm, Low gas alarm and Aux alarm.

* C7065E O₂ detector is not supported.

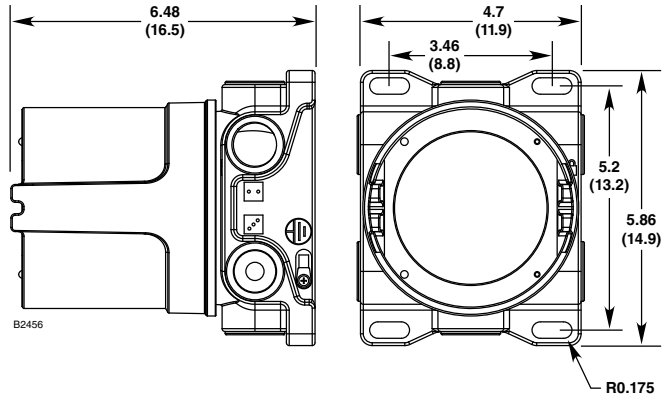
** Requires the use of a CGS Interface Board. See Instruction Manual 95-8661 for details.

SPECIFICATIONS

Operating Voltage	24 Vdc nominal, operating range is 18 to 30 Vdc.
Operating Power	Standard model, with heater and backlight off: No alarm: 1.5 watts @ 24 Vdc. Alarm: 3 watts @ 24 Vdc (20 mA current output, and all 3 alarm relays energized.) Backlight on: 0.5 watt additional. Heater on: 3.5 watts additional. CGS model: Add 4 watts with CGS interface board and CGS sensor installed. Maximum power in alarm, with heater and backlight on: 7 watts @ 30 Vdc (Standard model) 11 watts @ 30 Vdc (CGS model) NOTES: – Heater turns on when the internal temperature drops below –10°C. Heater function can be disabled to save power. – Appropriate relays will be activated when a fault or alarm occurs.
Current Output	Linear isolated 4-20 mA output with HART. Maximum loop resistance 600 ohms at 18 to 30 Vdc.
Relay Contacts	Three Alarm Relays: Form C, 5 amperes at 30 Vdc. Selectable energized/de-energized. Selectable latching/non-latching. One Fault Relay: Form C, 5 amperes at 30 Vdc. Normally energized for no fault condition with power applied.
Operating Temperature	–55°C to +75°C.
Storage Temperature	–55°C to +75°C.
Humidity Range	5 to 95% RH (Det-Tronics verified).
Wiring Terminals	14 to 18 AWG wire can be used.
Conduit Entries	3/4" NPT or M25.
Enclosure Material	Epoxy coated aluminum or 316 stainless steel.
Shipping Weight	Aluminum: 4.15 pounds (1.88 kilograms). Stainless Steel: 10.5 pounds (4.76 kilograms).
Warranty	12 months from date of installation or 18 months from date of shipment, whichever occurs first.
Electro-Magnetic Compatibility	EMC Directive 2004/108/EC EN55011 (Emissions) EN50270 (Immunity).

Dimensions

Dimensions shown in inches (centimeters).



Certification



FM: Class I, Div. 1, Groups B, C & D (T5);
 Class I, Div. 2, Groups B, C & D (T4);
 Class I, Zone 1/2 AEx d IIC (T5);
 Class II/III, Div. 1/2, Groups E, F & G.
 Tamb –55°C to +75°C
 NEMA/Type 4X, IP66
 Conduit seal not required.

Performance verified in accordance with:
 ANSI/ISA-92.00.01
 ANSI/ISA-12.13.01 (CGS excluded)
 FM 6310/6320
 ANSI/ISA-12.13.04/FM 6325

CSA: CSA 08 2029512.
 Class I, Div. 1, Groups B, C & D (T5);
 Class I, Div. 2, Groups B, C & D (T4);
 Class II/III, Div. 1/2, Groups E, F & G.
 (Tamb = –55°C to +75°C)
 Type 4X
 Conduit seal not required.
 Performance verified in accordance with:
 CSA C22.2 #152.

ATEX: 0539 II 2 G
 Ex d IIC T5
 Tamb –55°C to +75°C
 FM08ATEX0042X
 IP66
 Performance verified in accordance with:
 EN 60079-29-1 and EN 50241-1/-2.

IECEX: Ex d IIC T5 Gb
 Tamb –55°C to +75°C
 IECEX FMG 08.0010X
 IP66
 Performance verified in accordance with:
 IEC 60079-29-1.



Refer to Instruction Manual 95-8661 for in-depth information regarding the FlexVu UD10 Universal Display Unit.

Specifications subject to change without notice.

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Customer Service: (952) 946-6491 • Fax (952) 829-8750

<http://www.det-tronics.com> • E-mail: det-tronics@det-tronics.com

CLIENT: SHELL
 LOCATION: CARMON CREEK GAS PLANT
 JOB #: 338715 (CAMP)
 TAG #: UZT-21501B
 REF DWG: 338715-100 REV10
 AREA CLASSIFICATION: CLASS1 ZONE2

Infrared Hydrocarbon Gas Detector PointWatch Eclipse® Model PIRECL



DESCRIPTION



The Pointwatch Eclipse® Model PIRECL is a diffusion-based, infrared combustible gas detector that provides continuous, fixed monitoring of flammable hydrocarbon gases from 0 to 100% Lower Flammable Limit (LFL). Standard device outputs include an electrically isolated 4-20 mA signal with HART communication protocol, and RS-485 serial communication. Serial communication protocols supported include MODBUS and ASCII. An optional relay output board with two programmable alarm relay outputs and one fault relay output is available.

Ideally suited for protection of challenging on/offshore oil and gas facilities and other downstream hydrocarbon applications, the PointWatch Eclipse is globally certified for use in Class I, Divisions 1 and 2, and Zones 1 and 2 hazardous areas. In addition, the stainless steel construction, sapphire optics, and modular design all combine to deliver industrial grade hardness along with easy installation and the lowest cost of ownership available.

The PointWatch Eclipse is capable of detecting hundreds of flammable hydrocarbon gases and vapors. The Eclipse is performance certified to methane, propane, ethylene, and butane, and is shipped from the factory set and calibrated to one of these gases. Numerous additional operating parameters are programmable via digital communication or the optional hand-held communicator.



FEATURES AND BENEFITS

- Superior optics protection system.
- No undisclosed failure modes.
- SIL 2 model certified to IEC 61508 by *exida*®
- Routine calibration not required.
- Explosion-proof, stainless steel housing with tethered weather protection baffle.
- Integral wiring compartment eliminates need for external junction boxes.
- Built-in tri-color LED eliminates need for external display module.
- Built-in optional relay package eliminates need for external relay output module.
- EQP models available.
- Non-interfering HART communication capability.
- Optional Intrinsically Safe HART communication port
- Optional hand-held HART communicator enables field configuration and calibration.
- Heated sapphire optics deliver long-lasting, high performance detection capability.
- Immune to damage from exposure to constant background gases or to high gas concentrations.
- FM, CSA, DNV/MED, DEMKO and CE (including ATEX 94/9/EC) certifications.
- Certified to FM/CSA Div. 1 and DEMKO Ex d, e protection standards for maximum versatility.
- Gas performance verification by FM/CSA/DEMKO.
- Factory set and calibrated to methane, propane, ethylene, or butane.

SPECIFICATIONS

Input Voltage	24 Vdc nominal. Operating range is 18 to 32 Vdc. Ripple cannot exceed 0.5 volt P-P.
Power Consumption	4.0 watts nominal @ 24 Vdc 7.5 watts maximum @ 24 Vdc 10 watts maximum @ 32 Vdc.
Short Circuit Current	Isc: 5.4 amperes. Isc (fuse): 3.1 amperes. Power Supply Max Voltage: Um = 250V.
Warmup Time	Two minutes from cold power-up to normal mode; 1 hour minimum recommended.
Current Output Relays (Opt.)	Linear 4-20 mA (current source/sink, isolated/ non-isolated) rated at 600 ohms maximum loop resistance @ 24 Vdc operating voltage.
Temperature Range	Operating: -40°C to +75°C (-40°F to +167°F). Storage: -55°C to +85°C (-67°F to +185°F).
Humidity	0 to 99% R.H. (Det-Tronics verified). 5 to 95% R.H. (FM/CSA/DEMKO verified).
Detection Range	0 to 100% LFL standard. Other ranges are configurable.
Detectable Gases	Most flammable hydrocarbon vapors are detectable. Eclipse is performance certified to methane, propane, ethylene, and butane, and is shipped from the factory set and calibrated to one of these gases. For detection of other gases, configuration using HART, MODBUS, or EQP system software, and device calibration are required.
Device Configuration	Configuration parameters include tag number, measurement range, signal processing algorithm, alarm levels, and other selectable parameters.
Response Time in Sec. (With Methane Applied and Baffle Installed)	T50 T60 T90 With Hydrophobic Filter: 4.4 4.8 8.2 Testing based on EN 60079-29-1. See manual 95-8526 for other gases and other performance standards.
Alarm Setpoint Range	Low Alarm: 5 to 60% LFL High Alarm: 5 to 60% LFL. Note: Low alarm range for EQP model is 5-40% LFL.
Accuracy	±3% from 0 to 50% LFL, ±5% from 51 to 100% LFL.
Self-Diagnostic Test	All critical tests performed once per second.
Detector Housing Material	316 stainless steel (CF8M).
Conduit Entry Options	Two entries, 3/4 inch NPT or 25 mm.
Wiring Terminals	Field wiring screw terminals are UL/CSA rated for up to 14 AWG wire, and are DIN/VDE rated for 2.5 mm ² wire.
Shipping Weight (Approximate)	11.5 pounds (5.2 kg).
Dimensions	L = 9.3 in, W = 5.2 in, H = 4.6 in.

Certifications

FM & CSA:	Class I, Div. 1, Groups B, C & D (T4) with intrinsically safe output for HART communication in accordance with control drawing 007283-001. Class I, Div. 2, Groups A, B, C & D (T3C). Performance certified to Methane, Propane, Ethylene, & Butane in accordance with FM 6310/6320, ANSI/ISA 12.13.01, and CSA C22.2 No. 152. Tamb = -40°C to +75°C. Acidic atmospheres excluded. Conduit seal not required.
CE:	Conforms to: Low Voltage Directive: 2006/95/EC, EMC Directive: 2004/108/EC, ATEX Directive: 94/9/EC.
IEC:	IECEX ULD 04.0002X Ex de IIC T4-T5 Gb -- OR -- Ex de [ib] IIC T4-T5 Gb (with HART communication port) T5 (Tamb -50°C to +40°C) T4 (Tamb -50°C to +75°C) -- OR -- IECEX ULD 04.0002X Ex d IIC T4-T5 Gb -- OR -- Ex d [ib] IIC T4-T5 Gb (with HART communication port) T5 (Tamb -55°C to +40°C) T4 (Tamb -55°C to +75°C) IP66/IP67.
ATEX:	CE 0539 Ex II 2 G Ex de IIC T4-T5 Gb -- OR -- Ex de [ib] IIC T4-T5 Gb (with HART communication port) DEMKO 01 ATEX 129485X. (Performance certified to Methane, Propane, Ethylene, & Butane in accordance with EN 60079-29-1.) T5 (Tamb -50°C to +40°C) T4 (Tamb -50°C to +75°C) -- OR -- CE 0539 Ex II 2 G Ex d IIC T4-T5 Gb -- OR -- Ex d [ib] IIC T4-T5 Gb (with HART communication port) DEMKO 01 ATEX 129485X. (Performance certified to Methane, Propane, Ethylene, & Butane in accordance with EN 60079-29-1.) T5 (Tamb -55°C to +40°C) T4 (Tamb -55°C to +75°C) IP66/IP67.
DNV:	Certificate No. A-11023
MED:	Certificate No. MED-B-5866 Certificate No. MED-D-1508
SIL:	All Safety-Certified PIRECL models are certified compliant to: IEC61508: 2000 SIL 2 certified.

Specifications subject to change without notice.

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GENERAL	1	P&ID Number	Tag Number	338716-100	XAF-21601A
	2	Service		CMT Field Facilities and Infrastructure Phase 1 & 2	
	3	Application			
	4	Line Number	Equipment Number	---	0735A-08030
	5	Area Classification	Location	Class 1 Div 2 and Class 1 Zone 2	FIELD
	6	Ambient Temperature Range		-50°C TO 66°C	
	7	Operating Voltage		24VDC	
	8	Current Requirements		24VDC-1A	
	9				
HORN	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
TONE MODULE	18	Model		Federal Signal Model 302GCX-024	
	19	Amplifier Housing		Die Cast Aluminum Type 4X	
	20	Speaker Cone Tip & Projector		Spun aluminum alloy with powder coated finish	
	21	Sound Level on Axis @ 10ft (3m)		114dBA	
	22				
	23				
	24				
	25				
PURCHASE	26				
	27	Model		Federal Signal Model UTM	
	28	32 switchable tones			
	29	RFI and EMI shielded			
	30	UL and cUL listed, CSA Certified and CSFM Approved			
	31				
	32				
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46					
PURCHASE	47	Manufacturer		Federal Signal Corporations	
	48	Model		Federal Signal Model 302GCX-024	
	49	Purchase Order Number			
	50	Price			
	51	Serial Number			

Notes:

				INSTRUMENT SPECIFICATION				
				HORN				
1	ET	10/27/2015	Revised as per customer request	Instr. Chk	Process Chk	Appr.		
0	ET	10/15/2015	For approval	ET	ET		Sheet 1	
No.	By	Date	Description	Code:	Dwg No.:338716-100		Rev	1

MODELS 300GC, 300GCX, 302GC, AND 302GCX

**INSTALLATION AND SERVICE INSTRUCTIONS FOR
SELECTONE® MODELS 300GC, 300GCX, 302GC, AND 302GCX**

MODELOS 300GC, 300GCX, 302GC Y 302GCX

**INSTRUCCIONES PARA LA INSTALACIÓN Y EL MANTENIMIENTO DE LOS
MODELOS SELECTONE® 300GC, 300GCX, 302GC Y 302GCX**

MODÈLES 300GC, 300GCX, 302GC ET 302GCX

**CONSIGNES POUR L'INSTALLATION ET L'UTILISATION DES
MODÈLES SELECTONE® 300GC, 300GCX, 302GC ET 302GCX**

Address all communications and shipments to:
Dirija todas la correspondencia y envíós a:
Adressez toutes les communiations et expéditions à:



FEDERAL SIGNAL CORPORATION
Electrical Products Division
2645 Federal Signal Drive
University Park, IL 60466-3195

INSTALLATION AND SERVICE INSTRUCTIONS FOR MODELS 300GC, 300GCX, 302GC, AND 302GCX

SAFETY MESSAGE TO INSTALLERS

People's lives depend on your safe installation of our products. It is important to read, understand and follow all instructions shipped with these products. Listed below are some other important safety instructions and precautions you should follow:

- This unit must be installed by a qualified electrician in accordance with all National and Local Electrical Codes, and be acceptable to the Local Authority Having Jurisdiction.
- Do not connect this unit to the system wiring when circuits are energized.
- For optimum sound distribution do not install this device where objects would block any portion of the front of the speaker.
- All effective warning speakers produce loud sounds, which in certain circumstances, may cause permanent hearing loss. Take appropriate precautions such as wearing hearing protection. Recommendations in OSHA-Sound Level Standard (29 CFR 1910) should not be exceeded.
- After installation and completion of initial system test, provide a copy of this instruction sheet to all personnel responsible for operation, periodic testing, and maintenance of the equipment.

WARNING

Failure to follow all safety precautions and instructions may result in property damage, serious injury, or death to you or others.

I. GENERAL.

These four SelecTone® Models are high output, continuous duty, indoor/outdoor rated audible signal/amplified speaker devices with internal gain controls. A plug-in tone module is required for tone generation. If the use of externally generated tones or voice signals from a remote amplifier is desired, the plug-in speaker connector cards may be used. See the specification section for compatible plug-in models. These models may also be used for playback of pre-recorded messages or tones when used with the Model TM-33 Custom Tone Module. The mounting bracket is adjustable to allow positioning to obtain desired sound coverage. Speaker projectors on all models are adjustable and may be repositioned to obtain desired sound distribution.

The SelecTone Models 300GCX and 302GCX are designed for use in areas where Flammable Gases, Vapors and Liquids and Combustible Dusts are not normally present, except for abnormal conditions as defined by the National Electrical Code. These models are suitable for use in Class I, Division 2, Groups A, B, C, & D; Class II, Division 2, Groups F and G; Class III or non-hazardous locations only. Reference the product nameplate for additional information.

II. SPECIFICATIONS.

Operating Voltages:	24V AC/DC, 120VAC, 240VAC	
Supervisor Voltage:	50VDC (When speaker plug-in module is installed.)	
Current Requirements:		
300GC & 300GCX:	24VAC - 1.1A max.	24VDC - 1.1A max.
	120VAC - 0.3A max.	240VAC - 0.2A max.
302GC & 302GCX:	24VAC - 1.7A max.	24VDC - 1.7A max.
	120VAC - 0.4A max.	240VAC - 0.2A max.
Weight	24V AC/DC 120VAC, 240VAC	
300GC:	4.5 lbs. [2.0kg]	5.5 lbs. [2.5kg]
300GCX:	4.9 lbs. [2.2kg]	5.9 lbs. [2.7kg]
302GC:	6.1 lbs. [2.8kg]	7.5 lbs. [3.4kg]
302GCX:	6.5 lbs. [3.0kg]	7.9 lbs. [3.6kg]
Construction		
Amplifier Housing:	Die-cast aluminum alloy with powder coated finish. Housing sealed with a neoprene rubber gasket. External mounting bracket on Models 300GCX & 302GCX.	
Speaker Cone Tip & Projector:	Spun aluminum alloy with powder coated finish.	
Sound Level on Axis @ 10 feet [3m]:	300GC & 300GCX: 110dBA 302GC & 302GCX: 114dBA	
Approval Agency Listings:	Refer to product nameplate	
Compatible Tone Modules:	TM2, TM33*, or UTM * - Series A and B versions of the TM33 module are not compatible.	
Compatible Speaker Connector Cards:	AM25CK*, AM70CK*, EM3, 300CK, E-300CK, T-300CK, or 300CKS * - Series A versions of these connector cards are not compatible.	

III. INSTALLATION.

A. *Unpacking.*

After unpacking the speaker, examine it carefully for possible damage that may have occurred in transit. If equipment has been damaged, immediately file a claim with the carrier stating the extent of the damage. Carefully check all shipping labels and tags for special instructions before removing or destroying them.

B. *Mounting Arrangements (see figure 1).*



To maintain the Hazardous Location ratings of the Models 300GCX and 302GCX enclosure, do not use the 7/8" knockout (concealed conduit mounting.)

The amplified speaker can be mounted on any relatively flat surface. Conduit connections can be made to the two 1/2" threaded openings at bottom of the housing. A 1/2" conduit plug is supplied for field installation if one of the 1/2" threaded openings is not utilized. After the mounting location and mounting method have been selected, proceed with the applicable instructions below.

▲WARNING

Property damage, serious injury, or death could occur if an accumulation of water, snow, dust, etc. resides in the speaker projector, severely reducing or preventing operation of this device. Mount the unit so speaker projector is pointed horizontally or slightly downward.

▲WARNING

Property damage, serious injury, or death could occur if the projector is mishandled during installation or over time. DO NOT rotate the projector more than 180 degrees or internal speaker wiring may be damaged.

1. Flat Surface Mounting.

- a. Remove and retain the two screws that secure cover to housing.

Remove the cover.

▲WARNING

Property damage, serious injury, or death could occur if any objects are in front of the speaker, severely reducing optimum sound distribution. For maximum effectiveness, ensure that the front of the speaker is clear of obstructions.

- b. Select the mounting location and place rear of the housing against mounting surface.

- c. Using the mounting holes (two (2) inside for Models 300GC and 302GC's housing or four (4) outside for the Models 300GCX and 302GCX's external housing bracket) as a template, scribe drill position marks on the mounting surface. See figure 1 for mounting hole locations and dimensions.

▲CAUTION

Before drilling holes in any surface, ensure that both sides of surface are clear of items that could be damaged.

- d. Secure the unit to a wooden mounting surface with #10 x 1" wood screws. If mounting on a metal surface, drill 13/64" diameter holes and secure the unit with #10 screws, lockwashers and nuts.

- e. Route wires through the 1/2" threaded openings into the SelecTone unit in accordance with National and Local Electrical codes. Wire size depends upon the operating current and the distance from the power source.

f. Reposition speaker projector if necessary to obtain desired sound coverage. Loosen collar nut (see figure 1) and move projector to desired position.

2. Concealed Conduit Mounting (300GC and 302GC Models ONLY).

a. Remove and retain the two screws that secure cover to housing.
Remove the cover.

b. Remove the 7/8" knockout at rear of housing.

c. Install the conduit connection.

d. Route wires through the 1/2" threaded openings into the SelecTone unit in accordance with National and Local Electrical codes. Wire size depends upon the operating current and the distance from the power source.

e. Select the mounting location and place rear of housing against mounting surface.

f. Using the two (2) mounting holes as a template, scribe drill position marks on the mounting surface. See figure 1 for mounting hole locations and dimensions.



Before drilling holes in any surface, ensure that both sides of surface are clear of items that could be damaged.

g. Secure the unit to a wooden mounting surface with #10 x 1" wood screws. If mounting on a metal surface, drill 13/64" diameter holes and secure the unit with #10 screws, lockwashers and nuts.

h. Reposition speaker projector if necessary to obtain desired sound coverage. Loosen collar nut (see figure 1) and move projector to desired position. Install 1/2" conduit plugs in the unused bottom entryways (one plug supplied).

C. *Electrical Connections.*



To avoid electrical shock, do not connect wires when circuits are energized.



Never energize unit unless the cover is securely fastened to housing. Property damage, serious injury, or death could occur if the housing is not closed properly.

National and Local Electrical Codes must be adhered to in the installation and operation of these models. All electrical wiring must be routed through approved conduit and fittings as specified.

1. Power Connections.

Use only 12 to 18 AWG [2.5 – 1.0 mm²] wire for the power connection. Strip no more than .25 inch [6 mm] of wire insulation from the ends of the power leads. If stranded wire is used, be sure that there are no loose strands outside the connector plug that could touch the adjacent lead and cause a short circuit.

a. 24V AC/DC models.

For 24VDC operation, connect the power source positive (+) lead to one of the (+) terminals of the connector plug and connect the power source negative (-) lead to one of the (-) terminals of the connector plug as shown in figure 2. For 24VAC operation connect the line (hot) power source wire to the terminal marked “L”. Connect the common (neutral) power source wire to the terminal marked “N”. See figure 2. If required by local building codes, connect the earth ground wire to the green screw threaded into the interior of the housing.

b. 120VAC & 240VAC models.

Connect the line (hot) power source wire to the terminal marked “L”. Connect the common (neutral) power source wire to the terminal marked “N”. See figure 2. If required by local building codes, connect the earth ground wire to the green screw threaded into the interior of the housing.

Plug the connector into the receptacle provided on the printed circuit board.

2. Tone Card Installation.

NOTE

Tone card is purchased separately.

a. Plug the desired tone card into the socket as shown in figure 2.

b. To ensure a proper seal, be sure that the rubber cover gasket is properly seated in the housing groove and reinstall the housing cover.

3. Speaker Connector Card Installation (Models AM25CK, AM70CK, and 300CK).

NOTE

Connector card is purchased separately.

a. Route the audio signal leads into the enclosure and connect the signal leads to the connector card audio inputs. The connector cards are NOT polarity sensitive, however, polarity should be observed when placing units within close proximity to each other. Refer to the connector card installation manual provided with the connector card kit for additional wiring information.

b. Plug the desired connector card into the socket as shown in figure 2.

c. To ensure a proper seal, be sure that the rubber cover gasket is properly seated in the housing groove and reinstall the housing cover.



Property damage, serious injury, or death could occur if the housing is not closed properly. To reduce possibility of explosion, the housing cover must be kept tight while circuits are energized.

IV. TESTING/OPERATING.



These devices are capable of producing sounds loud enough to cause hearing damage. Adequate hearing protection should be worn if standing within close proximity to device while testing. Recommendations in the OSHA Sound Level Standard (29 CFR 1910F) should not be exceeded.

A. After installation is complete, be sure to test the system to verify that each amplified speaker operates satisfactorily. If it is found that the unit is too loud for its location, an internal volume control can be adjusted. Remove the housing cover. Using a slotted screwdriver with a 1/8" blade, gently turn control to desired loudness. See figure 2. Reinstall the housing cover.

B. After completion of initial system test, establish a program for periodic testing of this device.

C. Provide a copy of these instructions for the Safety Engineer, system operator(s) and maintenance personnel.

SAFETY MESSAGE TO OPERATORS

Even if your warning system is operating properly, it may not be completely effective. People may not hear or heed your warning signal. You must recognize this fact and ensure that your warning signal achieves its intended effect through proper test/training sequences within your specific application(s).

EXPLOSION HAZARD

Substitution of components may impair suitability for Class I, Division 2, and Class I, Zone 2.

V. MAINTENANCE.

SAFETY MESSAGE TO MAINTENANCE PERSONNEL

Failure to follow all safety precautions and instructions may result in property damage, serious injury, or death to you or others.

- Read and understand all instructions before performing maintenance on this unit.
- To reduce the risk of electrical shock or ignition of hazardous atmospheres, do not perform maintenance or service on this unit when circuits are energized.

- Periodic checks should be made to ensure that effectiveness of this device has not been reduced because speaker has become clogged with a foreign substance or because objects have been placed in front of the speaker.
- Any maintenance on this unit **MUST** be performed by a licensed electrician in accordance with NEC guidelines and local codes.
- Never alter these units in any manner. Note, additional openings or alterations made to the 300GCX or 302GCX Models may jeopardize the safety of the hazardous location.
- The nameplates, which contain cautionary or other information of importance to maintenance personnel, should not be obscured if the exterior of device is painted.

A. Periodically inspect this device to verify that there are no foreign substances in, or in front of the speaker, which will reduce its notification effectiveness.

B. Periodic evaluation on the performance of the unit should be conducted at regular intervals.

C. In the event a volume adjustment or other repair is required, be sure to refer to the Safety Message For Maintenance Personnel before proceeding.



Unauthorized repair/servicing of the unit may result in degradation of performance and/or safety, resulting in property damage, serious injury, or death to you or others. If a malfunctioning unit is encountered, do not attempt any field repair/retrofit of parts.

VI. SERVICE.

Federal Signal will service your equipment or provide technical assistance with any problems that cannot be handled locally.

Any units returned to Federal Signal for service, inspection, or repair, must be accompanied by a Return Material Authorization. This R.M.A. can be obtained from the local Distributor or Manufacturer's Representative.

At this time a brief explanation of the service requested or the nature of the malfunction, should be provided.

Address all communications and shipments to:

Federal Signal Corporation
 Electrical Products Division
 Service Department
 2645 Federal Signal Drive
 University Park, IL 60466-3195

VII. REPLACEMENT PARTS (Series D).

<u>Description</u>	<u>Part Number</u>
Amplifier Sub-assy., 300GC-024, 300GCX-024	K2005356A-05
Amplifier Sub-assy., 300GC-120, 300GCX-120, 300GC-240, and 300GCX-240	K2005356A-04
Amplifier Sub-assy., 302GC-024, 302GCX-024	K2005356A-03
Amplifier Sub-assy., 302GC-120, 302GCX-120, 302GC-240, and 302GCX-240	K2005356A-02
Amplifier Power Board., 300GC-024, 300GCX-024	K2001961A-05
Amplifier Power Board, 300GC-120, 300GCX-120, 300GC-240, and 300GCX-240	K2001961A-04
Amplifier Power Board, 302GC-024, 302GCX-024	K2001961A-03
Amplifier Power Board, 302GC-120, 302GCX-120, 302GC-240, and 302GCX-240	K2001961A-02
Speaker, 300GC-024, 300GCX-024, 300GC-120, 300GCX-120, 300GC-240, and 300GCX-240	8593082A
Speaker, 302GC-024, 302GCX-024, 302GC-120, 302GCX-120, 302GC-240, and 302GCX-240	8593103A
Transformer, 300GC-120, 300GCX-120	K120857A
Transformer, 300GC-240, 300GCX-240	K120858A
Transformer, 302GC-120, 302GCX-120	K120846A
Transformer, 302GC-240, 302GCX-240	K120856A
Voice Coil, 300GC-120, 300GCX-120, 300GC-240, and 300GCX-240	K8593035A
Voice Coil, 302GC-120, 302GCX-120, 302GC-240, and 302GCX-240	K8590246A

INSTRUCCIONES PARA LA INSTALACIÓN Y EL MANTENIMIENTO DE LOS MODELOS 300GC, 300GCX, 302GC Y 302GCX

MENSAJE DE SEGURIDAD PARA LOS INSTALADORES

La vida de personas depende de la instalación segura de nuestros productos. Es importante leer, comprender y seguir todas las instrucciones que vienen con estos productos. A continuación indicamos otras instrucciones importantes y precauciones de seguridad que debe seguir:

- Esta unidad debe ser instalada por un electricista calificado en conformidad con los Códigos Nacionales y Locales de Electricidad y aceptado por la autoridad local a la que corresponda la jurisdicción.
- No conecte esta unidad al cableado del sistema mientras los circuitos estén energizados.
- Para obtener una distribución óptima del sonido, no instale este dispositivo en lugares donde haya objetos que puedan obstruir cualquier porción de la parte delantera del altavoz.
- Todos los altavoces eficaces de alarma producen sonidos fuertes que pueden causar, en ciertas situaciones, la pérdida permanente de la audición. Tome las precauciones apropiadas como, por ejemplo, usar protección para los oídos. No se deben exceder las recomendaciones especificadas en la Norma de nivel de sonido (29 CFR 1910) de OSHA.
- Después de hacer la instalación y la prueba inicial del sistema, entregue una copia de estas instrucciones a todas las personas responsables de la operación, de las pruebas periódicas y del mantenimiento de estos equipos.

ADVERTENCIA

Si no se siguen todas las precauciones e instrucciones de seguridad, pueden ocasionarse daños a la propiedad o se pueden causar lesiones graves o mortales a usted o a otras personas.

I. GENERAL.

Estos cuatro modelos SelecTone® son dispositivos altavoces amplificados de alta potencia con controles internos de ganancia y señal audible nominal para servicio continuo en áreas interiores y exteriores. Es necesario un módulo enchufable para la generación de tonos. Si desea usar tonos generados externamente o señales de voz de un amplificador remoto, puede usar las tarjetas de conexión enchufables para altavoces. Consulte en la sección Especificaciones los modelos enchufables compatibles. Estos modelos también se pueden utilizar para reproducir mensajes o tonos grabados con anterioridad cuando se utilizan con el módulo de tonos personalizados (Custom Tone Module) modelo TM-33. El soporte de montaje es ajustable para permitir el cambio de posición y obtener la cobertura de sonido deseada. Los proyectores del altavoz de todos los modelos son ajustables y su posición se puede cambiar para obtener la distribución de sonido deseada.

Los modelos de SelecTone 300GCX y 302GCX están diseñados para su uso en áreas donde normalmente no hay presencia de gases, vapores o líquidos inflamables ni polvos combustibles, exceptuando las condiciones anormales que se definen en el Código Eléctrico Nacional. Estos modelos son adecuados para ser usados solamente en áreas Clase I, División 2, Grupos A, B, C y D; Clase II, División 2, Grupos F y G; Clase III o en áreas no peligrosas. Use como referencia la placa de identificación del producto para obtener información adicional.

II. ESPECIFICACIONES

Voltajes de operación:	24VCC, 24VCA, 120VCA, 240VCA	
Voltaje de referencia: está instalado).	50VCC (cuando el módulo enchufable del altavoz	
Requisitos de corriente:		
300GC y 300GCX:	24VCA - 1,1Amp máx. 120VCA - 0,3Amp máx.	24VCC - 1,1Amp máx. 240VCA - 0,2Amp máx.
302GC y 302GCX:	24VCA - 1,7Amp máx. 120VCA - 0,4Amp máx.	24VCC - 1,7Amp máx. 240VCA - 0,2Amp máx.
Peso		
300GC:	24VCC, 24VCA 4,5 lbs. [2,0kg]	120VCA, 240VCA 5,5 lbs. [2,5kg]
300GCX:	4,9 lbs. [2,2kg]	5,9 lbs. [2,7kg]
302GC:	6,1 lbs. [2,8kg]	7,5 lbs. [3,4kg]
302GCX:	6,5 lbs. [3,0kg]	7,9 lbs. [3,6kg]
Construcción		
Caja del amplificador:	Aleación de aluminio fundido con acabado de pintura en polvo. Caja sellada con una empaquetadura de caucho neopreno. Soporte de montaje externo en los modelos 300GCX y 302GCX.	
Punta del cono y proyector del altavoz:	Aleación de aluminio trenzado con acabado de pintura en polvo.	
Nivel de sonido en el eje a 10 pies [3 m]:	300GC y 300GCX: 110dBA 302GC y 302GCX: 114dBA	
Lista de agencias aprobatorias:	Consulte la placa de identificación del producto	
Módulos de tono compatibles:	TM2, TM33* o UTM * - Las versiones de las Series A y B del módulo TM33 no son compatibles.	
Tarjetas de conexión de altavoz compatibles:	AM25CK*, AM70CK*, EM3, 300CK, E-300CK, T-300CK o 300CKS * - Las versiones de la Serie A de estas tarjetas de conexión no son compatibles.	

III. INSTALACIÓN.

A. *Desempaque*

Después de desempacar el altavoz, revíselo cuidadosamente para detectar cualquier daño que pueda haber ocurrido durante su transporte. Si el equipo está dañado, presente inmediatamente una reclamación al transportador indicando la magnitud del daño. Revise cuidadosamente todos los sellos de embarque y las etiquetas para ver si hay alguna instrucción especial antes de quitarlos o destruirlos.

B. *Configuración del montaje (vea la Figura 1).*



Para mantener la clasificación para Áreas de Alto Riesgo de la caja de los modelos 300GCX y 302GCX, no use la abertura rompible de 7/8 de pulg (montaje de conducto oculto).

El altavoz amplificado se puede montar en cualquier superficie relativamente plana. Las conexiones del conducto se pueden hacer a las dos aberturas roscadas de 1/2 pulg en la parte inferior de la caja. Se suministra un tapón de conducto de 1/2 pulg para la instalación en el campo si no se utiliza alguna de las aberturas roscadas de 1/2 pulg. Después de seleccionar la ubicación y el método de montaje, proceda con las instrucciones descritas abajo que sean aplicables.

⚠ ADVERTENCIA

Pueden ocasionarse daños a la propiedad o lesiones graves o mortales si se acumula agua, nieve, polvo, etc. en el proyector del altavoz, reduciendo significativamente o impidiendo la operación de este dispositivo. Monte la unidad de tal manera que el proyector del altavoz se oriente horizontalmente o un poco hacia abajo.

⚠ ADVERTENCIA

Pueden ocasionarse daños a la propiedad o lesiones graves o mortales si el proyector es maltratado durante o después de la instalación. NO gire el proyector más de 180 grados porque pueden ocasionarse daños a los cables internos del altavoz.

1. Montaje en una superficie plana.
 - a. Quite y retenga los dos tornillos que sujetan la tapa a la caja. Quite la tapa.

⚠ ADVERTENCIA

Pueden ocasionarse daños a la propiedad o lesiones graves o mortales si hay algún objeto delante del altavoz, reduciendo significativamente la distribución óptima del sonido. Para obtener la mayor efectividad, asegúrese de que no hay ninguna obstrucción delante del altavoz.

- b. Seleccione la ubicación del montaje y coloque la parte trasera de la caja contra la superficie de montaje.
 - c. Utilice los orificios de montaje (dos (2) en el interior para la caja de los modelos 300GC y 302GC o cuatro en el exterior (4) para el soporte externo de la caja de los modelos 300GCX y 302GCX) como una plantilla para marcar la posición en la superficie de montaje donde se debe perforar. Vea la Figura 1 para obtener la ubicación y las dimensiones de los orificios de montaje.

⚠ PRECAUCION

Antes de perforar los orificios, asegúrese de que no hay nada que se pueda dañar en los dos lados de la superficie.

- d. Sujete la unidad en una superficie de montaje de madera con tornillos para madera #10 x 1 pulg. Cuando instale la unidad en superficies metálicas, perforo orificios de 13/64 pulg de diámetro en las posiciones marcadas y sujete la unidad con tornillos #10, arandelas de presión y tuercas.
 - e. Pase los cables a través de las aberturas roscadas de 12 pulg hacia la unidad SelecTone en conformidad con los Códigos Nacionales y Locales de Electricidad. El tamaño de los cables depende de la corriente que se está utilizando y la distancia a la fuente de energía.

f. Cambie la posición del proyector del altavoz si es necesario para obtener la cobertura de sonido deseada. Afloje la tuerca de collar (vea la Figura 1) y mueva el proyector a la posición deseada.

2. Montaje de conducto oculto (SÓLO en los modelos 300GC y 302GC).

tapa.

a. Quite y retenga los dos tornillos que sujetan la tapa a la caja. Quite la

b. Quite la abertura rompible de 7/8 pulg en la parte trasera de la caja.

c. Instale la conexión del conducto.

d. Pase los cables a través de las aberturas roscadas de 12 pulg hacia la unidad SelecTone en conformidad con los Códigos Nacionales y Locales de Electricidad. El tamaño de los cables depende de la corriente que se está utilizando y la distancia a la fuente de energía.

e. Seleccione la ubicación del montaje y coloque la parte trasera de la caja contra la superficie de montaje.

f. Use los dos orificios de montaje (2) como una plantilla para marcar la posición en la superficie de montaje donde se debe perforar. Vea la Figura 1 para obtener la ubicación y las dimensiones de los orificios de montaje.

▲ PRECAUCION

Antes de perforar los orificios, asegúrese de que no hay nada que se pueda dañar en los dos lados de la superficie.

g. Sujete la unidad en una superficie de montaje de madera con tornillos para madera #10 x 1 pulg. Cuando instale la unidad en superficies metálicas, perforo orificios de 13/64 pulg de diámetro en las posiciones marcadas y sujete la unidad con tornillos #10, arandelas de presión y tuercas.

h. Cambie la posición del proyector del altavoz si es necesario para obtener la cobertura de sonido deseada. Afloje la tuerca de collar (vea la Figura 1) y mueva el proyector a la posición deseada. Instale tapones de conducto de 1/2 pulg en las entradas inferiores que no se usen (se suministra un tapón).

C. *Conexiones eléctricas.*

▲ PELIGRO

Para evitar una descarga eléctrica, no conecte los cables cuando el sistema está energizado.

▲ ADVERTENCIA

Nunca energice la unidad a menos que la tapa esté sujeta firmemente a la caja. Pueden ocasionarse daños a la propiedad o lesiones graves o mortales si no se cierra correctamente la caja.

Se deben cumplir los Códigos Nacionales y Locales de Electricidad para la instalación y operación de estos modelos. Todos los cables eléctricos debe tenderse por un conducto aprobado y usando los conectores aprobados de acuerdo a las especificaciones.

1. Conexiones de energía.

Utilice sólo cables de 12 a 18 AWG (2,5 – 1,0 mm²) para las conexiones de energía. No quite más de 0,25 pulg (6 mm) de aislamiento de cable del extremo de los conductores de energía. Si utiliza cable trenzado, asegúrese de que no hay ninguna trenza suelta por fuera del enchufe conector que pueda entrar en contacto con un conductor adyacente y causar un corto circuito.

a. Modelos de 24V CA/CC.

Para la operación a 24VCC, conecte el conductor positivo de la fuente de potencia a uno de los terminales positivos (+) del enchufe conector y el conductor negativo a uno de los terminales negativos (-) del enchufe conector, como se muestra en la Figura 2. Para la operación de 24VCA, conecte el cable de línea (caliente) de la fuente de energía al terminal marcado con la letra “L”. Conecte el cable común (neutral) de la fuente de energía al terminal marcado con la letra “N”. Vea la Figura 2. Si los códigos de construcción locales lo exigen, conecte el cable de conexión a tierra al tornillo roscado verde en el interior de la caja.

b. Modelos de 120VCA y 240VCA.

Conecte el cable de línea (caliente) de la fuente de energía al terminal marcado con la letra “L”. Conecte el cable común (neutral) de la fuente de energía al terminal marcado con la letra “N”. Vea la Figura 2. Para la operación a 24V CA, conecte el cable de línea (caliente) de la fuente de energía al terminal marcado con la letra “L”.

Conecte el conector al receptáculo proporcionado en la tarjeta del circuito impreso.

2. Instalación de la tarjeta de tono

NOTA

La tarjeta de tono se compra separadamente.

- a. Instale la tarjeta de tono deseada en el receptáculo como se muestra en la Figura 2.
- b. Para obtener un sellado correcto, asegúrese de que la empaquetadura de goma de la tapa se asiente correctamente en la ranura de la caja e instale de nuevo la tapa de la caja.

3. Instalación de la tarjeta de conexión del altavoz (modelos AM25CK, AM70CK y 300CK).

NOTA

La tarjeta de conexión se compra separadamente.

- a. Pase los conductores de señal de audio al interior de la caja y conecte los conductores de señal a las entradas del conector de la tarjeta de audio. Las tarjetas de conexión NO son susceptibles a la polaridad; sin embargo, se debe observar la polaridad cuando se coloca una unidad muy cerca de otra. Consulte el manual de instalación de la tarjeta de conexión que se proporciona con el juego de tarjetas de conexión para obtener más información acerca del cableado.
- b. Conecte la tarjeta de conexión deseada en el receptáculo, como se muestra en la Figura 2.

c. Para obtener un sellado correcto, asegúrese de que la empaquetadura de goma de la tapa se asiente correctamente en la ranura de la caja e instale de nuevo la tapa de la caja.

ADVERTENCIA

Pueden ocasionarse daños a la propiedad o lesiones graves o mortales si no se cierra correctamente la caja. Para disminuir la posibilidad de una explosión, la tapa de la caja debe mantenerse ajustada mientras el sistema está energizado.

IV. PRUEBA/OPERACIÓN.

ADVERTENCIA

Estos dispositivos tienen la capacidad de producir sonidos lo suficientemente fuertes para causar daños al oído. Debe usar protección adecuada para los oídos si está cerca del dispositivo mientras se está probando. No se deben exceder las recomendaciones especificadas en la Norma de nivel de sonido (29 CFR 1910F) de OSHA.

A. Después de completar la instalación, asegúrese de probar el sistema para verificar que cada altavoz amplificado está funcionando correctamente. Si la unidad produce sonidos demasiado fuertes para el lugar donde está ubicada, se puede ajustar el control de volumen interno. Quite la tapa de la caja. Utilizando un atornillador acanalado con una hoja de 1/8 pulg, gire suavemente el control al nivel de volumen deseado. Vea la Figura 2. Instale de nuevo la tapa de la caja.

B. Después de la instalación y la prueba inicial del sistema, se debe establecer un programa de pruebas periódicas para este dispositivo.

C. Entregue una copia de estas instrucciones al ingeniero de seguridad, a los operadores del sistema y al personal de mantenimiento.

MENSAJE DE SEGURIDAD PARA LOS OPERADORES

Aunque su sistema de advertencia esté funcionando correctamente, es posible que no sea completamente efectivo. Es posible que las personas no escuchen o no hagan caso de su señal de advertencia. Debe reconocer este hecho y asegurarse de que su señal de advertencia cumple el efecto deseado realizando secuencias de pruebas y de entrenamiento para sus aplicaciones específicas.

ADVERTENCIA - PELIGRO DE EXPLOSIÓN

La sustitución de componentes puede deteriorar la idoneidad para Clase I, División 2 y Clase I, Zona 2.

V. MANTENIMIENTO.

MENSAJE DE SEGURIDAD PARA EL PERSONAL DE MANTENIMIENTO

Si no se siguen todas las precauciones e instrucciones de seguridad, pueden ocasionarse daños a la propiedad o se pueden causar lesiones graves o mortales a usted o a otras personas.

- Lea y comprenda todas las instrucciones antes de realizar trabajos de mantenimiento en esta unidad.

- Para disminuir el riesgo de descargas eléctricas o de incendios en atmósferas de alto riesgo, no realice trabajos de mantenimiento en este dispositivo mientras el sistema está energizado.
 - Se deben hacer revisiones periódicas para asegurar que la efectividad del dispositivo no ha disminuido debido a obstrucciones en el altavoz causadas por sustancias extrañas o porque se hayan colocado objetos delante del altavoz.
 - Todos los trabajos de mantenimiento en esta unidad DEBEN ser realizados por un electricista capacitado en conformidad con el Código Eléctrico Nacional y con los códigos locales.
 - Nunca altere estas unidades de ninguna manera. Tenga en cuenta que las aberturas adicionales y las alteraciones a los modelos 300GCX o 302GCX pueden poner en peligro la seguridad en áreas de alto riesgo.
 - Las placas de identificación, que pueden contener precauciones o información de importancia para el personal de mantenimiento, no se deben cubrir con pintura cuando se pinta el exterior del dispositivo.
- A. Inspeccione periódicamente este dispositivo para verificar que no hay sustancias extrañas en o delante del altavoz que puedan disminuir la efectividad anunciada.
- B. Se deben realizar evaluaciones periódicas del rendimiento de la unidad.
- C. Si es necesario ajustar el volumen o realizar alguna reparación, asegúrese de consultar el Mensaje de seguridad para el personal de mantenimiento antes de proceder.

⚠ ADVERTENCIA

Si se hacen trabajos de mantenimiento y reparación que no están autorizados, se puede ocasionar la degradación del rendimiento y de la seguridad de la unidad, con la posibilidad de causar daños a la propiedad y lesiones graves o mortales a usted o a otras personas. Si tiene una unidad averiada, no intente reparar ni adaptar ninguna de las piezas.

VI. SERVICIO.

Federal Signal reparará su equipo o le prestará asistencia técnica con cualquier problema que no pueda corregirse localmente.

Todas las unidades devueltas a Federal Signal para su mantenimiento, inspección o reparación deben enviarse con una Autorización de Devolución de Materiales R.M.A. Esta R.M.A. puede obtenerse de su distribuidor local o del representante del fabricante.

En ese momento se le pedirá una breve explicación del servicio solicitado o la naturaleza del desperfecto.

Dirija toda su correspondencia y todos sus envíos a:

Federal Signal Corporation
 Electrical Products Division
 Service Department
 2645 Federal Signal Drive
 University Park, IL 60466-3195

VII. COMPONENTES DE REEMPLAZO (Serie D).

<u>Descripción</u>	<u>Número de parte</u>
Subconjunto de amplificador, 300GC-024, 300GCX-024	K2005356A-05
Subconjunto de amplificador, 300GC-120, 300GCX-120, 300GC-240 y 300GCX-240	K2005356A-04
Subconjunto de amplificador, 302GC-024, 302GCX-024	K2005356A-03
Subconjunto de amplificador, 302GC-120, 302GCX-120 302GC-240 y 302GCX-240	K2005356A-02
Tablero de alimentación del amplificador, 300GC-024, 300GCX-024	K2001961A-05
Tablero de alimentación del amplificador, 300GC-120, 300GCX-120 300GC-240 y 300GCX-240	K2001961A-04
Tablero de alimentación del amplificador, 302GC-024, 302GCX-024	K2001961A-03
Tablero de alimentación del amplificador, 302GC-120, 302GCX-120 302GC-240 y 302GCX-240	K2001961A-02
Altavoz, 300GC-024, 300GCX-024, 300GC-120, 300GCX-120, 300GC-240 y 300GCX-240	8593082A
Altavoz, 302GC-024, 302GCX-024, 302GC-120, 302GCX-120, 302GC-240 y 302GCX-240	8593103A
Transformador, 300GC-120, 300GCX-120	K120857A
Transformador, 300GC-240, 300GCX-240	K120858A
Transformador, 302GC-120, 302GCX-120	K120846A
Transformador, 302GC-240, 302GCX-240	K120856A
Bobina de voz, 300GC-120, 300GCX-120, 300GC-240 y 300GCX-240	K8593035A
Bobina de voz, 302GC-120, 302GCX-120, 302GC-240 y 302GCX-240	K8590246A

CONSIGNES POUR L'INSTALLATION ET L'UTILISATION DES MODÈLES 300GC, 300GCX, 302GC ET 302GCX

MESSAGE DE SÉCURITÉ POUR LES INSTALLATEURS

Des vies humaines dépendent de l'installation sans danger que vous faites de nos produits. Il est important de lire, de comprendre et de suivre toutes les consignes jointes à ces produits. De plus, sont énumérées ci-dessous quelques autres consignes et mesures de sécurité importantes à suivre :

- Un électricien qualifié doit installer cette unité conformément aux codes électriques national et locaux; l'autorité ayant juridiction doit l'accepter.
- Ne pas brancher cette unité au système quand celui-ci est sous tension.
- Pour une répartition optimale du son, ne pas installer cet appareil là où des objets feraient obstacle à l'avant du haut-parleur.
- Tous les haut-parleurs d'avertissement efficaces produisent des sons puissants qui, dans certaines situations, peuvent causer une perte auditive permanente. Vous devez prendre des précautions adéquates comme le port d'une protection auditive. Il ne faut pas dépasser les recommandations de la norme de niveau sonore (29 CFR 1910) de l'OSHA.
- Après l'installation et l'exécution d'un premier essai du système, fournir une copie de cette feuille de consignes à tout le personnel responsable du fonctionnement, des essais périodiques et de l'entretien de cet équipement.

AVERTISSEMENT

Le non respect de toutes les mesures et consignes de sécurité pourrait entraîner des dommages aux biens, de sérieuses blessures ou la mort pour vous ou d'autres

I. GÉNÉRALITÉS.

Ces quatre modèles SelecTone® sont des haut-parleurs à sortie élevée, à service continu, amplifiés/à signal audible homologué intérieur/extérieur avec réglages internes de puissance de son. Un module enfichable de tonalité est requis pour la génération de tonalité. Pour des tonalités générées à l'extérieur ou des signaux vocaux à partir d'un amplificateur à distance, vous pouvez utiliser les cartes de connecteur enfichables. Voir les modèles enfichables compatibles au chapitre spécification. Vous pouvez aussi vous servir de ces modèles pour la lecture de messages ou de tonalités préenregistrées avec le module à tonalités personnalisées modèle TM-33. Le support de fixation est réglable pour placer l'appareil de façon à obtenir la couverture sonore désirée. Sur tous les modèles, les cornets de haut-parleurs sont réglables et peuvent être repositionnés pour obtenir la diffusion de son désirée.

Les modèles SelecTone 300GCX et 302GCX sont conçus pour servir dans des aires où des gaz, vapeurs et liquides inflammables et des poussières combustible ne sont pas présents normalement, excepté dans des conditions anormales telles que définies par le Code électrique national. Ces modèles conviennent seulement pour les endroits de classe I, division 2, groupes A, B, C, et D; classe II, division 2, groupes F et G; classe III ou sans danger. Se reporter à la plaque signalétique du produit pour plus d'information

II. SPÉCIFICATIONS

Tensions de fonctionnement :	24 V CA/CC, 120 V CA, 240 V CA	
Tension du superviseur :	50 V CC (Quand le module enfichable du haut-parleur est installé.)	
Courants exigés :		
300GC et 300GCX:	24 V CA - 1,1 A max.	24 V CC - 1,1 A max.
	120 V CC - 0,3 A max.	240 V CA - 0,2 A max.
302GC & 302GCX:	24 V CA - 1,7 A max.	24 V CC - 1,7 A max.
	120 V CC - 0,3 A max.	240 V CA - 0,2 A max.

24V 24 V CA/CC, 120 V CA, 240 V CA		
300GC:	2 kg [4,5 lb]	2,5 kg [5,5 lb]
300GCX:	2,2 kg [4,9 lb]	2,7 kg [5,9 lb]
302GC:	2,8 kg [6,1 lb]	3,4 kg [7,5 lb]
302GCX:	3 kg [6,5 lb]	3,6 kg [7,9 lb]

Construction du boîtier d'amplificateur : Fonte d'alliage d'aluminium avec fini de revêtement en poudre
Boîtier scellé par un joint de néoprène
Support de montage externe sur les modèles 300GCX et 302GCX.

Bout du cône diffuseur et cornet du haut-parleur : Alliage d'aluminium avec fini de revêtement en poudre.

Niveau sonore (sur l'axe @ 3m [10 pi]) : 300GC et 300GCX : 110 dBA
302GC et 302GCX : 114 dBA

Listes d'homologation : Se reporter à la plaque signalétique du produit

Modules compatibles de tonalité : TM2, TM33*, ou UTM
* - Les versions **Séries A et B** du module TM33 ne sont pas compatibles.

Cartes de connecteur compatibles avec le haut-parleur : AM25CK*, AM70CK*, EM3, 300CK, E-300CK, T-300CK, ou 300CKS

* - Les versions de série A de ces cartes de connecteur ne sont pas compatibles.

III. INSTALLATION.

A. Déballage.

Après avoir déballé le haut-parleur, vérifier soigneusement s'il a été endommagé lors du transport. Si l'équipement a été endommagé, faire immédiatement au transporteur une réclamation déclarant l'étendue des dommages. Examiner soigneusement toutes les étiquettes d'expédition et de consignes particulières avant de les enlever ou de les détruire.

B. Dispositions de Montage (Voir figure 1)



Pour maintenir la classification pour endroits dangereux des modèles d'enceinte 300GCX et 302GCX, ne pas utiliser l'entrée défonçable de 7/8 po (montage à conduit caché).

Le haut-parleur peut être fixé sur une surface relativement plane capable de supporter son poids. Les conduits de câbles peuvent être raccordés aux ouvertures taraudées de 1/2 po situées à la base du boîtier. Un bouchon de conduit de 1/2" est fourni pour l'installation si une des ouvertures taraudées de 1/2 po n'est pas utilisée. Après avoir choisi emplacement et la méthode de montage, procéder selon les consignes applicables suivantes.

▲ AVERTISSEMENT

Il pourrait arriver des dommages aux biens, des blessures sérieuses ou la mort si de l'eau, de la neige, de la poussière, etc. s'accumulent dans le cornet du haut-parleur, réduisant gravement ou empêchant le fonctionnement de cet appareil. Fixer l'unité pour que le cornet du haut-parleur soit dirigé horizontalement ou légèrement vers le bas.

▲ AVERTISSEMENT

Il pourrait arriver des dommages aux biens, des blessures sérieuses ou la mort si le cornet est manipulé sans précaution lors de l'installation ou postérieurement. NE PAS faire pivoter le cornet de plus de 180 degrés afin de ne pas endommager le câblage intérieur du haut-parleur.

1. Montage sur Surface Plane.

a. Retirer et garder les deux vis qui fixent le couvercle au boîtier. Retirer le boîtier.

▲ AVERTISSEMENT

Il pourrait arriver des dommages aux biens, des blessures sérieuses ou la mort si des objets se trouvaient devant le haut-parleur, réduisant gravement la répartition optimale du son. Pour une efficacité maximale, faire en sorte qu'il n'y ait aucune obstruction à l'avant du haut-parleur.

b. Choisir l'emplacement de montage et placer l'arrière du boîtier contre la surface de montage.

c. Se servir des trous de montage (deux [2] à l'intérieur du boîtier des modèles 300GC et 302GC ou quatre [4] dans le support de montage externe des modèles 300GCX et 302GCX) comme gabarit, pour marquer les positions de perçage sur la surface de montage. Voir la figure 1 pour l'emplacement des trous de fixation et leurs dimensions.

▲ ATTENTION

Avant de percer des trous sur une surface, s'assurer que ses deux faces sont exemptes de quoi que ce soit qui pourrait être endommagé.

d. Fixer l'appareil à une surface de bois avec des vis à bois de 1 po No 10. En cas de montage sur une surface métallique, percer des trous de 13/64" de diamètre et fixer l'appareil avec des boulons No 10, des rondelles-frein et des écrous.

e. Passer les fils par les ouvertures taraudées d'1/2 po dans l'appareil SelectTone conformément aux codes électriques national et locaux. Le calibre du fil dépend du courant de fonctionnement et de la distance de la source d'alimentation

f. Repositionner le cornet du haut-parleur si nécessaire pour obtenir la couverture sonore désirée. Desserrer l'écrou à embase (voir figure 1) et déplacer le cornet jusqu'à la position désirée.

2. Montage avec Conduit Caché (Modèles 300GC et 302GC SEULEMENT).

a. Retirer et garder les deux vis qui fixent le couvercle au boîtier. Retirer le boîtier.

b. Retirer l'entrée défonçable de 7/8" à l'arrière du boîtier.

c. Installer le raccord de conduit.

d. Passer les fils par les ouvertures taraudées d'1/2 po dans l'appareil SelectTone conformément aux codes électriques national et locaux. Le calibre du fil dépend du courant de fonctionnement et de la distance de la source d'alimentation

e. Choisir l'emplacement de montage et placer l'arrière du boîtier contre la surface de montage.

f. À l'aide du support de fixation comme gabarit, marquer la position des trous à percer sur la surface de fixation. Voir la figure 1 pour l'emplacement des trous de fixation et leurs dimensions.

▲ ATTENTION

Avant de percer des trous sur une surface, s'assurer que ses deux faces sont exemptes de tout élément qui pourrait être endommagé.

g. Fixer l'appareil à une surface de bois avec des vis à bois de 1 po No 10. En cas de montage sur une surface métallique, percer des trous de 13/64" de diamètre et fixer l'appareil avec des boulons No 10, des rondelles-frein et des écrous.

h. Repositionner le cornet du haut-parleur si nécessaire pour obtenir la couverture sonore désirée. Desserrer l'écrou à embase (voir figure 1) et déplacer le cornet jusqu'à la position désirée. Installer des bouchons de conduits de 1/2" dans les entrées non utilisées (un bouchon fourni).

C. *Connexions électriques*

▲ DANGER

Pour éviter un choc électrique, ne pas connecter de fils quand les circuits sont sous tension.

▲ AVERTISSEMENT

Ne jamais mettre l'appareil sous tension si le couvercle n'est pas bien fixé sur le boîtier. Il pourrait arriver des dommages aux biens, des blessures sérieuses ou la mort si le boîtier n'est pas bien fermé.

Il faut suivre le code électrique national ainsi que les codes locaux pour l'installation de ces modèles. Tout le câblage électrique doit passer par les conduits et les raccords homologués tel que spécifié.

1. Connexions à l'alimentation

Utiliser seulement un fil de calibre 12 à 18 AWG (2.5 – 1.0 mm²) pour la connexion à l'alimentation. Ne pas dénuder plus de 6 mm (25 po) de fil aux extrémités des conducteurs. Si vous utilisez du fil toronné, assurez-vous qu'il n'y a pas de toron flottant à l'extérieur du connecteur qui pourrait toucher le conducteur adjacent et causer un court-circuit.

a. Modèles 24 V CA/CC

Pour le fonctionnement en 24 V CC, connecter le fil (+) positif d'alimentation à une des bornes (+) et le fil (-) négatif à une des bornes (-) du connecteur enfichable comme montré à la figure 2. Pour le fonctionnement en 24 V CA, connecter le fil de ligne (vivant) de la source de courant à la borne indiquée « L ». Connecter le fil commun (neutre) de la source de courant à la borne indiquée « N ». Voir figure 2. En cas d'exigence des codes locaux de construction, connecter le fil de mise à la terre à la vis verte filetée à l'intérieur de l'enceinte.

b. Modèles 120 V CC et 240V CC

Connecter le fil de ligne (vivant) de la source de courant à la borne indiquée « L ». Connecter le fil commun (neutre) de la source de courant à la borne indiquée « N ». Voir figure 2. En cas d'exigence des codes locaux de construction, connecter le fil de mise à la terre à la vis verte filetée à l'intérieur de l'enceinte.

Brancher le connecteur dans la prise fournie sur la carte de circuits imprimés.

2. Installation de la carte de tonalité

NOTE

La carte de tonalité s'achète séparément.

- a. Insérer la carte de tonalité désirée dans la prise femelle comme le montre la figure 2.
- b. Pour s'assurer d'une bonne étanchéité, vérifier que le joint de caoutchouc du couvercle est bien installé dans la rainure du boîtier et reposer le couvercle du boîtier.

3. Installation des cartes de connecteurs de haut-parleur (Modèles AM25CK, AM70CK, et 300CK).

NOTE

La carte de connecteurs s'achète séparément.

- a. Passer les conducteurs de signal audio dans l'enceinte et les connecter aux entrées audio de la carte de connecteurs. Les cartes de connecteurs NE sont PAS sensibles à la polarité; cependant, il faut observer la polarité en plaçant les unités à proximité l'une de l'autre. Se reporter au manuel d'installation de cartes de connecteurs fourni avec la trousse de cartes de connecteurs pour des renseignements supplémentaires sur les branchements.
- b. Insérer la carte de connecteur désirée dans la prise femelle comme le montre la figure 2.
- c. Pour s'assurer d'une bonne étanchéité, vérifier que le joint de caoutchouc du couvercle est bien installé dans la rainure du boîtier et reposer le couvercle du boîtier.

AVERTISSEMENT

Il pourrait arriver des dommages aux biens, des blessures sérieuses ou la mort si le boîtier n'est pas bien fermé. Pour réduire la possibilité d'explosion, il faut que le couvercle du boîtier soit bien fermé pendant la mise sous tension des circuits.

IV. ESSAIS / FONCTIONNEMENT.

AVERTISSEMENT

Dans certaines situations, ces appareils sont capables de produire des sons suffisamment puissants pour causer une diminution de l'acuité auditive. Vous devez porter une protection auditive adéquate si vous êtes à proximité de l'appareil pendant les essais. Il ne faut pas dépasser les recommandations de la norme de niveau sonore (29 CFR 1910) de l'OSHA.

A. Une fois l'installation terminée, faire l'essai du système pour vérifier que chaque haut-parleur amplifié fonctionne de manière satisfaisante. Si l'unité est trop bruyante pour son emplacement, on peut régler le volume à l'aide d'une commande interne. Reposer le couvercle du boîtier. À l'aide d'un tournevis plat avec une lame de 1/8", tourner doucement la commande à l'intensité sonore désirée. Voir figure 2. Reposer le couvercle du boîtier.

B. Une fois terminé le premier essai du système, il faut établir un programme d'essai périodique de cet appareil.

C. Fournir une copie de ces consignes à l'ingénieur de la sécurité, aux opérateurs du système et au personnel d'entretien.

MESSAGE DE SÉCURITÉ AUX OPÉRATEURS

Même si votre système fonctionne correctement, il pourrait ne pas être totalement efficace. Les gens pourraient ne pas entendre ou tenir compte du signal avertisseur. Vous devez reconnaître ce fait et vous assurez que votre signal avertisseur atteint son but par de séquences appropriées d'essais et de formation dans le cadre de vos applications spécifiques.

WARNING - RISQUE D'EXPLOSION

La substitution de composants pourrait réduire la compatibilité avec la classe 1, division 2 et classe 1, zone 2

V. ENTRETIEN.

MESSAGE DE SÉCURITÉ AU PERSONNEL D'ENTRETIEN

Le non respect de toutes les mesures et consignes de sécurité pourrait entraîner des dommages aux biens, de sérieuses blessures ou la mort pour vous ou d'autres

- Lire et comprendre toutes les consignes avant d'effectuer l'entretien de cette unité.
- Pour réduire le risque de chocs électriques ou un allumage d'atmosphères dangereuses, ne pas effectuer d'entretien ou de réparation sur cet appareil si les circuits sont sous tension.
- Il faut faire des vérifications périodiques pour s'assurer que l'efficacité de cet appareil n'a pas été réduite parce qu'une substance étrangère obstrue le haut-parleur ou que des objets ont été placés en devant celui-ci.

- Un électricien formé DOIT effectuer tout entretien de cette unité conformément aux directives du NEC et des codes locaux.
- Ne jamais modifier ces appareils d'aucune façon. Note : Faire d'autres ouvertures ou modifications aux modèles 300GCX or 302GCX pourrait compromettre la sécurité de emplacement dangereux.
- Si l'extérieur de l'appareil est peint, il ne faut pas masquer les plaques signalétiques qui comportent des avertissements et autres renseignements d'importance pour le personnel d'entretien.

A. Inspecter périodiquement cet appareil pour vérifier qu'il n'y a aucune substance étrangère dans ou devant le haut-parleur, ce qui réduirait son efficacité.

B. Il faut effectuer une évaluation périodique de la performance de l'appareil à intervalles réguliers.

C. En cas d'ajustement de volume ou d'une autre réparation, assurez-vous de vous reporter au message de sécurité pour le personnel d'entretien avant de continuer.

▲ AVERTISSEMENT

Une réparation ou un dépannage non autorisés de cette unité pourrait entraîner une dégradation de la performance et/ou des dommages aux biens, de sérieuses blessures ou la mort pour vous ou d'autres. Si une unité présente un mauvais fonctionnement, ne pas essayer de réparer sur place ou de remplacer des pièces.

VI. SERVICE.

Federal Signal dépannera votre équipement et vous fournira de l'assistance technique pour tout problème qui ne peut être traité localement.

Tout appareil retourné à Federal Signal pour dépannage, inspection ou réparation doit être accompagné d'une autorisation de retour de matériel (RMA). Votre distributeur local ou un représentant du fabricant peut vous fournir cette RMA.

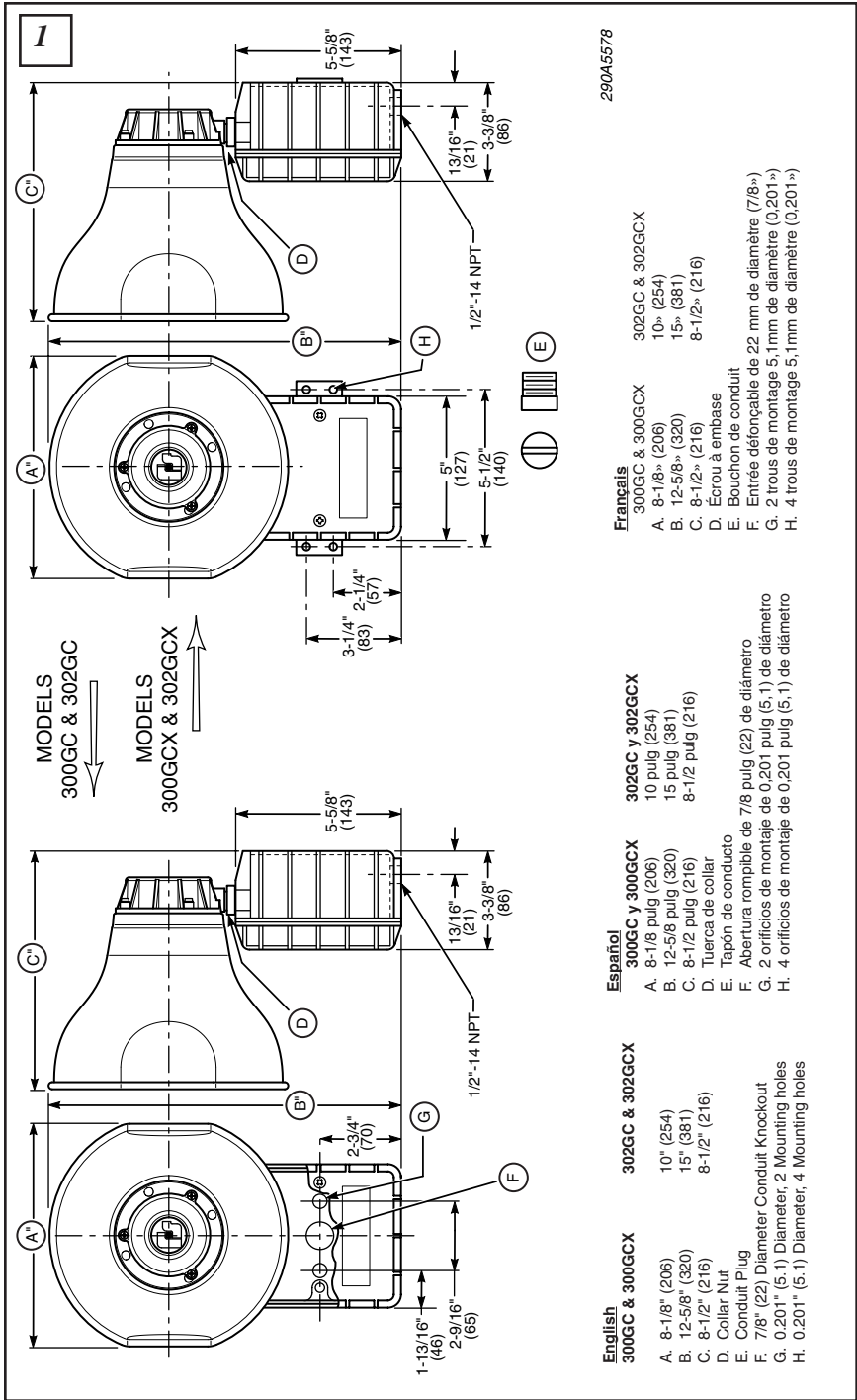
À ce moment-là, vous devrez donner une brève explication du service requis ou de la nature du mauvais fonctionnement.

Adresser toutes les communications et envois à :

Federal Signal Corporation
 Electrical Products Division
 Service Department
 2645 Federal Signal Drive
 University Park, IL 60466-3195

VII. PIÈCES DE RECHANGE (Série D).

<u>Description</u>	<u>Numéro de pièce</u>
Sous-ensemble d'amplificateur, 300GC-024, 300GCX-024	K2005356A-05
Sous-ensemble d'amplificateur, 300GC-120, 300GCX-120, 300GC-240 et 300GCX-240	K2005356A-04
Sous-ensemble d'amplificateur, 302GC-024, 302GCX-024	K2005356A-03
Sous-ensemble d'amplificateur, 302GC-120, 302GCX-120, 302GC-240 et 302GCX-240	K2005356A-02
Circuit d'alimentation d'amplificateur, 300GC-024, 300GCX-024	K2001961A-05
Circuit d'alimentation d'amplificateur, 300GC-120, 300GCX-120 300GC-240 et 300GCX-240	K2001961A-04
Circuit d'alimentation d'amplificateur, 302GC-024, 302GCX-024	K2001961A-03
Circuit d'alimentation d'amplificateur, 302GC-120, 302GCX-120 302GC-240 et 302GCX-240	K2001961A-02
Haut-parleur, 300GC-024, 300GCX-024, 300GC-120, 300GCX-120, 300GC-240 et 300GCX-240	8593082A
Haut-parleur, 302GC-024, 302GCX-024, 302GC-120, 302GCX-120, 302GC-240 et 302GCX-240	8593103A
Transformateur, 300GC-120, 300GCX-120	K120857A
Transformateur, 300GC-240, 300GCX-240	K120858A
Transformateur, 302GC-120, 302GCX-120	K120846A
Transformateur, 302GC-240, 302GCX-240	K120856A
Bobine acoustique, 300GC-120, 300GCX-120, 300GC-240 et 300GCX-240	K8593035A
Bobine acoustique, 302GC-120, 302GCX-120, 302GC-240 et 302GCX-240	K8590246A



1

MODELS
300GC & 302GC

MODELS
300GCX & 302GCX

290A5578

English

- 300GC & 300GCX**
- A. 8-1/8" (206)
 - B. 12-5/8" (320)
 - C. 8-1/2" (216)
 - D. Collar Nut
 - E. Conduit Plug
 - F. 7/8" (22) Diameter Conduit Knockout
 - G. 0.201" (5.1) Diameter, 2 Mounting holes
 - H. 0.201" (5.1) Diameter, 4 Mounting holes

302GC & 302GCX

- A. 10" (254)
- B. 15" (381)
- C. 8-1/2" (216)
- D. Tuercas de collar
- E. Tapón de conducto
- F. Abertura rompible de 7/8 pulg (22) de diámetro
- G. 2 orificios de montaje de 0.201 pulg (5.1) de diámetro
- H. 4 orificios de montaje de 0.201 pulg (5.1) de diámetro

Español

- 300GC y 300GCX**
- A. 8-1/8 pulg (206)
 - B. 12-5/8 pulg (320)
 - C. 8-1/2 pulg (216)
 - D. Tuerca de collar
 - E. Tapón de conducto
 - F. Abertura rompible de 7/8 pulg (22) de diámetro
 - G. 2 orificios de montaje de 0.201 pulg (5.1) de diámetro
 - H. 4 orificios de montaje de 0.201 pulg (5.1) de diámetro

302GC y 302GCX

- A. 10 pulg (254)
- B. 15 pulg (381)
- C. 8-1/2 pulg (216)
- D. Tuercas de collar
- E. Tapón de conducto
- F. Abertura rompible de 7/8 pulg (22) de diámetro
- G. 2 orificios de montaje de 0.201 pulg (5.1) de diámetro
- H. 4 orificios de montaje de 0.201 pulg (5.1) de diámetro

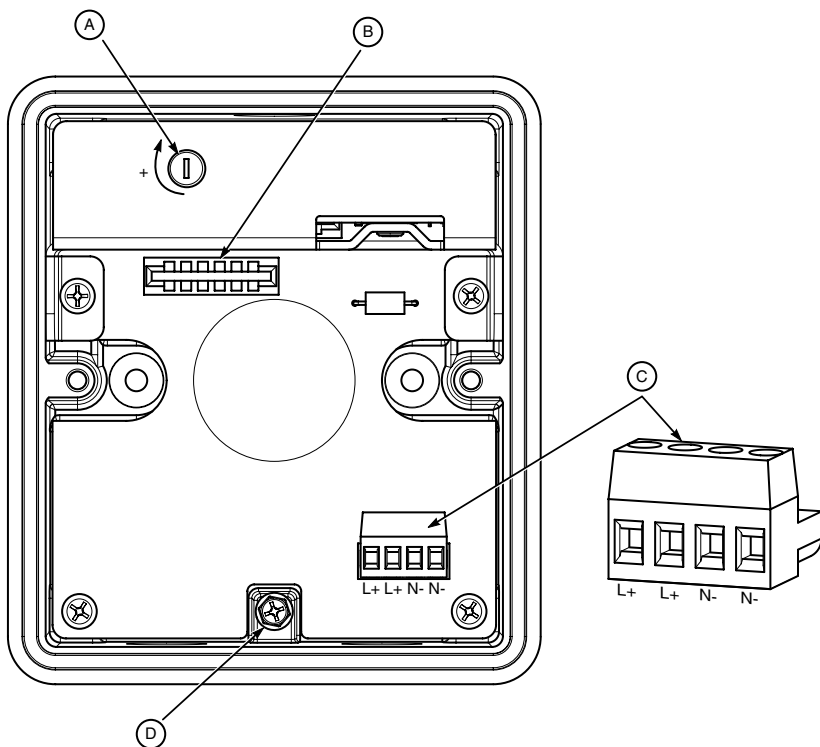
Francés

- 300GC & 300GCX**
- A. 8-1/8" (206)
 - B. 12-5/8" (320)
 - C. 8-1/2" (216)
 - D. Écrou à embase
 - E. Bouchon de conduit
 - F. Entrée défonçable de 22 mm de diamètre (7/8")
 - G. 2 trous de montage 5,1mm de diamètre (0.201")
 - H. 4 trous de montage 5,1mm de diamètre (0.201")

302GC & 302GCX

- A. 10" (254)
- B. 15" (381)
- C. 8-1/2" (216)
- D. Écrou à embase
- E. Bouchon de conduit
- F. Entrée défonçable de 22 mm de diamètre (7/8")
- G. 2 trous de montage 5,1mm de diamètre (0.201")
- H. 4 trous de montage 5,1mm de diamètre (0.201")

2



English

- A. Volume Control
- B. Tone/Connector Card Socket
- C. Power Connector Plug
- D. Earth Grounding Terminal

Español

- A. Control de volumen
- B. Receptáculo de la tarjeta de conexión/tono
- C. Tapón del conector de potencia
- D. Terminal de conexión a tierra

Français

- A. Commande de volume
- B. Prise femelle pour carte de connecteur/tonalité
- C. Connecteur d'alimentation
- D. Borne de mise à la terre

290A5579

SelecTone® Universal Tone Module

Model UTM



A TONE FOR EVERY SIGNALING NEED

- 32 switchable tones
- Compatible with all SelectTone® equipment
- Plug-in installation
- RFI and EMI shielded
- UL and cUL Listed, CSA Certified and CSFM Approved

Federal Signal's Universal Tone Module (UTM) is a microcontroller-based tone generator capable of producing 32 different tones. The UTM is the key component of a SelectTone® System or a single SelectTone device. Tone selection is made by setting five DIP switches.

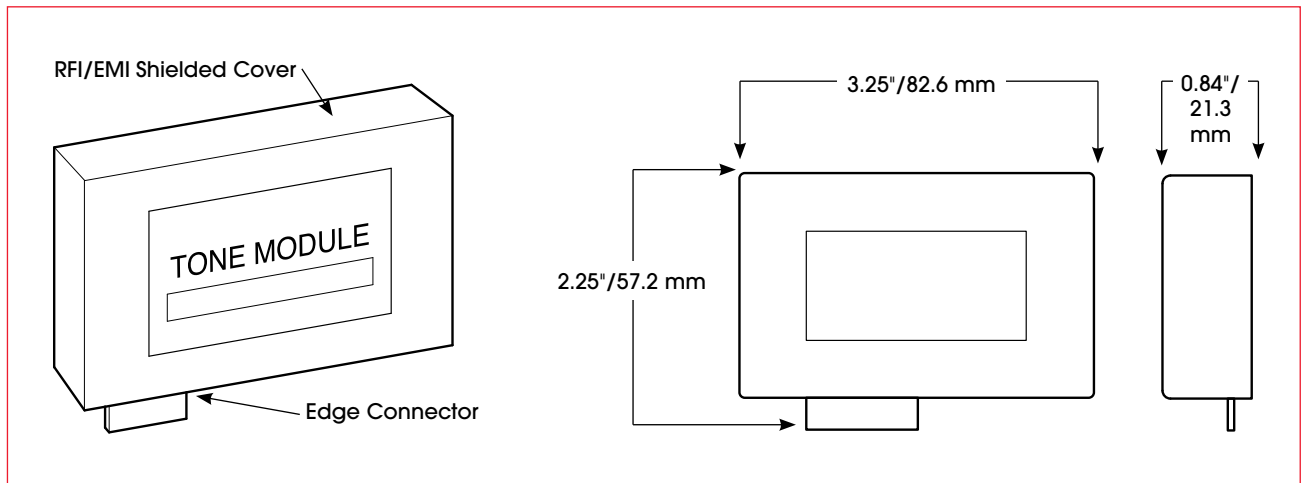
Housed in a plastic cover impregnated with stainless steel fibers, the circuitry is shielded from RFI (radio frequency interference) and EMI (electro-magnetic interference). The edge connector allows for quick and simple installation.

In addition to working with the entire SelectTone® line of speaker/amplifier products, the Model UTM is compatible with the EM3 Extension Module, 300VSC-1 Command Unit, 300VSC-1044SB Command Unit and 300SCW-1 Command Unit. Federal Signal's UTM provides crisp, clear digital signals easily distinguished from the ambient noise of commercial, institutional and industrial environments.

All tones can be reviewed on www.federalsignal.com




UNIVERSAL TONE MODULE (UTM)



DIP Switch	Tone	Sound	Frequency	Repetition Rate	
1	2	3	4	5	
↑ ↑ ↑ ↑ ↑	Wail	TM1	Conventional Siren	560-1055Hz	11 cycles/minute
↑ ↑ ↑ ↓ ↓	Yelp	TM2	Rapid Siren	560-1055Hz	3.3 cycles/second
↑ ↑ ↑ ↓ ↑	Hi-Low	TM3	Alternating Hi and Low	561Hz and 760Hz	50 cycles/minute
↑ ↑ ↑ ↓ ↓	Bell	TM4	Bell, Struck Rapidly	801Hz	50 cycles/minute
↑ ↑ ↓ ↑ ↑	Yeow	TM5	Descending High to Low, Repeated	545Hz and 1296Hz	36 cycles/minute
↑ ↑ ↓ ↓ ↓	Horn	TM6	Steady Horn	470Hz	Continuous
↑ ↑ ↓ ↓ ↑	Beep	TM7	Slow Intermittent Horn	470Hz	50 cycles/minute
↑ ↑ ↓ ↓ ↓	Stutter	TM8	Rapid Intermittent Horn	470Hz	5 cycles/minute
↑ ↓ ↑ ↑ ↑	Slow Whoop	TM9	Slow Ascending Low to High, Repeated	424Hz and 1163Hz	15 cycles/minute
↑ ↓ ↑ ↓ ↓	Gradual Horn	TM10	Steady Horn, Gradually Increasing in Volume	514Hz	Continuous
↑ ↓ ↑ ↓ ↑	Temporal Slow Whoop	TM11	NFPA Coded Slow Whoop	424Hz and 774Hz	15 cycles/minute
↑ ↓ ↑ ↓ ↓	Westminster Chime	TM12	Westminster Chime	Musical Tone	1 cycle/8 tones
↑ ↓ ↓ ↑ ↑	Evac	TM13	Amplitude Modulated Siren	479Hz	4.3 cycles/second
↑ ↓ ↓ ↓ ↓	Air Horn	TM14	Steady Horn	400Hz and 800Hz	Continuous
↑ ↓ ↓ ↓ ↑	Chime	TM15	Single Strike Chime	Musical Tone	49 cycles/minute
↑ ↓ ↓ ↓ ↓	Phaser	TM16	Rapid Siren	600-1200Hz	15 cycles/second
↓ ↑ ↑ ↑ ↑	Alternating Hi/Low	TM17	Alternating High-to-Low	363Hz and 518Hz	60 cycles/minute
↓ ↑ ↑ ↑ ↓	Warble	TM18	Extremely Rapid Siren	560-1055Hz	6.3 cycles/second
↓ ↑ ↑ ↓ ↑	Alert	TM19	Slow Sweep Tone	400-1560Hz	Ascending
↓ ↑ ↑ ↓ ↓	Euro-Police	TM20	Alternating Hi and Low	969Hz and 800Hz	30 cycles/minute
↓ ↑ ↓ ↑ ↑	Euro-Fire	TM21	Sweep Tone	900-800Hz	Continuous
↓ ↑ ↓ ↓ ↓	Euro-Slow Whoop	TM22	Slow Sweep Tone	650-1290Hz	17 cycles/minute
↓ ↑ ↓ ↓ ↑	Euro-General	TM23	Intermittent Horn	969Hz	60 cycles/minute
↓ ↑ ↓ ↓ ↓	Euro-Toxic	TM24	Steady Horn	969Hz	Continuous
↓ ↓ ↑ ↑ ↑	Euro-Police II	TM25	Slow Alternating Hi and Low	554Hz and 440Hz	Alternating Slow
↓ ↓ ↑ ↑ ↓	Euro-Stutter	TM26	Intermittent Beep	2840Hz	252 ms/cycles
↓ ↓ ↑ ↓ ↑	Euro-Sweep	TM27	Sweep Tone	1163 - 397Hz	Descending
↓ ↓ ↑ ↓ ↓	Ringer	TM28	Continuous Ringing Tone	560Hz and 326Hz	Fast Alternating
↓ ↓ ↓ ↑ ↑	Buzzer	TM29	Buzzer Tone	1318Hz and 760Hz	Continuously Alternating
↓ ↓ ↓ ↓ ↓	Attention	TM30	Extremely Rapid Siren	Multiple Frequency	1 cycle, 8 tones
↓ ↓ ↓ ↓ ↑	Multi-Tone	TM31	Extremely Rapid Siren	Multiple Frequency	1 cycle, 8 tones
↓ ↓ ↓ ↓ ↓	Caution	TM32	Extremely Rapid Siren	Multiple Frequency	1 cycle, 8 tones


GENERAL	1	P&ID Number	Tag Number	SLS-338716-100	XAF-21603A1
	2	Service		CMT Field Facilities and Infrastructure Phase 1 & 2	
	3	Application			
	4	Line Number	Equipment Number	---	0735A-08030
	5	Area Classification	Location	Class 1 Div 2	FIELD
	6	Ambient Temperature Range		-50°C TO 66°C	
	7	Operating Voltage		24VDC	
	8				
	9				
RED BEACON	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18	Model	Federal Model 191XL-024R		
19	Flashes/Minute	60 FPM			
20	Maximum Operating Current	380mA			
21	Frequency	DC/50/50			
22	DC In -Rush Current	1.75A at 24 VDC for 5 ms			
23	Environment Rating	Type 4X (water-tight and corrosion resistant) and indoor/outdoor use			
24		IP66 (dust-tight and protection against heavy seas) and			
25		outside type (salt water)			
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	45				
	46				
PURCHASE	47	Manufacturer	Federal Signal Corporation		
	48	Model	Federal Model 191XL-024R		
	49	Purchase Order Number			
	50	Price			
	51	Serial Number			

Notes:

				INSTRUMENT SPECIFICATION				
				RED BEACON STROBE				
1	ET	10/27/2015	Revised as per customer request	Instr. Chk	Process Chk	Appr.		
0	ET	9/15/2015	For Approval	ET	ET		Sheet 1	
No.	By	Date	Description	Code:	Dwg. No.: 338716-100	REV	1	


GENERAL	1	P&ID Number	Tag Number	338716-100	XAF-21603A2	
	2	Service			CMT Field Facilities and Infrastructure Phase 1 & 2	
	3	Application				
	4	Line Number	Equipment Number	---	0735A-08030	
	5	Area Classification	Location	Class 1 Div 2	FIELD ▼	
	6	Ambient Temperature Range			-50°C TO 66°C	
	7	Operating Voltage			24VDC	
	8					
	9					
RED BEACON	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18	Model	Federal Model 191XL-024R			
19	Flashes/Minute	60 FPM				
20	Maximum Operating Current	380mA				
21	Frequency	DC/50/50				
22	DC In -Rush Current	1.75A at 24 VDC for 5 ms				
23	Environment Rating	Type 4X (water-tight and corrosion resistant) and indoor/outdoor use				
24		IP66 (dust-tight and protection against heavy seas) and				
25		outside type (salt water)				
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	43					
	44					
	45					
	46					
PURCHASE	47	Manufacturer	Federal Signal Corporation			
	48	Model	Federal Model 191XL-024R			
	49	Purchase Order Number				
	50	Price				
	51	Serial Number				

Notes:

				INSTRUMENT SPECIFICATION				
				RED BEACON STROBE				
1	ET	10/27/2015	Revised as per customer request	Instr. Chk	Process Chk	Appr.		
0	ET	9/15/2015	For Approval	ET	ET		Sheet 1	
No.	By	Date	Description	Code:	Dwg. No.:	338716-100	REV 1	


GENERAL	1	P&ID Number	Tag Number	338716-100	XAF-21605A1	
	2	Service			CMT Field Facilities and Infrastructure Phase 1 & 2	
	3	Application				
	4	Line Number	Equipment Number	---	0735A-08030	
	5	Area Classification	Location	Class 1 Div 2	FIELD ▼	
	6	Ambient Temperature Range			-50°C TO 66°C	
	7	Operating Voltage			24VDC	
	8					
	9					
RED BEACON	10					
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24		IP66 (dust-tight and protection against heavy seas) and				
25		outside type (salt water)				
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	46					
PURCHASE	47	Manufacturer	Federal Signal Corporation			
	48	Model	Federal Model 191XL-024R			
	49	Purchase Order Number				
	50	Price				
	51	Serial Number				

Notes:

				INSTRUMENT SPECIFICATION				
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1	ET	10/27/2015	Revised as per customer request	Instr. Chk	Process Chk	Appr.		
0	ET	9/15/2015	For Approval	ET	ET		Sheet 1	
No.	By	Date	Description	Code:	Dwg. No.: 338716-100		REV	1

GENERAL	1	P&ID Number	Tag Number	338716-100	XAF-21605A2
	2	Service		CMT Field Facilities and Infrastructure Phase 1 & 2	
	3	Application			
	4	Line Number	Equipment Number	---	0735A-08030
	5	Area Classification	Location	Class 1 Div 2	FIELD
	6	Ambient Temperature Range		-50°C TO 66°C	
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No.	By	Date	Description	Code:	Dwg. No.:	338716-100	REV 1	



Flashing LED Hazardous Location Warning Light with XLT™

Model 191XL

RUGGED DESIGN FOR USE IN HAZARDOUS LOCATIONS

- XLT™ Technology
- Available in 24VAC/DC, 120-240VAC and 277VAC
- Five lamp/lens colors
- Flashing mode standard, configurable to Steady-burn
- 60,000 hour, vibration resistant LED lamp
- Available in 3/4-inch NPT pipe mount or surface mount
- Dome guard included
- Type 4X, IP66 enclosure, Marine Listed
- UL and cUL Listed

The model 191XL is a hazardous location flashing signal light that features the super bright LED array with XLT™, eXtreme Light Technology. The unit is available in 24VAC/DC, 120VAC or 240VAC and five colors: Amber, Blue, Clear, Green, and Red. The 191XL comes standard in flashing mode and is field configurable to steady burn mode for maximum functionality.

The Model 191XL has been certified by UL as meeting Type 4X water-tight and corrosion-resistant requirements, and IP66 rated. This hazardous location warning light has an aluminum base, coated for corrosion-resistance, that can be ordered. A dome guard fits over the glass dome to protect it against accidental collision with moving equipment, such as a forklift.

Federal Signal's super bright LED array used in the 191XL produces intense light output and 60,000 hours of service. Increased shock and vibration resistance add to this unit's rugged industrial portfolio of features.

The 191XL is UL Listed for Class I, Division 2, Groups A, B, C and D; Class II Division 1, Groups E, F and G; and Class III.

Model	Voltage	Operating Current	In-rush Current	Flash Rate/Minute	Mount
191XL-*024**	24VAC/DC	0.40 amps	1.75 amps, 5.0 mS	60	3/4" NPT Pipe
191XL-*120-240**	120/240VAC	0.21/0.13 amps	2.0 amps, 0.25 mS	60	3/4" NPT Pipe
191XL-*277**	277VAC	0.13 amps	9.75 amps, 0.25mS	60	3/4" NPT Pipe

* Include (S) for Surface Mount Option (Example part number: 191XL-S024R for surface mount option, 191XL-024R for pipe mount)

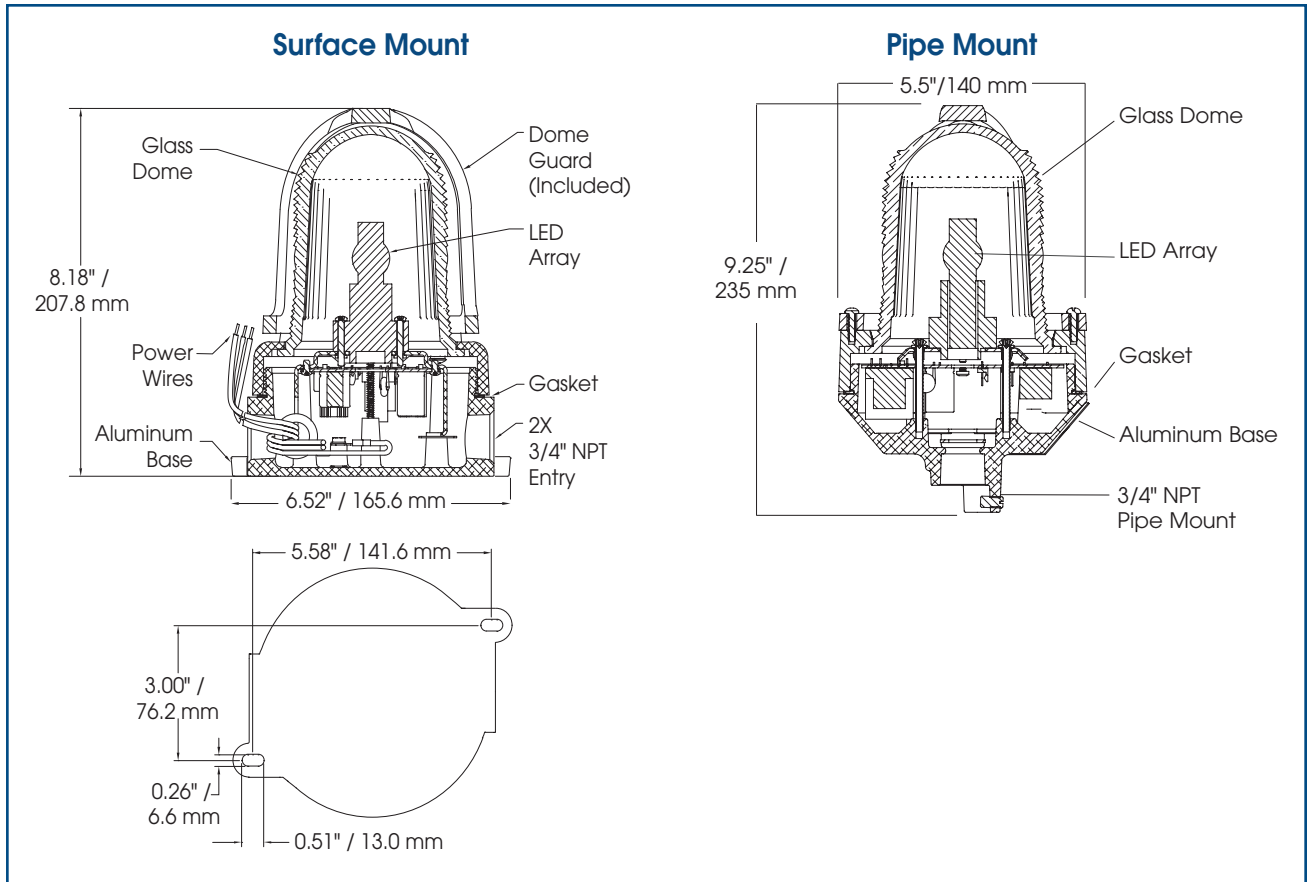
** Indicates color: (A) Amber, (B) Blue, (C) Clear, (G) Green or (R) Red



Hazardous Location Rating:

Hazardous Location	T-Code at Maximum Ambient Temperature, °C								
	40°C			55°C			66°C		
	24V	100-265VAC	277VAC	24V	100-265VAC	277VAC	24V	100-265VAC	277VAC
Class I, Div 2, Groups A, B, C, D	T6	T6	T5	T5	T5	T5	T4A	T4A	T5
Class II, Div 1, Groups E, F and G	T6	T6	T5	T6	T6	T5	T6	T6	T5
Class III	T6	T6	T5	T6	T6	T5	T6	T6	T5

HAZARDOUS LOCATION LED WARNING LIGHT (191XL)



SPECIFICATIONS

Lamp Life:	60,000 Hours	60,000 Hours
Light Source:	LED Array	LED Array
Operating Temperature:	-58°F to 150°F	-50°C to 66°C
Net Weight:	4.0 lbs.	1.82 kg
Shipping Weight:	4.25 lbs.	1.93 kg
Height (with Dome Guard):	9.25"	235.0 mm
Diameter:	5.5"	140.0 mm

HOW TO ORDER

- Specify model, mount, voltage, and color
- Optional Accessories:
Hazardous Location Mounting Bracket (LHWB)

REPLACEMENT PARTS

<u>Description</u>	<u>Part Number</u>	<u>Dome and Ring Assembly</u>	<u>Part Number</u>
LED array, Amber	K14700030A-A	Glass Dome/Ring Assembly, Amber ¹	K8449078C-01
LED array, Blue	K14700030A-B	Glass Dome/Ring Assembly, Blue ¹	K8449078C-06
LED array, Clear	K14700030A-W	Glass Dome/Ring Assembly, Clear ¹	K8449078C-04
LED array, Green	K14700030A-G	Glass Dome/Ring Assembly, Green ¹	K8449078C-07
LED array, Red	K14700030A-R	Glass Dome/Ring Assembly, Red ¹	K8449078C
PC Board Assembly, 24VDC	K2005455A	Guard, Dome	K8449090B
PC Board Assembly, 120/240VAC	K2005416A		
PC Board Assembly, 277VAC	K2005416A-01		

¹ Assembly includes a gasket



FEDERAL SIGNAL

Safety and Security Systems / **Industrial**

Advancing security and well being

Model 191XL Series Beacon for Use in Hazardous Conditions



Installation and Maintenance Manual

2561421G
REV. G 912
Printed in U.S.A.



Warranty – Seller warrants all goods for five years on parts and 2-1/2 years on labor, under the following conditions and exceptions: Seller warrants that all goods of Seller's manufacture will conform to any descriptions thereof for specifications which are expressly made a part of this sales contract and at the time of sale by Seller such goods shall be commercially free from defects in material or workmanship. Seller reserves the right at the Seller's discretion to "Repair and Return" or "Replace" any item deemed defective during the warranty period. This warranty does not cover travel expenses, the cost of specialized equipment for gaining access to the product, or labor charges for removal and reinstallation of the product. This warranty shall be ineffective and shall not apply to goods that have been subjected to misuse, neglect, accident, damage, improper maintenance, or to goods altered or repaired by anyone other than Seller or its authorized representative, or if five years have elapsed from the date of shipment of the goods by Seller with the following exceptions: lamps and strobe tubes are not covered under this warranty. Outdoor warning sirens and controllers manufactured by Federal Warning Systems are warranted for two years on parts and one year on labor. No agent, employee, representative or distributor of Seller has any authority to bind the Seller to any representation, affirmation, or warranty concerning the goods and any such representation, affirmation or warranty shall not be deemed to have become a part of the basics of the sales contract and shall be unenforceable. THE FOREGOING WARRANTIES ARE EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES OR MERCHANTABILITY, FITNESS FOR PURPOSE AND OF ANY OTHER TYPE, WHETHER EXPRESS OR IMPLIED. These warranties shall not apply unless Seller shall be given reasonable opportunity to investigate all claims for allegedly defective goods. Upon Seller's instruction a sample only of allegedly defective goods shall be returned to Seller for its inspection and approval. The basis of all claims for alleged defects in the goods not discoverable upon reasonable inspection thereof pursuant to paragraph 8 hereof must be fully explained in writing and received by Seller within thirty days after Buyer learns of the defect or such claim shall be deemed waived.



Industrial Systems
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Tel: 1-877-289-3246 • Fax: 708-534-4852
www.federal-signal-indust.com • www.fs-isys.com

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Safety Messages to Installers

⚠ WARNING

It is important to follow all instructions shipped with this product. This device is to be installed by a trained electrician who is thoroughly familiar with the National Electrical Code and/or Canadian Electrical Code and will follow the NEC and/or CEC Guidelines as well as all local codes. This beacon should be considered a part of the warning system and not the entire warning system.

The selection of the mounting location for the beacon, its controls and the routing of the wiring are to be accomplished under the direction of the facilities engineer and the safety engineer. In addition, listed below are some other important safety instructions and precautions you should follow:

- Read and understand all instructions before installing or operating this beacon.
- Do not connect this beacon to the system when power is on.
- Do not disconnect the beacon while circuit is live or unless the area is known to be free of ignitable concentrations. Keep the beacon tightly closed when in operation.
- After installation, make sure that all set screws and threaded joints are properly tightened.
- Never alter the unit in any manner. Safety in hazardous locations may be endangered if additional openings or other alterations are made in units specifically designed for use in these locations.
- To be an effective warning device, this product produces bright beacon that can be hazardous to your eyesight when viewed at a close range. Do not stare directly into this lighting product at a close range or permanent damage to your eyesight may occur.

Installation and Service Instructions

- After installation, test the beacon to make sure that it is operating properly.
- Keep the unit tightly closed when in operation.
- After testing is complete; provide a copy of this instruction booklet to all personnel.
- Establish a procedure to routinely check the beacon for proper activation and operation.

Failure to follow all safety precautions and instructions may result in property damage, serious injury, or death.

An Overview of the 191XL Series

This equipment is suitable for use in Class I, Division 2, Groups A, B, C and D; Class II, Division 1, Groups E, F & G; Class III OR non-hazardous locations only.

This strobe light can be mounted to a Federal Signal Model LHWB bracket. If installed in this way, the entire assembled device is suitable only for Class I, Div. 2, Groups A, B, C, and D; Class II, Div. 2, Groups F and G; Class III locations.

The Model 191XL LED Beacon is a UL listed visual signal for operation in harsh environments and hazardous locations and has been investigated by UL as meeting Type 4X and IP66 enclosure requirements. The unit is rated for operation on 100Vac to 265 Vac, 50/60 Hz, 0.21 A, 277 Vac, 50/60 Hz, 0.13A, or 24 Vdc/ac 50/60 Hz, 0.38 A. The 191XL can be supplied with colors of red, amber, green, blue, and clear. The 191XL is factory-set to operate 60 flashes/minute. There is an option to operate the LED Beacon in Steady Mode. (See “Changing from Flash Mode to Steady Mode” on page 13). Models are available for pipe mounting (191XL) or surface mounting (191XL-S).

These devices are intended for permanent installation and operation in accordance with Title 46, Code of Federal Regulations, Parts 110–113, or Title 33, Code of Federal Regulations, Part 183, Sub-part I, Section 183.410, and the

applicable requirements of the American Boat and Yacht Council, Inc., and/or ANSI/NFPA 302, “Fire Protection Standard for Pleasure and Commercial Motor Craft.”

Unpacking the Beacon

⚠ WARNING

EXPLOSION HAZARD—Damaged domes can lead to explosions that could result in serious injury or death.

After unpacking the beacon, examine it for damage that may have occurred in transit. If the beacon has been damaged, do not attempt to install or operate it. File a claim immediately with the carrier, stating the extent of the damage. Carefully check all envelopes, shipping labels, and tags before removing or discarding them. Disposal of all shipping materials must be carried out in accordance with national and local codes and standards. If any parts are missing, please call Federal Signal Customer Support at 708-534-4756.

Table 1 Electrical ratings

Operating Voltage:	24 Vdc/ac	100–265, 277 Vac	277 Vac
Flashes/Minute:	60 FPM	60 FPM	60 FPM
Maximum Operating Current:	380 mA	210 mA	130 mA
Frequency:	DC/50/60	50/60	50/60
DC In-Rush Current:	1.75 A at 24 Vdc for 5 ms.		
AC In-Rush Current:	2.0 A at 85 Vac and 1.5 A at 265 and 277 Vac for 0.25 ms.		

Table 2 Installation Environment Ratings

Ambient Storage Rating: –55 °C to +70 °C
Ambient Operating Rating: –50 °C to +66 °C
Type 4X (water-tight and corrosion resistant) and indoor/outdoor use
IP66 (dust-tight and protection against heavy seas) and outside type (saltwater)

Table 3 Ambient and Operating Temperature Range

	Temperature Code or Maximum Temperature, °C								
	40 °C Ambient			55 °C Ambient			66 °C Ambient		
Hazardous Locations	24 V	100–265 Vac	277 Vac	24 V	100–265 Vac	277 Vac	24 V	100–265 Vac	277 Vac
Class I, Div 2, Groups A, B, C, and D	T6	T6	T5	T5	T5	T5	T4A	T4A	T5
Class II, Div 1, Groups E, F, and G	T6	T6	T6	T6	T6	T6	T6	T6	T6
Class III	T6	T6	T6	T6	T6	T6	T6	T6	T6

Pipe-Mounting the Beacon (191XL)

⚠ WARNING

EXPLOSION HAZARD—*To reduce the risk of fire or explosion, do not install the beacon in a hazardous location if the operating temperature exceeds the hazardous atmosphere’s ignition temperature. Before proceeding, consult the product nameplate and determine the operating temperature of the beacon.*

NOTE: To comply with NEC Section 300-14, which requires a minimum of 6 inches (15.25 cm) of free conductor at a junction, when mounting the Model 191XL, the mounting pipe used to join the unit to a splice box should be no longer than 10 inches (25.4 cm).

The Model 191XL has provisions for mounting a 3/4" pipe and can be mounted in any position.

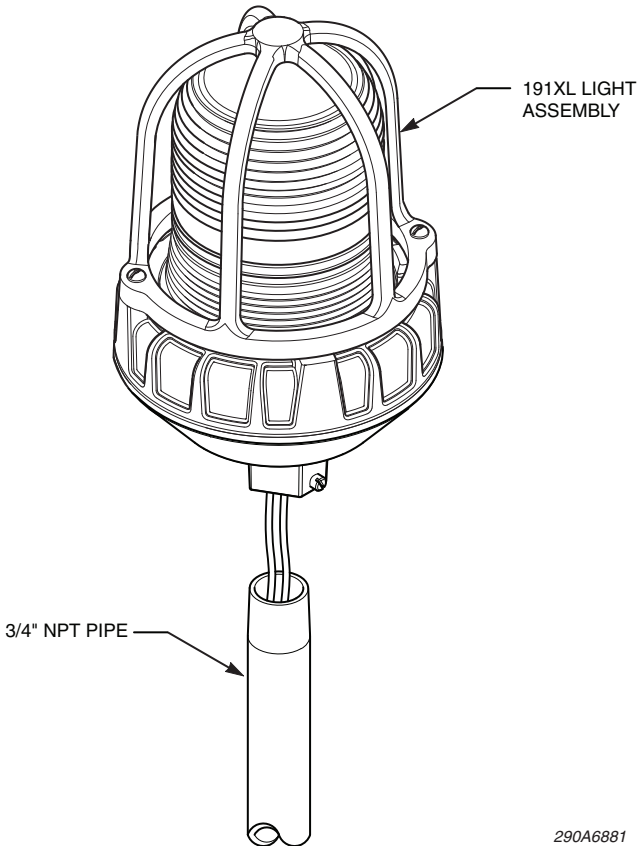
1. Before mounting the beacon, ensure that the mating threads are clean.
2. To prevent the ingress of water and dust, apply conductive sealant to the conduit threads prior to mounting. If non-conductive sealant is used, the enclosure must be earthed via the provided internal grounding wire/grounding screw to ensure proper grounding continuity.

3. In high-humidity environments when units are mounted dome down, condensation may occur in the conduit system. Use properly rated conduit seals/drain to prevent moisture from entering the fixture.

IMPORTANT: To prevent the connection from loosening, tighten the fixture to a MINIMUM torque of 5 ft-lb (6.8 N·m) after threading it onto the pipe.

4. Thread the fixture onto the 3/4" pipe and secure it with the set screw.

Figure 1 Pipe-mounted beacon



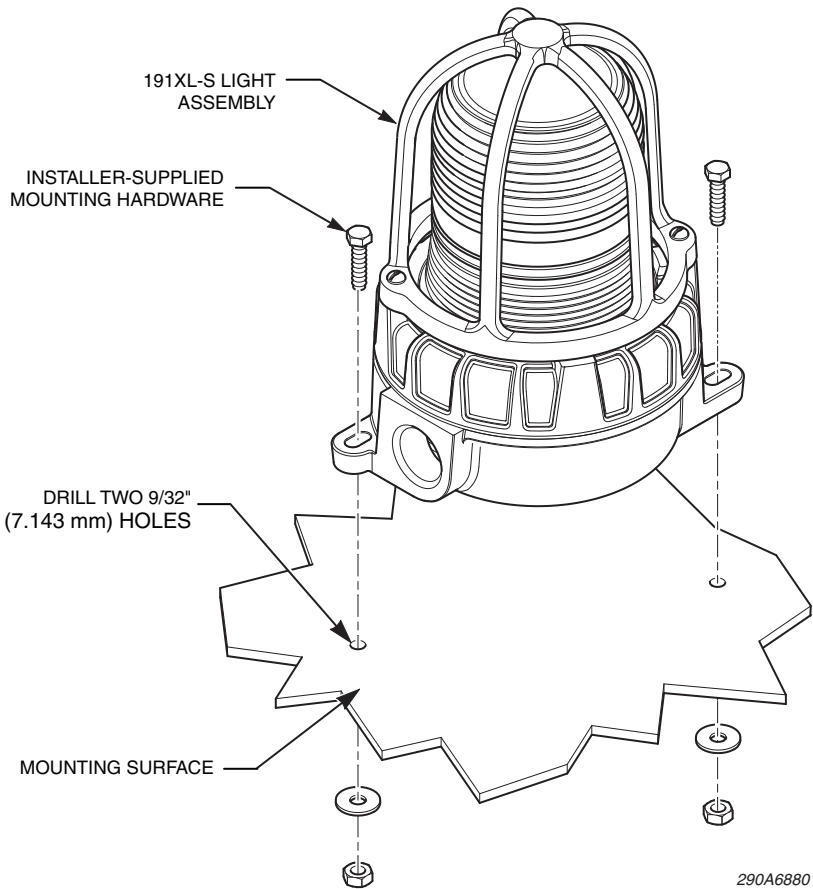
290A6881

Surface-Mounting the Beacon (191XL-S)

To surface mount the beacon:

1. Use the mounting base as a template to mark the location of the two mounting holes.
2. Drill a 9/32 inch (7.143 mm) hole at each mark.
3. Secure the beacon to the mounting surface with installer supplied hardware.

Figure 2 Surface-mounted beacon



290A6880

Wiring the Beacon

⚠ WARNING

SHOCK HAZARD

To avoid electrical shock hazards, do not connect wires while power is applied.

⚠ WARNING

EXPLOSION HAZARD

Do not disconnect the beacon while the circuit is live or unless the area is known to be free of ignitable concentrations. Keep the beacon tightly closed when in operation.

Wiring must comply with the National Electrical Code or Canadian Electrical Code and the local authority having jurisdiction.

The Model 191XL Series LED Beacon should be installed per the NEC or CEC, STATE and LOCAL CODES. Alternate installation locations and/or orientations should only be performed with the approval of the authority having jurisdiction. In addition, the unit can be mounted using an optional ceiling mount or optional wall mount.

⚠ WARNING

SHOCK HAZARD—*To avoid electrical shock hazards, do not connect wires while power is applied.*

NOTE: Model 191XL that are 24 V models are designed to operate on AC and DC supply voltages. The 120–240 Vac model is designed to operate 100 Vac to 265 Vac at 50/60 Hz. See Table 1 on page 7 for electrical ratings.

NOTICE

REVERSE POLARITY/MISWIRING—*The 191XL is not polarity sensitive, but MAY BE DAMAGED by incorrect electrical hookup. Damage will result if the voltage rating of the particular model is exceeded.*

Installation and Service Instructions

NOTE: Field terminations made inside of the surface mount enclosure will require the printed circuit board (PCB) assembly to be removed from the housing. See Figure 3 on page 15 and follow steps 1–4 and 6–8 of “Changing from Flash Mode to Steady Mode” on page 13 for the PCB removal and installation process.

The surface mount enclosure is not suitable for feed-through branch-circuit conductors.

Wiring 120-240, 277 Vac Models

The 120-240, 277 Vac models are supplied with three 24-inch leads: white, black, and green/yellow. Connect the black lead to the phase (hot) side of the power source and the white lead to the common (neutral) side of the power source. If required, the green/yellow lead in the housing is provided for connection to an earth ground.

Wiring 24 Vac/dc Models

The 24 Vac/dc models are supplied with two 24" leads, one red and one black. Connect the red (+) lead to the positive or phase (hot) side of the power source and the black (–) lead to the negative or common (neutral) side of power source.

Safety Message to Maintenance Personnel

WARNING

Listed below are some important safety instructions and precautions you should follow:

- Read and understand all instructions before operating this system.
- Any maintenance to the light system must be done with power turned off.
- Any maintenance to the light system must be performed by a trained electrician who is thoroughly familiar with all applicable national and local codes in the country of use.
- Do not connect this beacon to the system when power is on.

- Do not disconnect the beacon while circuit is live or unless the area is known to be free of ignitable concentrations. Keep the beacon tightly closed when in operation.
- Never alter the unit in any manner. Safety of the unit may be affected if additional openings or other alterations are made to the internal components or housing.
- The nameplate should NOT be obscured, as it contains cautionary and/or other information of importance to maintenance personnel. Ensure the nameplate remains readable if the housing exterior is painted.
- If the dome is damaged in any way, it MUST be replaced.
- After performing any maintenance, test the light system to ensure that it is operating properly.

Failure to follow all safety precautions and instructions may result in property damage, serious injury, or death to you or others.

Changing from Flash Mode to Steady Mode

WARNING

EXPLOSION HAZARD— *To prevent ignition of hazardous atmospheres, disconnect the fixture from the supply circuit before opening it.*

WARNING

EXPLOSION HAZARD
Do not disconnect the beacon while circuit is live or unless the area is known to be free of ignitable concentrations. Keep the beacon tightly closed when in operation.

WARNING

EXPLOSION HAZARD— *To maintain the vapor-tight enclosure, do not damage the dome or threads while disassembling or reassembling the unit. Lubricated threaded joints exposed for long periods of time may attract small particles of dirt or other foreign materials. Housing and cover joints should be reassembled immediately, with all the threads fully engaged.*

Installation and Service Instructions

To change from the default Steady Mode to Flashing Mode.

1. Disconnect power to the device.
2. See Figure 3 on page 15. Remove the threaded dome assembly by twisting it counterclockwise.
3. Using a No. 2 Phillips screwdriver, remove two #8-32 pan-head screws holding the printed circuit board assembly to the die-cast housing. Be sure to retain the two nylon screw bushings isolating the bracket from the screws.
4. Gently lift the printed circuit board (PCB) assembly from the housing and turn the assembly over to access the component side of the printed circuit board.
5. See Figure 4 on page 16. Locate jumper J3 and lift the jumper to remove it from “Flash” setting. Re-seat the jumper over the pins labeled “Steady.”
6. Place the printed circuit board assembly back into housing, making sure that four insulating pads are seated between the metal bracket and die-cast housing. The bracket must be oriented so that the notch in the bracket is aligned with the ground screw in the die-cast housing. This step must be carefully followed to prevent arcing and dielectric failure.
7. Slide two #8-32 pan-head screws into the screw bushings and tighten screws to secure the printed circuit board assembly to the die-cast housing.
8. Thread the dome assembly back onto the housing by turning it clock-wise to tighten.

 WARNING

SHOCK HAZARD

To avoid electrical shock hazards, do not connect wires while power is applied.

9. Reconnect the beacon to power.

10. Test the device by applying power and verifying the steady operation of the LED lamp.

Figure 3 PCB removed from housing

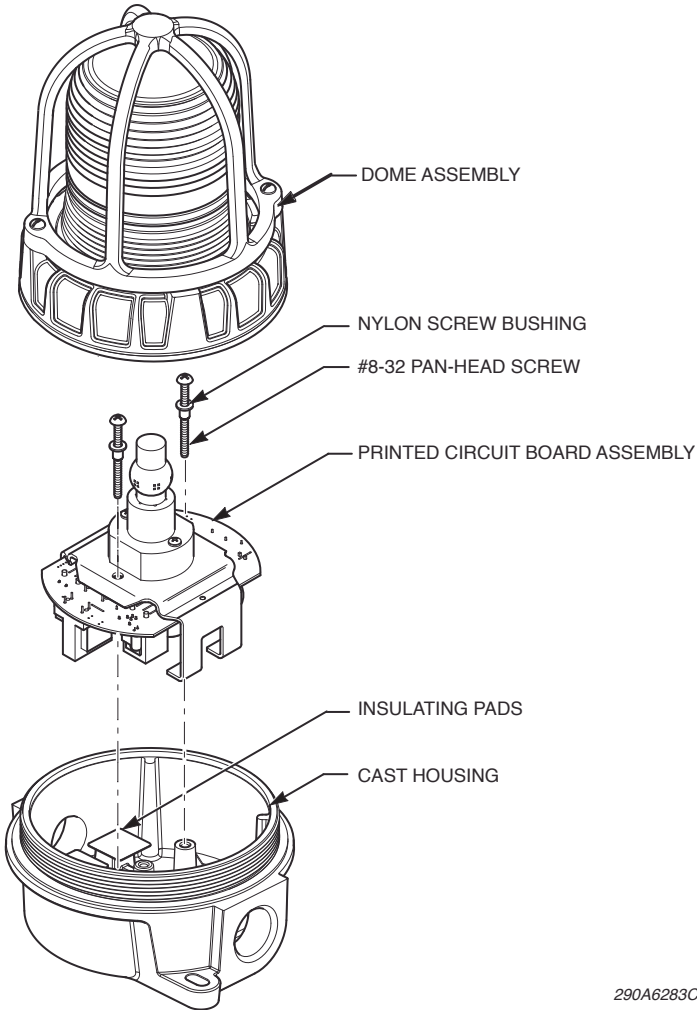
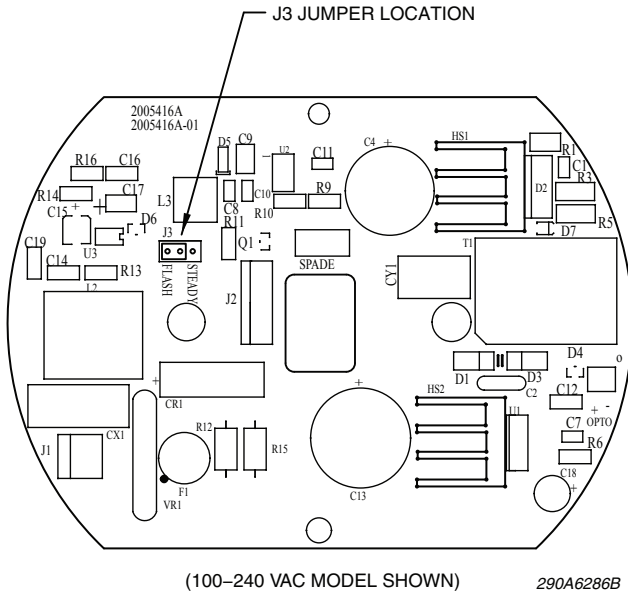


Figure 4 Location of jumper J3 on PCB



Cleaning the Fixture

⚠ WARNING

EXPLOSION HAZARD—Never use an abrasive material or file to remove corrosive materials from threaded surfaces. In extremely corrosive locations, equipment should be periodically inspected to guard against unusual deterioration and possible porosity, since this may weaken the enclosure structurally.

Maintenance procedures sometimes require fixtures to be hosed down for good housekeeping. The circuit should be turned off prior to hosing down the fixture.

The fixture should be cleaned periodically to maintain maximum light output. Only mild, non-abrasive cleaning agents should be used. The glass dome should be regularly inspected for scratches and chips, and if damaged, MUST be replaced.

Lubricating the Threaded Joint

The threaded joint on the cover should be kept well lubricated with a corrosion inhibiting grease such a petrolatum or soap-thickened mineral oil. If corrosive materials have accumulated on the threaded joints and cannot be removed with solvents, the parts should be discarded and replaced.

Getting Service, Assistance, and Parts

Please call 1-877-289-3246 for service, assistance and replacement parts. For instruction manuals and information about related products, please go to <http://www.federsignal-indust.com>.

⚠ WARNING

EXPLOSION HAZARD—Substitution of components may impair suitability for Class I, Division 2.

Typical spare parts are listed below. Due to certification, certain component parts are not available for field replacement. Units with this type of damage must be either replaced entirely or returned to Federal Signal for service.

Table 4 Replacement parts

Description	Part Number
Dome Assy., Red	K8449078
Dome Assy., Amber	K8449078-01
Dome Assy., Clear	K8449078-04
Dome Assy., Blue	K8449078-06
Dome Assy., Green	K8449078-07
Gasket	K8449080
Grease, 8 oz Tube	KR81-05-01
Dome Guard	K8449090
LED Emitter, Amber	K147169-06
LED Emitter, Blue	K147169-07
LED Emitter, Green	K147169-08
LED Emitter, Red	K147169-09
LED Emitter, Clear	K147169-10

Returning the Product for Credit

Product returns for credit require a return authorization from your local distributor prior to returning the product to Federal Signal. Please contact your distributor for assistance.

A product is qualified to be returned for credit when the following conditions are met:

- Product is resalable and in the original cartons
- Product has not been previously installed
- Product is the current revision
- Product has not been previously repaired
- Product is a standard product
- Product is not a service part

All returns are subject to a re-stock fee.

Defective products that are returned within the warranty period will be repaired or replaced at Federal Signal's sole discretion. Defective products do not include those products with lamp failure.

Circumstances other than those listed above will be addressed on a case-by-case basis.



FEDERAL SIGNAL

Safety and Security Systems / **Industrial**

Industrial Systems


2645 Federal Signal Drive • University Park, IL 60484-3167

Tel: 1-877-289-3246 • Fax: 708-534-4852

www.federal-signal-indust.com • www.fs-isys.com


GENERAL	1	P&ID Number	Tag Number	SLS-338716-100	HZS-21601A
	2	Service		CMT Field Facilities and Infrastructure Phase 1 & 2	
	3	Application			
	4	Line Number	Equipment Number	---	0735A-08030
	5	Area Classification	Location	Class 1 Div 2, Group A,B,C,D	FIELD ▼
	6	Ambient Temperature Range			
	7	Operating Voltage		up to 400VAC, 6amps	
	8				
	9				
ESD BUTTON	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18	Model		Crouse Hinds GHG43 control station, non metallic	
19	Enclosure		NEMA 4X, IP66 and meets also UL 94-VO		
20	Certifications		Class 1 Div 2, Groups A,B,C,D		
21			PUSHBUTTON # SGT-555-1-2-06		
22	Assembly Number		GHG 432 SGT551206/0026		
23					
24					
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	46				
PURCHASE	47	Manufacturer		Crouse Hinds	
	48	Model		GHG43 Control Station	
	49	Purchase Order Number			
	50	Price			
	51	Serial Number			

Notes:

				INSTRUMENT SPECIFICATION				
				ESD BUTTON				
1	ET	10/27/15	Revised as per customer request	Instr. Chk	Process Chk	Appr.	Sheet	1
0	ET	09/15/2015	For Approval	ET	ET		Rev	1
No.	By	Date	Description	Code:	Dwg. No.:	338716-100		

GENERAL	1	P&ID Number	Tag Number	338716-100	HZS-21602A	
	2	Service		CMT Field Facilities and Infrastructure Phase 1 & 2		
	3	Application				
	4	Line Number	Equipment Number	---	0735A-08030	
	5	Area Classification	Location	Class 1 Div 2, Group A,B,C,D	FIELD ▼	
	6	Ambient Temperature Range				
	7	Operating Voltage		up to 400VAC, 6amps		
	8					
	9					
ESD BUTTON	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18	Model		Crouse Hinds GHG43 control station, non metallic		
19	Enclosure		NEMA 4X, IP66 and meets also UL 94-VO			
20	Certifications		Class 1 Div 2, Groups A,B,C,D			
21			PUSHBUTTON #SGT-55-1-2-06			
22	Assembly Number		GHG 432 SGT551206/0026			
23						
24						
25						
26						
	27					
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	45					
	46					
PURCHASE	47	Manufacturer		Crouse Hinds		
	48	Model		GHG43 Control Station		
	49	Purchase Order Number				
	50	Price				
	51	Serial Number				

Notes:

				INSTRUMENT SPECIFICATION				
				ESD BUTTON				
1	ET	10/27/2015	Revised as per customer request	Instr. Chk	Process Chk	Appr.		
0	ET	09/15/2015	For Approval	ET	ET		Sheet 1	
No.	By	Date	Description	Code:	Dwg. No.:	338716-100	Rev 1	

4C GHG43 Series Control Stations

Nonmetallic or 316L Stainless Steel Corrosion Resistant

UL/cUL listed
 Cl. I, Div. 2, Groups A, B, C, D
 Cl. I, Zones 1 and 2,
 (A) Ex de IIB + H₂ T6
 Cl. II, Div. 1, Groups E, F, G (cUL)

PTB ATEX CERTIFIED 3117
 Ex de IIC, T6,
 Zones 1 and 2
 Ex de IIC, T6 Zones 21 and 22
 IP 66, NEMA 4X

Applications:

Control stations are used as a remote means of:

- Motor control
- Visual indication of equipment performance
- On-off control of circuits
- Circuit selection

Common applications include:

- Areas which are hazardous due to the presence of flammable vapors, gases or highly combustible dusts
- For installation at petroleum refineries, chemical and petrochemical plants and other process industry facilities where similar hazards exist

Features:

- NEMA 4X, IP66 enclosure with formed-in-place gasket
- Available with all operators: indicator lights, potentiometers, control switches, pushbuttons, terminal blocks and meters
- Base-mounted contact blocks
- Easy change-out components snap in place on DIN rail
- Enclosure meets UL 94-VO. Also available in anti-static Ex e materials
- Inserts for mounting DIN rails
- Available with a maximum of 2 entries - top and bottom for conduit fittings or cable glands
- Suitable for universal mounting plates on pipes, conduit, wall or channels
- Mounting dimensions data molded on back
- Captive, corrosion-resistant cover screws
- Built-in mounting slots for wall installation
- Available in 316L stainless steel

Certifications and Compliances:

- UL/cUL Listed
- Class I, Div. 2, Groups A, B, C, D
- Class II, Div. 1, Groups E, F, G (cUL)
- Class I, Zones 1 and 2, Ex de IIB + H₂, T6
- AEx de IIB + H₂, T6
- Type 3, 4, 4X; IP66
- CENELEC-PTB 00 ATEX 3117
- Ex de IIC, T6, Zones 1 and 2, IP66

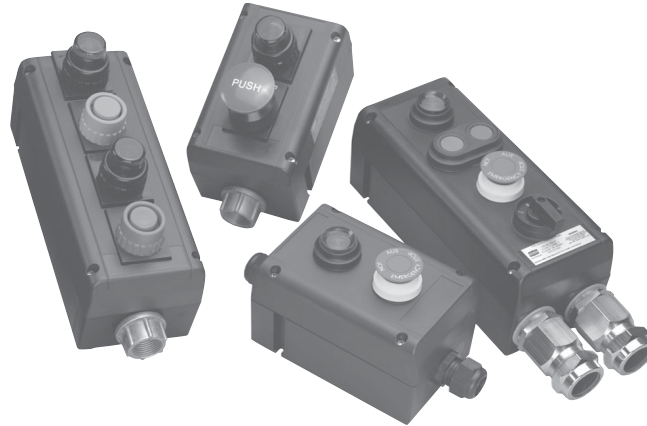
Options:

Description

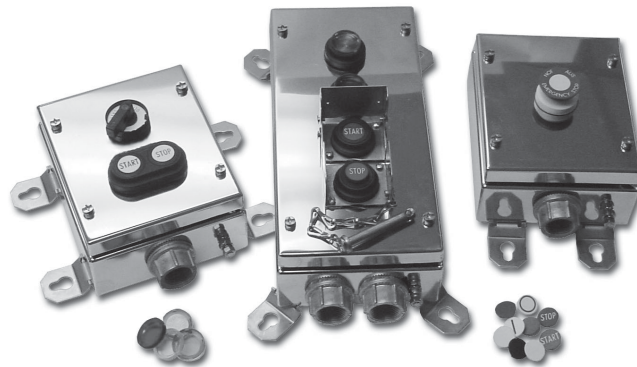
Eaton's Crouse-Hinds GHG43 Series control stations are now available with 316L stainless steel enclosures, making them ideal for corrosive and adverse locations - especially offshore platform applications

Suffix

S860



GHG43 Nonmetallic Control Stations



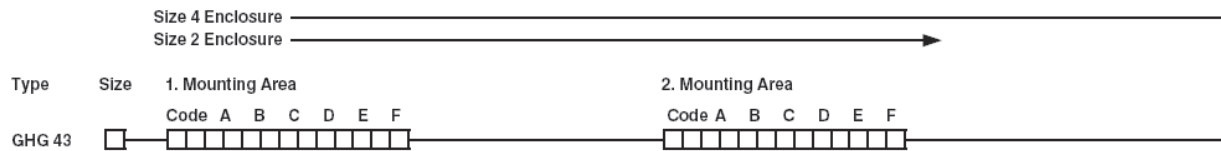
GHG43 Stainless Steel Control Stations



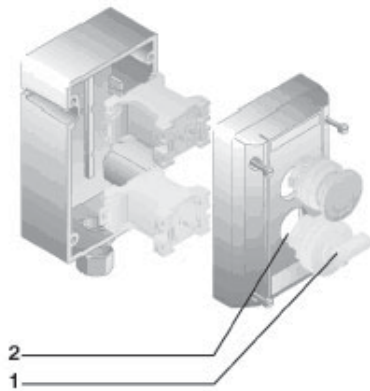
Crouse-Hinds
 by **F.T.N**

4C

Nonmetallic or 316L Stainless Steel Corrosion Resistant



GHG43 2 - Size 2 Enclosure



Mounting Area*



Pushbutton DRT

Code A B C D

Codes see page 559

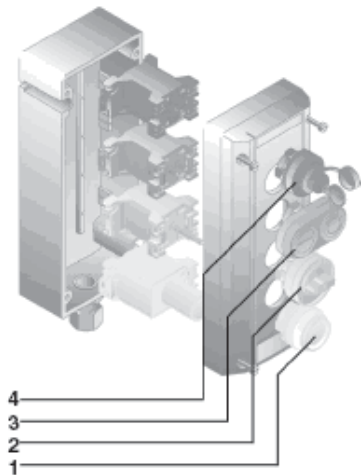


Double Pushbutton

Code A B C D E

Codes see page 559

GHG43 4 - Size 4 Enclosure



Mounting Area*



Key Operated Pushbutton

Code A B C

Codes see page 559



Mushroom-Head Pushbutton

Code A B C D E F

Codes see page 560



Signal Lamp

Code A B C

Codes see page 560

‡For a GHG43 control station with 316L stainless steel enclosure, add suffix "S860" to end of catalog number.
 *Unoccupied spaces must be filled in with KLM for correct positioning of devices.

Nonmetallic or 316L Stainless Steel Corrosion Resistant

4C



Potentiometer

Code A Code B

Codes see page 561



Measuring Instrument

Code A Code B Code C

Codes see page 562
Requires 2 spaces



Switch

Code A Code B Code C Code D

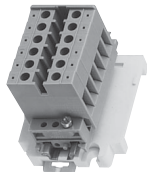
Codes see pages 563-564



Control Switch Ex 23 10A

Code A Code B Code C Code D Code E

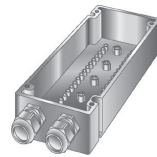
Codes see pages 563-564
Requires 2 spaces



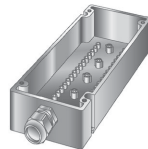
Terminals and cover blanking plug

Code A Code B

Code see page 561



Two entries



One entry

Cable Entries

NPT

No entries

2 x 1/2" Myers Hub, STGK1 Zinc Gland plate

2 x 3/4" Myers Hub, STGK2 Zinc Gland plate (Stainless Steel Control Stations only)

2 x 1/2" Myers Hub, SSTGK1 Stainless steel Gland plate

2 x 3/4" Myers Hub, SSTGK2 Stainless steel Gland plate (Stainless Steel Control Stations only)

1 x 3/4" Myers Hub, STGK2, Zone 1 Gland plate

1 x 1/2" Myers Hub, STGK1, Zone 1 Gland plate

1 x 1/2" Myers Hub, SSTGK1 Stainless st. Gland plate

1 x 3/4" Myers Hub, SSTGK2 Stainless st. Gland plate

Metric

No entries

2 x M25 Plastic Cable gland M25 Blanking plug

2 x M20 Threaded entries Gland plate

2 x M25 Threaded entries Gland plate

1 x M32 Plastic Cable gland

1 x M25 Threaded Entry, Blanking plug and Gland plate

2 x M25 Threaded Entry, 1 blanking plug and Gland plate

1 x M20 Threaded entry Blanking plug and Gland plate

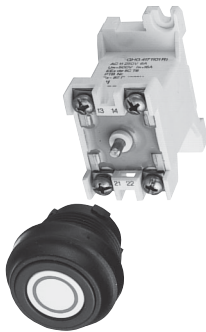
1 x 3/4" Myers Hub SSTGK2 stainless steel, Gland plate

†For a GHG43 control station with 316L stainless steel enclosure, add suffix "S860" to end of catalog number.
*Unoccupied spaces must be filled in with KLM for correct positioning of devices.

Nonmetallic or 316L Stainless Steel Corrosion Resistant

Pushbuttons:

- Used for logic controls in hazardous areas
- Single or double units
- Used with all operators
- Base mounting



Type of Protection	Ex de IIC T6
Certificate of Conformity	PTB No. Ex-87.B.1007U
Approvals	PTB, UL, cUL
Rated Voltage	Up to 400V
Rated Current	NEC/CEC 10A IEC 16 A
Terminal Wiring	2 x 2.5mm ² / 14AWG
Mechanical and Electrical Life	>10 ⁵ Operations

See page 564 for explanation of contact symbols.

Pushbutton DRT

	D	R	T	O				
Code	A				B	C	D	
Contact System								
Code B	13				14	15		
Inscription	ALL *	0	I	II	Stop	Start	Special-Text On Order †	
Code C	01	02	03	04	06	07	99	

Lockout see page 565

Code D (leave blank if no lockout required)

Double Pushbutton DDTO

	D	D	T	O					
Code	A				B	C	D	E	
Contact System									
Code B	43				44	45			
Inscription	ALL *	0	I	II	Stop	Start	Special-Text on Order †		
Code C, D Left/Right	01	02	03	04	06	07	99		

Lockout see page 565

Code E (leave blank if no lockout required)

Key-Operated Pushbutton SLT

	S	L	T	O			
Code	A			B	C		
Contact System							
Code B	23			24	25		
Pushbutton	Key						
Not Depressed	Lockable	Yes	Yes	Yes	No	No	Yes
	Key Removable	Yes	Yes	No	No	Yes	Yes
Depressed	Lockable	Yes	No	Yes	Yes	Auto	Yes
	Key Removable	No	No	Yes	Yes	Yes	Yes
Code C	1	2	3	4	5	6	

* 01 - Includes the following discs - Start, stop, I, O, and red, green, yellow, white and black blank discs.
 † For Marking Guide for Pushbuttons see page 565.



**Nonmetallic or 316L Stainless Steel
Corrosion Resistant**



Mushroom-Head Pushbutton SGT

	<table border="1"><tr><td>S</td><td>G</td><td>T</td></tr></table>	S	G	T	<table border="1"><tr><td></td><td></td></tr></table>			<table border="1"><tr><td></td></tr></table>		<table border="1"><tr><td></td></tr></table>		<table border="1"><tr><td></td><td></td></tr></table>			<table border="1"><tr><td></td></tr></table>	
S	G	T														
Code	A	B	C	D	E	F										
Contact System																
Code B	53	54	55													
Color of Pushbutton	Red	Yellow	Black Actuator													
Code C	1	2	3													
Function	Spring Return	Maintained	Key Release													
Code D	1	2	3													
Inscription	Stop	Start	Black Actuator													
Code E	06	07	11													
Lockout	see page 565															
Code F	(leave blank if no lockout required)															

4C

Signal Lamp

- Used for positive feedback indication
- High intensity with special reflector and optical lens
- Accommodates most input voltages
- Base mounting



	Lamp
Type of Protection	Ex de IIC T6
Certificate of Conformity	PTB No. Ex-88.B.2106U
Approvals	PTB, UL, cUL
Lamp Life	>100,000 Hours (11.5 Years)
Rated Voltages	Up to 240VAC, 50 / 60 Hz Up to 110VDC
Rated Current	Max. 15 mA
Power Consumption	<1.2W
Terminal Wiring	2 x 2.5mm ² / 14AWG
Colors	Red, Green, Yellow, Clear & Blue

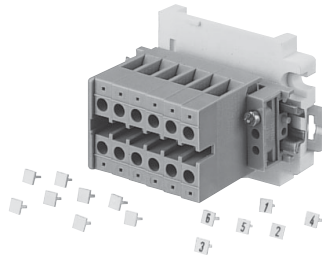
Signal Lamp SIL

	<table border="1"><tr><td>S</td><td>I</td><td>L</td></tr></table>	S	I	L	<table border="1"><tr><td></td></tr></table>		<table border="1"><tr><td></td><td></td></tr></table>		
S	I	L							
Code	A	B	C						
Colored Lens Cover	White	Yellow	Red	1 pkg white, yellow, red, green	Green	Blue			
Code B	1	2	3	4	5	6			
Voltage	20-250VAC/DC			10-33VAC/DC					
Code C	01			31					

Nonmetallic or 316L Stainless Steel Corrosion Resistant

Terminal Blocks

- Terminal block for easy field connections
- Base mounting



Terminal Blocks	
Type of Protection	Ex e II
Certificate of Conformity	PTB No. Ex-88.B.3112U
Rated Voltages	Up to 400V
Rated Current	23A
Conductor Size	4mm ² / 12AWG

Terminals and Cover Plugs KLM



Code A B

	6 Terminals 2 x 4 mm ²	Undrilled Cover (No Terminals)
Code B	61	00

Potentiometers

- Used to adjust resistance to vary motor speed or light levels
- Scale 0 to 100%
- Base mounting



Potentiometers	
Type of Protection	Ex de IIC T6
Certificate of Conformity	PTB No. Ex-87.B.1007U
Approvals	PTB, UL, cUL
Rated Voltages	>250V
Power Consumption	1.0W
Resistance	100–10,000W
Angle of Rotation	270°
Scale	0–100%
Connection Terminals	2 x 2.5mm ² / 14AWG

Potentiometer POT



Code A B

	1W			
Resistance W	1,000	2,200	4,700	10,000
Code B	4	7	5	6

4C

**Nonmetallic or 316L Stainless Steel
Corrosion Resistant**

Ammeters

- Used to measure motor current draw for efficiencies and maintenance
- Slide in scales to accommodate any amperage range
- Red indicator for quick visual indication to compare set points and actual values

4C



Ammeters	
Type of Protection	Ex e II T6
Certificate of Conformity	PTB No. Ex-87.B.2016U
Approvals	PTB, UL, cUL
Movement	Moving iron (core)
Accuracy	2.5% of range (class 2.5)
Measuring Range	0-16A direct, C.T. n/1 A
Operating Position	Vertical
Scale	Interchangeable for C.T. n/1 A
Zero Adjustment	At instrument
Terminal Wiring	2 x 2.5 mm ² / 14 AWG
Rated Current Marking	Red indicator

**Ammeter Measuring
Instrument AM 72***



Code A B C

Movement	Direct	n/1 A	0 - 2 mA	4-20 mA
Code B	1	2	3	6

Movements 0-20 mA and 4-20 mA are only available with 0 - 100 / 120% scale

Direct Measurement		Interchangeable Scale for C.T. n/1A					
Code C	Scale	Code C	Scale	Code C	Scale	Code C	Scale
02	0 - 1/1.5A	02	0 - 1/1.5A	09	0 - 30/45A	16	0 - 200/300A
03	0 - 2.5/3.75A	03	0 - 2.5/3.75A	10	0 - 40/60A	17	0 - 250/375A
04	0 - 5/7.5A	04	0 - 5/7.5A	11	0 - 50/75A	18	0 - 300/450A
05	0 - 10/15A	05	0 - 10/15A	12	0 - 60/90A	19	0 - 400/600A
07	0 - 16/24A	06	0 - 15/22.5A	13	0 - 75/112.5A	20	0 - 500/750A
		08	0 - 20/30A	14	0 - 100/150A	21	0 - 600/900A
				15	0 - 150/225A	22	0 - 100/150A

* Requires 2 spaces.

Nonmetallic or 316L Stainless Steel Corrosion Resistant

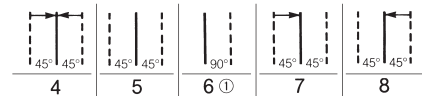
Rotary Control Switches

- Used for selectable operations (i.e. Hand-Off-Auto)
- 2 independent contacts
- Available in any contact configuration
- Spring return or maintained position
- Available with lockout positions



	SCT	Ex 23
Type of Protection	Ex de IIC T6	Ex de IIC T6
Certificate of Conformity	Ex.87.B.1007U	PTB no. Ex-88.B.1047U
Approvals	PTB, UL, cUL	PTB, UL, cUL
Rated Voltage	400 V	Up to 500 V
Rated Current	NEC 10 A IEC 16 A	NEC 10 A IEC 16 A
Terminal Wiring	2 x 2.5mm ² / 14 AWG	2 x 2.5mm ² / 14 AWG
Mechanical Life	>10 ⁵ Operations	>10 ⁵ Operations
Electrical Life	>10 ⁵ Operations	>10 ⁵ Operations
Switching Capacity	AC II: 20V/6A 400V/4A DC II: 24V/6A 60V/0.8A 110V/.5A 220V/.2A	AC I: 500G/10A AC II: 230V/6A 500V/6A DC II: 24V/6A 48V/4A 60V/0.8A 110V/0.5A 220V/0.4A

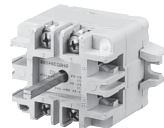
Rotary Control Switch SCT



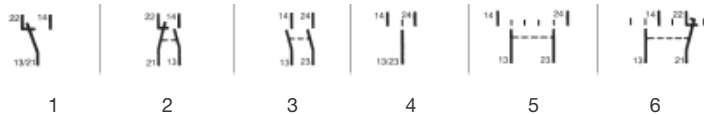
Switch Mechanism

Code B	Inscription	Code C	Inscription			
01	0	I	07	I	0	II
03	STOP	START	13	LOCAL	REMOTE	AUTO
04	HAND	AUTO	14	STOP	0	START
06	REMOTE	LOCAL	15	HAND	0	AUTO
29	OFF	ON	99	Special – text to be given on order		

Same as SCT above except up to 4 independent contacts



Contact System



Rotary Control Switch Ex 23*



Code B	Inscription
01	0
03	STOP
04	HAND
06	remote
07	I
13	LOCAL
14	STOP
23	OFF
24	HAND
27	START
29	OFF
32	ON
99	Special – text to be given on order

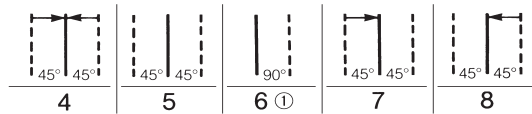
* Requires 2 spaces in cover.

Nonmetallic or 316L Stainless Steel
Corrosion Resistant

4C

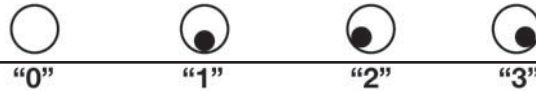
Code C	Contact System	Type	Code C	Contact System	Type
00		2 Position	09		3 Position
01		2 Position	10		3 Position
02		2 Position	12		3 Position
03		Single Pole Changeover	13		2 Position
05		HOA	14		2 Position
07		3 Position Single Level	15		3 Position Double Pole Changeover

Switched Mechanism
Code D



Padlocking Facility

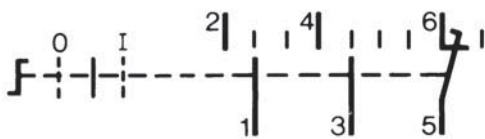
Code E



Contact Configurations

Normally Closed			Normally Open
Normally Closed Extended Over 2 Positions			Normally Open Early Make/Late Break
Change-Over Break Before Make			Change-Over Make Before Break

Example of Switch Type 10



This example is the switch type 10 Stop-Run-Stop. The switch has 3 positions – the normal position is center and can be switched left or right. An arrow (→←) indicates spring return. (See codes for switch mechanism). Contacts 1-2 only close in the Stop position. Contacts 3-4 close only in the Start position. Contacts 5-6 are normally closed and remain closed when switched to the Start position and open when switched to the Stop position.

Nonmetallic or 316L Stainless Steel Corrosion Resistant

Lockouts for DRTO Pushbuttons



X
Code D
Shroud Cover For
Pushbutton
Y-Lockout with bolt and chain



Z
Code D
Padlocking Fire Alarm
Cover For Pushbutton

Lockouts for DDTO Double Pushbuttons



X
Code ED
Padlocking Cover For
Double Pushbutton
Without Hole



Z
Code E
Padlocking Cover For
Double Pushbutton
With Hole

Lockouts for SGT Mushroom-Head Pushbuttons



X
Code F
Padlocking Cover For
Emergency Stop Pushbutton



Z
Code F
Padlocking Cover For
Emergency Stop Pushbutton
With Bolt & Chain
Not permitted in IEC hazardous
locations.

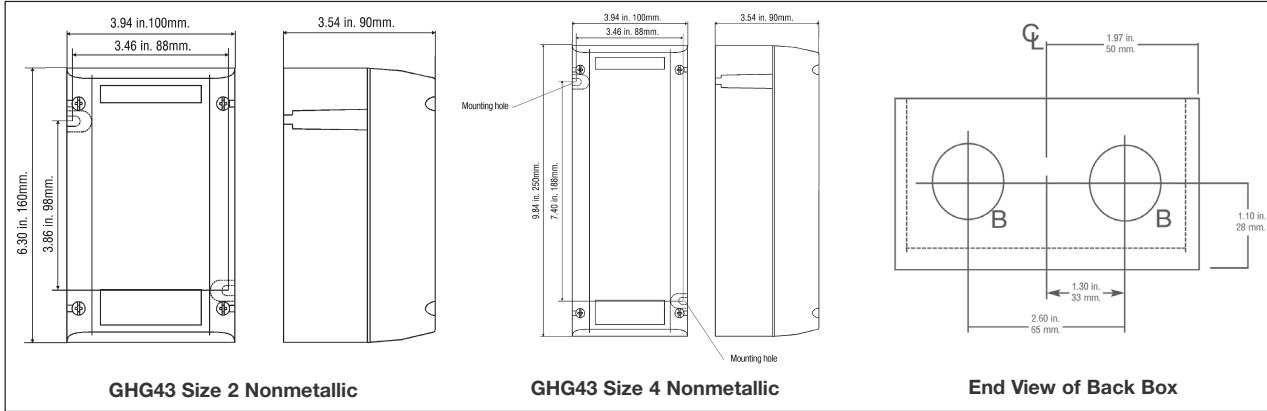
Marking Guide For Pushbuttons

Special Text

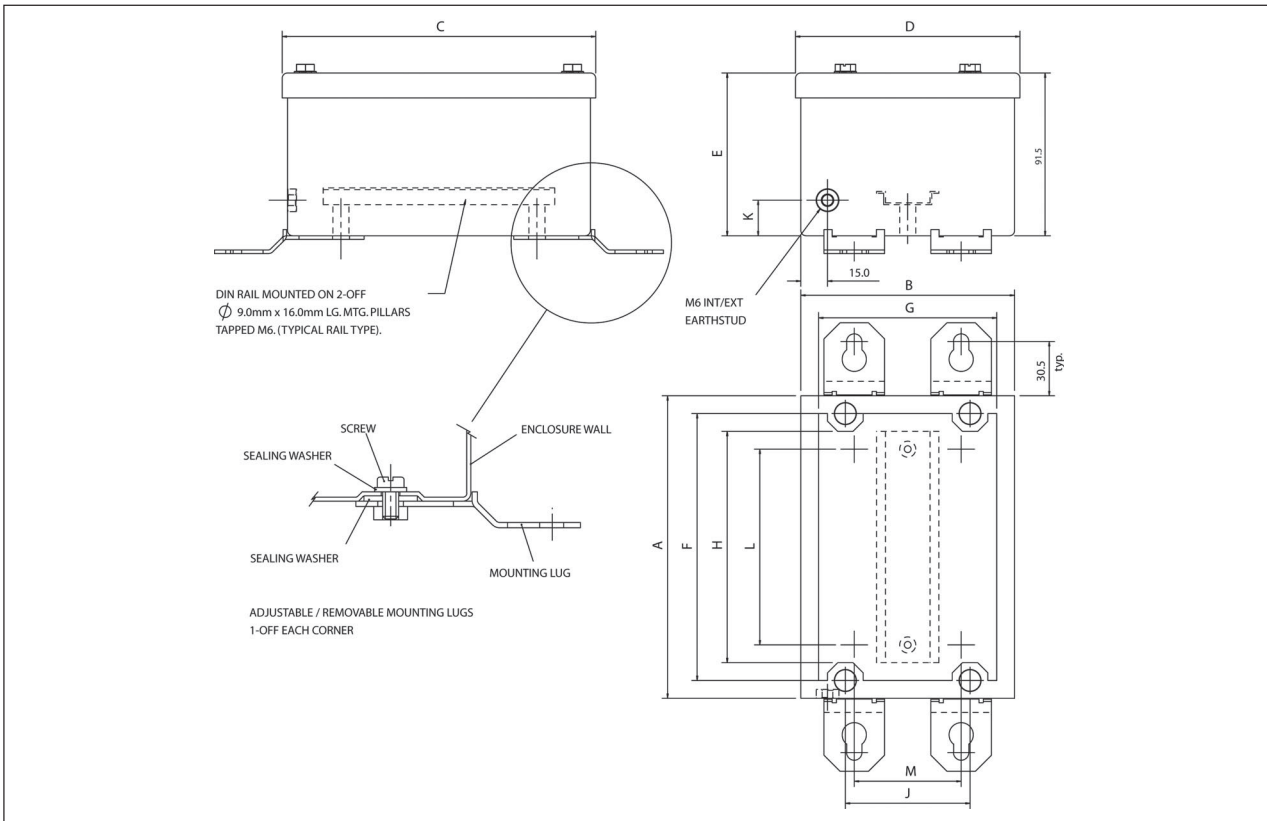
Marking Required	Standard Abbreviation	Actual Marking on Disc
Acknowledge	AK	ACK
Alarm	AM	ALARM
Automatic	AU	AUTO
Close	CL	CLOSE
Down	DN	DOWN
Fast	FS	FAST
Forward	FW	FWD
Hand	HN	HAND
High	HI	HIGH
In	IN	IN
Jog	JG	JOG
Local	LC	LOCAL
Lower	LO	LOWER
Maintain	MT	MAINT
Manual	MN	MANUAL
Normal	NR	NORMAL
Off	OF	OFF
On	ON	ON
Open	OP	OPEN
Out	OT	OUT
Raise	RA	RAISE
Remote	RM	REMOTE
Reset	RS	RESET
Reverse	RV	REV
Run	RN	RUN
Slow	SL	SLOW
Test	TT	TEST
Trip	TP	TRIP
Up	UP	UP

Nonmetallic or 316L Stainless Steel
Corrosion Resistant

GHG43 Nonmetallic Control Stations



GHG43 Stainless Steel Control Stations



Box Type

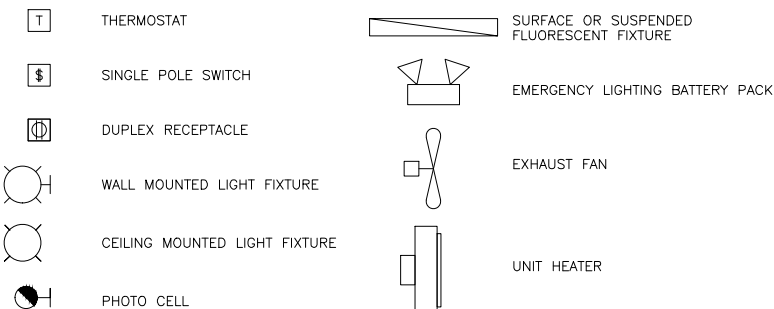
Dimension (inches)

	A	B	C	D	E	F	G	H	J	K	L	M
1 Operator Control Station	4.72	4.72	4.96	4.96	3.60	3.94	3.94	3.15	2.76	0.79	2.36	2.36
2 Operator Control Station	6.69	4.72	6.93	4.96	3.60	5.90	3.94	5.12	2.76	0.79	4.33	2.36
3 Operator Control Station	8.66	4.72	8.90	4.96	3.60	7.87	3.94	7.09	2.76	0.79	6.30	2.36
4 Operator Control Station	10.63	4.72	10.87	4.96	3.60	9.84	3.94	9.06	2.76	0.79	8.27	2.36



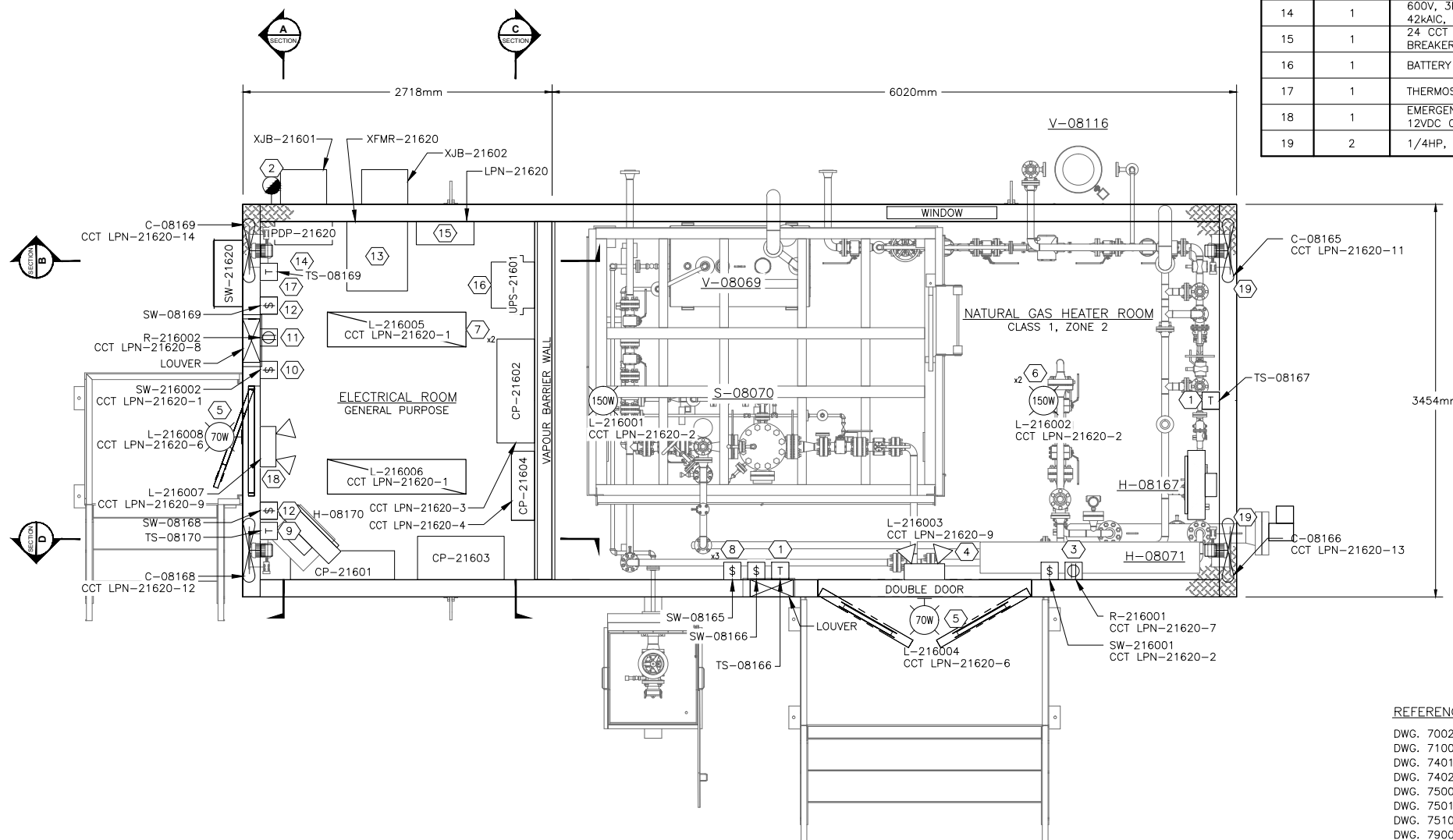
DWG NORTH

LEGEND



BILL OF MATERIALS

ITEM	QUANTITY	DESCRIPTION	MANUFACTURER	CATALOG NO.	SUPPLIER
1	2	SPDT THERMOSTAT, 1/2 HP @ 125VAC. CLASS 1, ZONE 1 & 2.	RUFFNECK	XT-312	VENDOR
2	1	EXTERIOR LIGHT PHOTO CELL	OPEN	OPEN	VENDOR
3	1	20A, 125V RECEPTACLE ASSEMBLY c/w SINGLE GANG ANGLE TYPE COVER. CLASS 1, ZONE 1 & 2, DEAD END.	CROUSE-HINDS	ENR21201	VENDOR
4	1	EMERGENCY LED LIGHTING SYSTEM WITH BATTERY BACK-UP, 120VAC INPUT, 12VDC OUTPUT, TWO 4W LED LAMP HEADS. CLASS 1, ZONE 2.	LUMACELL	RG12HZ72LD7	VENDOR
5	2	70W, 120VAC WALL MOUNT THROUGH FEED HIGH PRESSURE SODIUM LUMINAIRE. CLASS 1, ZONE 2, T3.	CROUSE-HINDS	VMVS2TW070GP S826	VENDOR
6	2	150W, 120VAC PENDANT MOUNTED HIGH PRESURE SODIUM LUMINAIRE. CLASS 1, ZONE 2, T3.	CROUSE-HINDS	VMVS2A150GP S826	VENDOR
7	2	2 x 32W INDUSTRIAL TYPE, FLUORESCENT FIXTURE, 120V ELECTRONIC BALLAST, c/w LAMPS AND LENS.	COOPER	DIF-232-120V-EB81-U	VENDOR
8	3	FULLY ASSEMBLED, FACTORY SEALED, 1 POLE SNAP SWITCH. CLASS 1, ZONE 1 & 2, THROUGH FEED.	CROUSE-HINDS	EDSC2129	VENDOR
9	2	THERMOSTAT, 3/4 HP @ 125VAC, OPEN ON RISE.	RUFFNECK	ET5-S	VENDOR
10	1	SINGLE-POLE, 15A, 120/277VAC INDUSTRIAL SPEC. GRADE LIGHT SWITCH c/w METAL BOX & METAL COVER PLATE, NON-HAZARDOUS.	OPEN	OPEN	VENDOR
11	1	20A SPEC. GRADE, DUPLEX RECEPTACLE c/w METAL BOX & METAL COVER PLATE, NON-HAZARDOUS.	OPEN	OPEN	VENDOR
12	1	1P SWITCH c/w MOUNTING BOX NON HAZARDOUS, THROUGH FEED.	CROUSE-HINDS	MC21271	VENDOR
13	1	TRANSFORMER, 30KVA, 600V-208/120V, DELTA-WYE, 3 Ph, NEMA TYPE 3R, DRY TYPE, 150°C.	HAMMOND	C3F030PBS	VENDOR
14	1	600V, 3PH, 3W, POWER DISTRIBUTION PANEL WITH 100A BUS AND MAIN BREAKER, 42kAIC, BOTTOM ENTRY AND BOLT ON BREAKERS.	EATON	P3aB3C4-30FDC400	VENDOR
15	1	24 CCT DISTRIBUTION PANEL, 208/120, 3 PHASE, 4 WIRE, 100 A BUS AND MAIN BREAKER, 10kAIC BOLT ON BREAKERS.	EATON	P1aT4C1-24EHD100	VENDOR
16	1	BATTERY CHARGER WITH 120V, 16A, 1 PHASE, 60Hz INPUT. 24VDC, 30ADC OUTPUT.	HALEY	CCE24A30R19H17	VENDOR
17	1	THERMOSTAT, 277VAC, 25A, DPST - CLOSE ON RISE	CALORITECH	ARRO464	VENDOR
18	1	EMERGENCY LED LIGHTING SYSTEM WITH BATTERY BACK-UP, 120VAC INPUT, 12VDC OUTPUT, TWO 4W LED LAMP HEADS. NON HAZARDOUS	LUMACELL	RG125LD7722	VENDOR
19	2	1/4HP, 120V, EXPLOSION PROOF EXHAUST FAN MOTOR	MARATHON MOTORS	G650	VENDOR



PLAN VIEW
SCALE: 1:50

NOTES:

- MATERIAL LIST IS A GUIDE ONLY AND IT IS THE CONTRACTORS RESPONSIBILITY TO CHECK ALL CATALOGUE NUMBERS AND QUANTITIES BEFORE ORDERING.
- CONTRACTOR MAY USE APPROVED EQUIVALENT.
- ALL NONCURRENT CARRYING PARTS OF ELECTRICAL SHALL BE BONDED TOGETHER AND MADE ELECTRICAL CONTINUOUS. GROUNDING LUGS SHALL BE PROVIDED INSIDE THE TERMINAL BOXES TO TERMINATE THE GROUND CONDUCTOR.
- ALL METALLIC ELECTRICAL EQUIPMENT AND ENCLOSURES SHALL BE BONDED TO THE SUPPORTING METAL FRAME IN ACCORDANCE WITH CEC.
- TWO(2) STAINLESS STEEL GROUNDING PADS WELDED TO THE SKID FRAME AT DIAGONALLY OPPOSITE ENDS SHALL BE PROVIDED FOR CONNECTION TO THE AREA GROUND GRID.
- THE GROUNDING PADS SHALL HAVE NEMA STANDARD TWO-HOLE DRILLING WITH 14.4mm (9/16 in.) DIAMETER HOLES SPEED 44.5mm (1-3/4 in.) APART.
- POWER CIRCUITS SHALL INCLUDE A GREEN GROUND CONDUCTOR WITH EACH CIRCUIT SIZED IN ACCORDANCE WITH CEC.
- EXTERNAL BONDING JUMPERS SHALL BE PROVIDED BETWEEN THE CONDUIT SYSTEM AND MOTORS, CONTROL PANELS, AND OTHER DEVICES.

REFERENCE DRAWINGS:

- DWG. 7002 - AREA CLASSIFICATION
- DWG. 7100 - SINGLE LINE DIAGRAM
- DWG. 7401 - ANALOG & CONTROL GENERAL LAYOUT
- DWG. 7402 - ELECTRICAL ELEVATIONS
- DWG. 7500 - CABLE SCHEDULE (SHEET 1 OF 2)
- DWG. 7501 - CABLE SCHEDULE (SHEET 2 OF 2)
- DWG. 7510 - 120/208 VAC DISTRIBUTION PANEL SCHEDULE
- DWG. 7900 - JUNCTION BOX LAYOUTS & BOM
- CCI DWG NO. D23074

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PROJECT NAME:	CARMON CREEK
CUSTOMER:	SHELL
LOCATION:	CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG:	0735A-08030
SLS#:	338716
QUOTE:	CGY2014-85
PO#:	4512-109-130
DWN BY:	KS
DATE:	AUG 11/14
CHK BY:	JS
DATE:	AUG 11/14
APP BY:	-
DATE:	-
DWG #:	214068-7400
PAGE:	1 OF 4
CAD:	N/A
REV:	1

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	AS-BUILT	LS	JS	-	NOV 09/15
0	ISSUED FOR CONSTRUCTION	JB	JS	-	SEP 21/15
D	ISSUED FOR INFORMATION	JP	JS	-	AUG 10/15
C	RE-ISSUED FOR APPROVAL	JP	JS	-	MAR 26/15
B	ISSUED FOR APPROVAL	RS	JS	-	JAN 30/15
A	ISSUED FOR INFORMATION	KS	JS	-	SEP 11/14

CMT NG PRESSURE REDUCTION SKID PACKAGE
ELECTRICAL POWER LAYOUT & BOM



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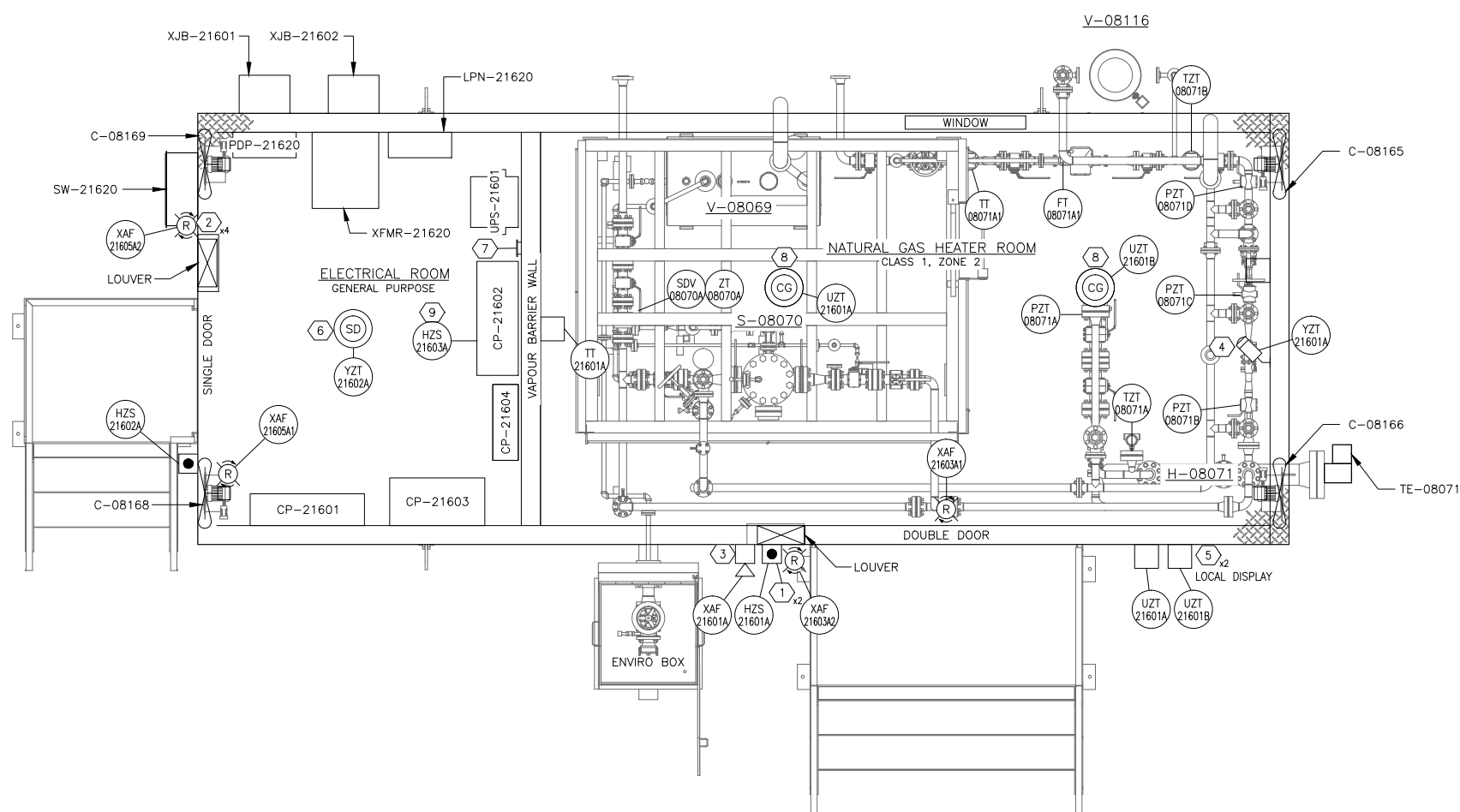
DWG NORTH

BILL OF MATERIALS

ITEM	QUANTITY	DESCRIPTION	MANUFACTURER	CATALOG NO.	SUPPLIER
1	2	ESD BUTTON	CROUSE-HINDS	4-SGT-55-1-2-06-26	VENDOR
2	4	STROBES	FEDERAL SIGNAL	191XL-024R	VENDOR
3	1	HORN	FEDERAL SIGNAL	302GCX-024	VENDOR
4	1	FIRE EYE	DET-TRONICS	X3301A4N13W1	VENDOR
5	2	COMBUSTIBLE GAS DETECTOR DISPLAY	DET-TRONICS	UD10A5N25T2	VENDOR
6	1	SMOKE DETECTOR	GENTEX	8240PY	VENDOR
7	1	ISOLATED GROUND BAR	OPEN	OPEN	VENDOR
8	2	COMBUSTIBLE GAS DETECTOR	DET-TRONICS	8240PY	VENDOR
9	1	ESD PUSHBUTTON	ALLEN-BRADLEY	800T-FX6D4	VENDOR
10					

LEGEND

- RED STROBE LIGHT FOR SMOKE, FIRE, AND LEL
- SMOKE DETECTOR
- HORN
- FIRE DETECTOR
- EMERGENCY SHUTDOWN BUTTON
- GAS HEAD



PLAN VIEW
SCALE: 1:50

NOTES:

- MATERIAL LIST IS A GUIDE ONLY AND IT IS THE CONTRACTORS RESPONSIBILITY TO CHECK ALL CATALOGUE NUMBERS AND QUANTITIES BEFORE ORDERING.
- ALL ELECTRICAL EQUIPMENT TO BE GROUNDED IN ACCORDANCE WITH THE C.E.C. AND AS SHOWN.

REFERENCE DRAWINGS:

- DWG. 7305 - CP-21601 PLC PANEL POWER DISTRIBUTION
- DWG. 7309 - CP-21601 PLC PANEL SYSTEM ARCHITECTURE
- DWG. 7320 - CP-21601 PLC DISCRETE INPUT SCHEMATIC
- DWG. 7330 - CP-21601 PLC DISCRETE OUTPUT SCHEMATIC
- DWG. 7340 - CP-21601 PLC ANALOG INPUT SCHEMATIC (SHEET 1 OF 2)
- DWG. 7341 - CP-21601 PLC ANALOG INPUT SCHEMATIC (SHEET 2 OF 2)
- DWG. 7347 - CP-21601 PLC ANALOG OUTPUT SCHEMATIC
- DWG. 7602 - CP-21602 IPS PANEL 24VDC POWER DISTRIBUTION (SHEET 1 OF 2)
- DWG. 7602A - CP-21602 IPS PANEL 24VDC POWER DISTRIBUTION (SHEET 2 OF 2)
- DWG. 7603 - CP-21602 IPS PANEL SCHEMATICS (SHEET 1 OF 3)
- DWG. 7604 - CP-21602 IPS PANEL SCHEMATICS (SHEET 2 OF 3)
- DWG. 338716-100-REV8-CMT - NG PRESSURE REDUCTION SKID PACKAGE P&ID

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PROJECT NAME: CARMON CREEK

CUSTOMER: SHELL

LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2

TAG: 0735A-08030

SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130

DWN BY: KS DATE: AUG 11/14 DWG #:

CHK BY: JS DATE: AUG 11/14

APP BY: - DATE: -

214068-7401

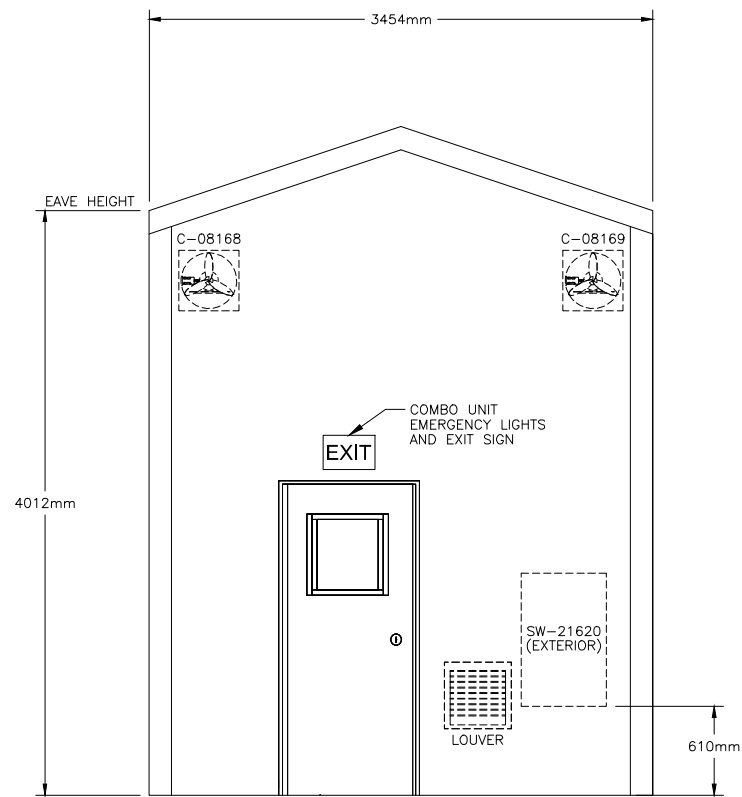
PAGE: 2 OF 4 CAD: N/A REV: 1

REV	DESCRIPTION	DWN	CHK	APP	DATE
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0	ISSUED FOR CONSTRUCTION	JB	JS	-	SEP 21/15
C	ISSUED FOR INFORMATION	JP	JS	-	AUG 10/15
B	RE-ISSUED FOR APPROVAL	JP	JS	-	MAR 26/15
A	ISSUED FOR APPROVAL	RS	JS	-	JAN 30/15

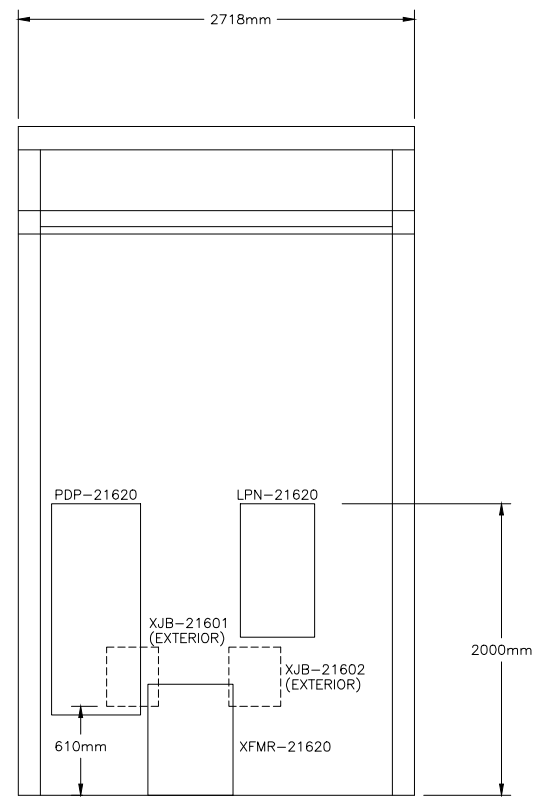
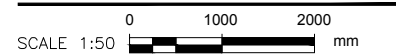
CMT NG PRESSURE REDUCTION SKID PACKAGE
ANALOG & CONTROL GENERAL LAYOUT



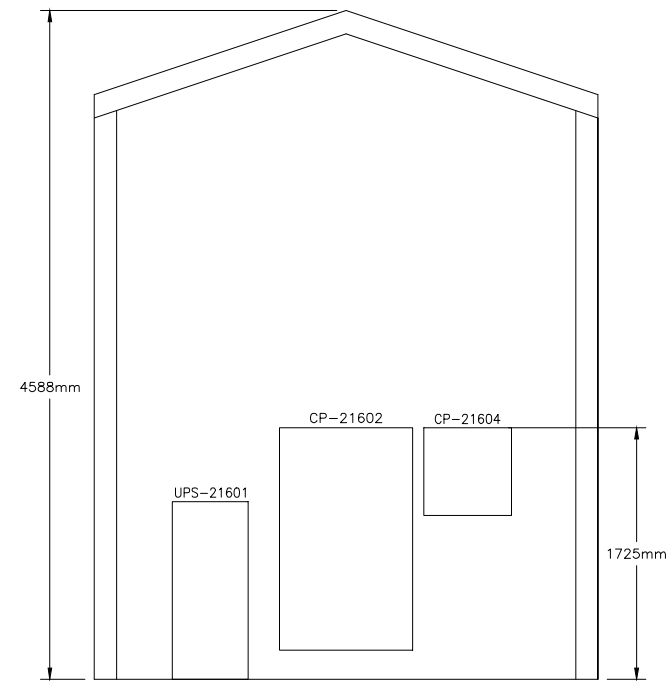
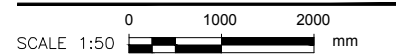
**COLLEAUX
ENGINEERING
INC.**



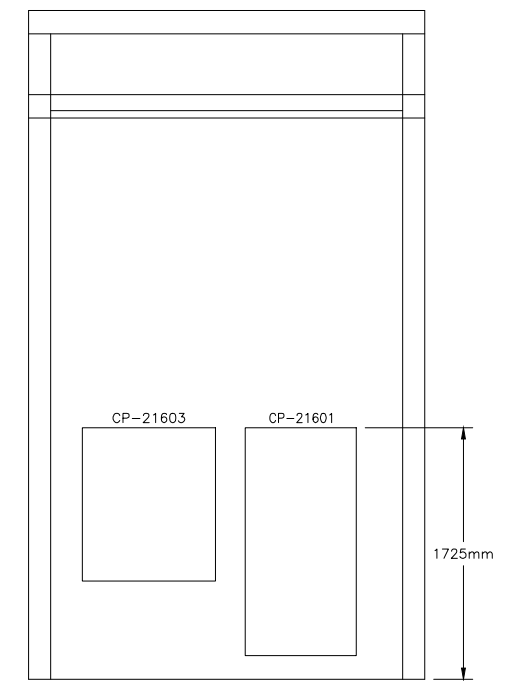
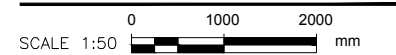
SECTION A



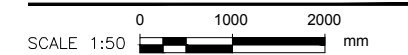
SECTION B



SECTION C



SECTION D



REFERENCE DRAWINGS:
DWG. 7400 - ELECTRICAL POWER LAYOUT & BOM

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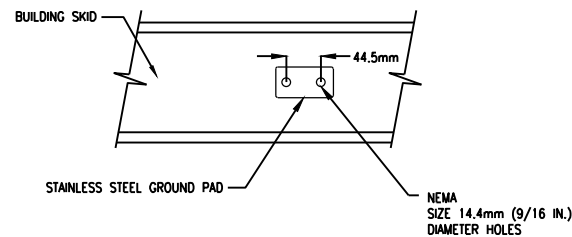
PROJECT NAME: CARMON CREEK	
CUSTOMER: SHELL	
LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2	
TAG: 0735A-08030	
SLS#: 338716	QUOTE: CGY2014-85
PO#: 4512-109-130	
DWN BY: KS	DATE: OCT 06/14
CHK BY: JS	DATE: OCT 06/14
APP BY: -	DATE: -
DWG #: 214068-7402	
PAGE: 3 OF 4	CAD: N/A
REV: 1	

REV	DESCRIPTION	DWN	CHK	APP	DATE
1	AS-BUILT	LS	JS	-	NOV 09/15
0	ISSUED FOR CONSTRUCTION	JB	JS	-	SEP 21/15
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B	ISSUED FOR APPROVAL	RS	JS	-	JAN 30/15
A	ISSUED FOR INFORMATION	KS	JS	-	-

CMT NG PRESSURE REDUCTION SKID PACKAGE
POWER SUPPLY CABLE BOX ELEVATION VIEW



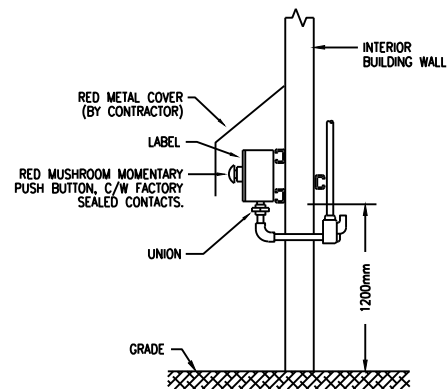
**COLLEAUX
ENGINEERING
INC.**



- NOTES:**
- TWO(2) STAINLESS STEEL GROUNDING PADS WELDED TO THE SKID FRAME AT DIAGONALLY OPPOSITE ENDS SHALL BE PROVIDED FOR CONNECTION TO THE AREA GROUND GRID.
 - THE GROUNDING PADS SHALL HAVE NEMA STANDARD TWO-HOLE DRILLING WITH 14.4mm (9/16 in.) DIAMETER HOLES SPACED 44.5mm (1-3/4 in.) APART.

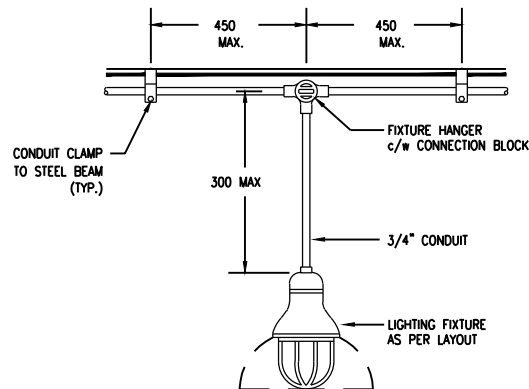
GROUND PAD INSTALLATION

DETAIL 100
N.T.S.



EXTERIOR WALL MOUNTED ESD STATION

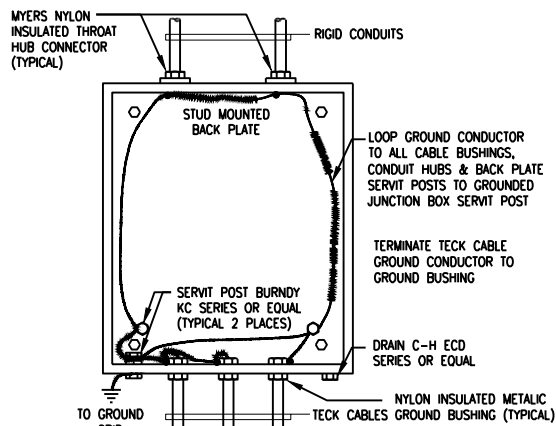
DETAIL 104
N.T.S.



- NOTES:**
- CONDUIT FITTINGS ZONE 2 GROUP IIA & UNCLASSIFIED AREAS - VAPOUR TIGHT
 - SEE ELECTRICAL LAYOUT DRAWING FOR MOUNTING HEIGHT
 - LENGTH OF 3/4" CONDUIT TO FIXTURE CAN BE GREATER THAN 300mm IN AN UNCLASSIFIED AREA.

PENDANT MOUNTED LIGHTING FIXTURE - 300mm OR LESS
ZONE 2 & NON-HAZARDOUS AREAS

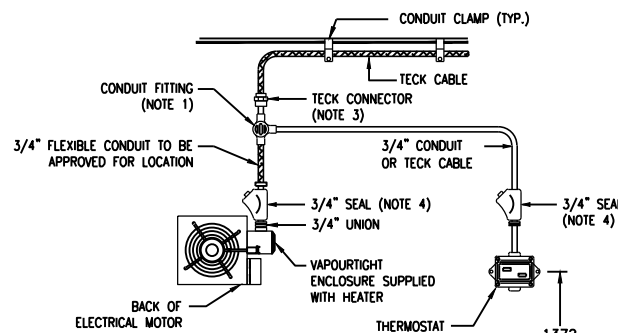
DETAIL 108
N.T.S.



- NOTE:**
- TOP ENTRY INTO ENCLOSURES IS ACCEPTABLE ON INDOOR ENCLOSURES ONLY.

STANDARD ENCLOSURE GROUNDING DETAILS

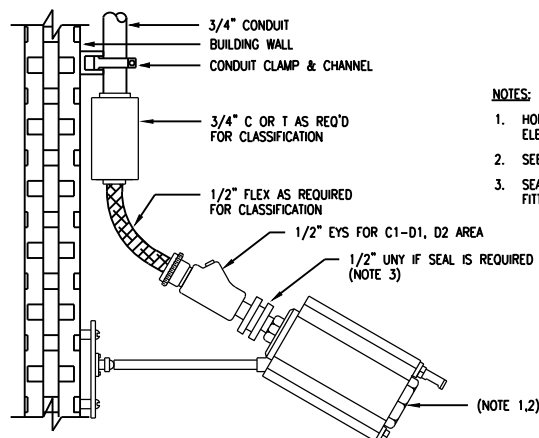
DETAIL 101
N.T.S.



- NOTES:**
- CONDUIT FITTINGS ZONE 2 & UNCLASSIFIED AREAS - VAPOUR TIGHT
 - STRIP TECK ARMOUR ONLY AT THIS POINT. RUN CONDUCTORS IN CONDUIT AND TERMINATE AT END DEVICE.
 - TECK CONNECTORS ZONE 2 & UNCLASSIFIED AREAS - WATERTIGHT
 - SEAL IS NOT REQUIRED IN UNCLASSIFIED AREAS ON FACTORY SEALED UNITS.

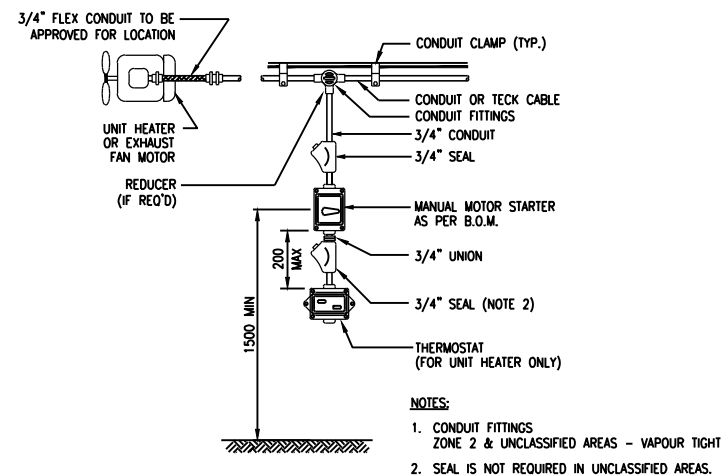
ELECTRICAL UNIT HEATER
ZONE 2 & NON-HAZARDOUS AREAS

DETAIL 105
N.T.S.



FIRE DETECTOR CONDUIT CONNECTION
ZONE 2 & NON-HAZARDOUS AREAS

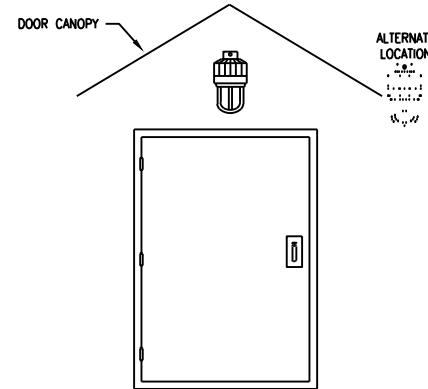
DETAIL 109
N.T.S.



- NOTES:**
- CONDUIT FITTINGS ZONE 2 & UNCLASSIFIED AREAS - VAPOUR TIGHT
 - SEAL IS NOT REQUIRED IN UNCLASSIFIED AREAS.

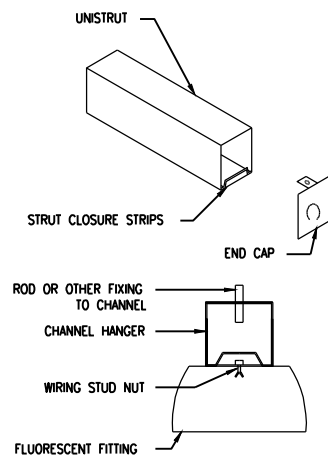
GLYCOL UNIT HEATER OR EXHAUST FAN
ZONE 2 & NON-HAZARDOUS AREAS

DETAIL 102
N.T.S.



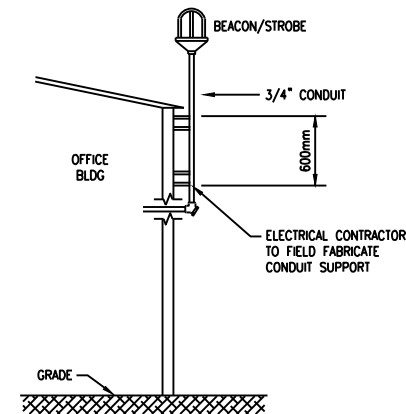
EXTERIOR WALLMOUNT DOOR LIGHTING

DETAIL 106
N.T.S.



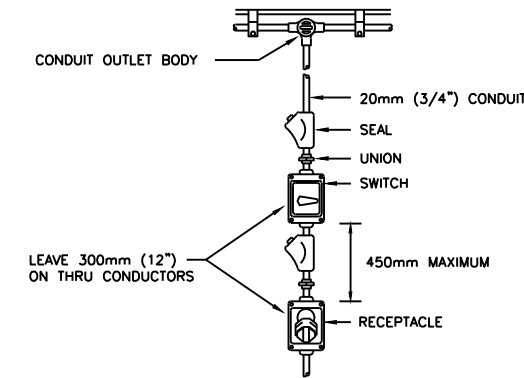
CHANNEL MOUNTED FLUORESCENT LIGHTING FIXTURE
NON-HAZARDOUS AREAS

DETAIL 110
N.T.S.



ALARM BEACON/STROBE

DETAIL 103
N.T.S.



LIGHT SWITCH/RECEPTACLE DETAILS
ZONE 2 & NON-HAZARDOUS AREAS

DETAIL 107
N.T.S.

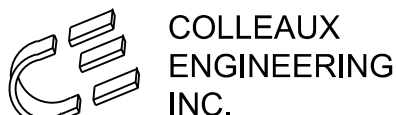
- NOTE:**
- NRTL, CSA, OR ETL LISTED AND LABELED CONDUIT DRAINS SHALL BE PROVIDED AT LOW POINTS IN CONDUIT RUNS.

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATIONAL PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.



PROJECT NAME: CARMON CREEK
 CUSTOMER: SHELL
 LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
 TAG: 0735A-08030

SLS#: 338716 QUOTE: CGY2014-85 PO#: 4512-109-130
 DWNBY: KS DATE: AUG 14/14 DWG #: 214068-7950
 CHKBY: JS DATE: AUG 14/14
 APPBY: - DATE: - PAGE: 4 OF 4 CAD: N/A REV: 0




0	ISSUED FOR FIELD CONSTRUCTION	RS	JS	-	AUG 18/15
REV	DESCRIPTION	DWN	CHK	APP	DATE
CMT NG PRESSURE REDUCTION SKID PACKAGE ELECTRICAL DETAILS					

SECTION 6.0
FINAL CALCULATIONS

DOCUMENT FRONT SHEET

PURCHASERS NAME	National Process Equipment
PURCHASE ORDER NO	PUR630251
EXHEAT REFERENCE	041168
SDR DOCUMENT NO	041168.VESSDC
CLIENT DOCUMENT NO	
DOCUMENT TITLE	Vessel Design Calculations

Doc Num	Revision	Issue	Date	Initials	Supplier's Approval Signature	Approval By
F01	1	1	08/09/2014	RDav		22/09/2014

To be filled by the reviewer of this document prior to its return

Tick Box	Code	Status	Description
<input type="checkbox"/>	E1	Approved	Approval given, no comments, final issue.
<input type="checkbox"/>	E2	Approved to Proceed	Approval given for work to proceed with document to be submitted as Final Issue providing comments are incorporated
<input type="checkbox"/>	E3	Not Approved	Document rejected and must be re-submitted with incorporation of comments. Work may NOT proceed
<input type="checkbox"/>	E4	Information Only	No comments made or approval given, for information purposes only.
<input type="checkbox"/>	E5	As-Built	Approval given for work to proceed provided comments incorporated in As-Built revision.

PAGES (Including this one)

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COMMENTS

Please be aware that EXHeat will not be held responsible for late approval of documents and will not be held liable for any liquidated damages as a consequence.

Late approval of documents by the client may impact on the contractual delivery date.

EXHEAT LTD

Threxton Road Industrial Estate, Watton, IP25 6NG

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Vessco Engineering Ltd
Calculations for
6" 900# Shell Line Heater

Client	Exheat Ltd
Plant	In Alberta, Canada
Unit	6" Shell Line Heater Vessel
Doc No.	VQ0511
Issue	1
Description	First Issue
Date	04 Sep 14
Checked	_____
Approved	_____

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
Client : Exheat Ltd

Doc No. :
Issue : 1

VQ0511
Page : 1

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Item	Code	Page
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Data Sheet/Manual Calcs		3
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Shells - External Pressure	ASME VIII Div.1	15
Nozzles & Openings	ASME VIII Div.1	21
Local Loads on Cylinders	ASME VIII Div.1	32
External Loads on Horizontal Vessels	ASME VIII Div.1	77

When specified by the operator, explanatory notes for each calculation will be printed at the beginning of the relevant section.

Total number of pages: 83

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
Client : Exheat Ltd

Doc No. :
Issue : 1

VQ0511
Page : 2

Revision History

Program version numbers comprise three parts:

- (a) The Code year of issue.
- (b) The latest Code amendment incorporated.
- (c) Intermediate revisions.

The history of this calculation is as follows:-

Issue	Description	Date	By
1	First Issue	15 Aug 14	MVD

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
Client : Exheat Ltd

Doc No. :
Issue : 1

VQ0511
Page : 3

Title : Design Summary

MANUFACTURE DESIGN SUMMARY

DESIGN DATA:

Item No = TBC

Equipment Name = 6" 900# Shell Line Heater Vessel

Dimension = 168.3 O/D x 1726 long

Capacity = 0.03 m³

Orientation = Horizontal

Design Code = ASME VIII Div 1, Edition 2013

Software used for mechanical calculation = Finglow

Internal Design Pressure = 99.3 BarG (9930KPa.g)

External Design Pressure = FV

Design temperature = -45 to 93 degrees C

MDMT = -45 degrees C at 99.3 BarG (9930KPa.g)

Corrosion allowance = 1.5mm

Joint efficiency = 1.0

Wind Loading = As per ABC 2006, vessel will be operating indoors, so N/A

Seismic Loading = As per ABC 2006, Sa(0.2) = 0.12g

Transport Loading = Not requested by client

Blast Loading = Not requested by client

MAWP = 99.3 BarG (9930KPa.g) @ 93 degrees C

Limited by = Set equal to the design pressure

Hydrotest Pressure. (1.3xMAWPx(St/Sd)) = 129.09BarG (12909KPa.g)

MAEWP = FV @ 93 degrees C

Radiography = Full

Ultrasonic testing = All nozzle to shell welds

MPI = All attachment welds

Special service = None

Post Weld Heat Treatment = None

Impact testing = Yes, for all pressure retaining materials except comp pads

Impact testing temperature = -45 degrees C or below

ASME Flange used = B16.5

Flange class & type used = class 900 & RFWN

Flange pressure and temperature rating table = 2-1.1

Flange at design temperature = 141.3 BarG (14130 KPa.g)

Finglow Software :

04 Sep 14 By MVD

Data Sheet/Manual Calcs

Version Dec 13

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
Client : Exheat Ltd

Doc No. :
Issue : 1

VQ0511
Page : 4

Title : UG-22 Loadings

ASME UG-22 Requirements:

- a) Internal or external pressure: Both
- b) Weight of vessel & contents: Vessel- yes, Contents- no, as it is a gas
- c) Reactions from attached equipment: Nozzle loads
- d) Vessel supports: Saddles
- e) Cyclic loadings : N/A
- f) Wind, snow, seismic: Seismic (wind & snow N/A as vessel is indoors)
- g) Fluid Shock: N/A
- h) Temperature gradients N/A
- i) Abnormal pressures: N/A
- j) Test pressure: Yes

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
Client : Exheat Ltd

Doc No. :
Issue : 1

VQ0511
Page : 5

Title : Design Parameters

MAWP

MAWP (hot & corroded) = 99.3 BarG (9930KPa.g)

MAWP is set equal to the design pressure

Vessel strength calculations have been calculated at the MAWP of 99.3 BarG

Test Pressure per UG-99 b):

Test pressure = $1.3 \times \text{MAWP} \times \text{Lowest Stress Ratio}$

= $1.3 \times 99.3 \times (118/118)$

= 129.09 BarG (12909KPa.g)

Check Flange Rating

Flanges will be 900# and standard to ASME B16.5 with temperature

and pressure rating as stated in Table 2-1.1

Allowable Pressure @ 99.3 degrees = 141.3 BarG > Design Pressure 99.3 BarG.

Hence no further consideration is necessary.

MDMT

The lowest arbitrary temperature specified by the client and in the vessel data sheet is -45 degrees C

Check impact requirements at this temperature:

Exempt per UG-20? No

Check UCS 66 curves:

Shell: SA333-6, 10.97mm, Curve C: Impacts are required

Cap: SA420 WPL6, 10.97mm, Curve C: Impacts are required

6" Body Flange: SA350-LF2, 10.97mm, Curve C, Impacts are required

2" schXXS pipe: SA333-6, 11.07mm, Curve C, Impacts are required

2" Flange: SA350-LF2, 11.07mm, Curve C: Impacts are required

2" Compensation Pads: SA516 Gr70N, 6mm, Curve D: Impacts are not required

When impact testing is required this shall be done at or below the MDMT.

Loadings from Meteorologic Data:

Client has stated that the vessel will be located and operating inside a building, therefore the vessel is sheltered from wind, rain & snow loads.

Wind loads: N/A

Precipitation loads: N/A

Snow loads: N/A

Sesimic loads: Based on Alberta Building Code

Seismic spectral response acceleration (5% damped), $S_a(0.2) = 0.12g$

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
 Client : Exheat Ltd

Doc No. :
 Issue : 1

VQ0511
 Page : 6

Title : Fabrication Weight

Centre of Gravity Calculation

Description	Weight (kg)	Vertical	North	East
Shell	64	0	0	892
Cap	5	0	0	1687
Body Flange	50	0	0	60
N1	16	0	0	275
N2	16	0	0	1372
N3	16	0	0	750
Fix saddle	24	0	0	350
Sli saddle	24	0	0	1300
Ancillaries	20	0	0	892
Total Weight	235			

Centre of Gravity : Vertical from base = 0
 : North = 0
 : East = 699

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
 Client : Exheat Ltd

Doc No. :
 Issue : 1

VQ0511
 Page : 7

Title : Hydrottest Weight

Centre of Gravity Calculation

Description	Weight (kg)	Vertical	North	East
Shell	64	0	0	892
Cap	5	0	0	1687
Body Flange	50	0	0	60
N1	16	0	0	275
N2	16	0	0	1372
N3	16	0	0	750
Fix saddle	24	0	0	350
Sli saddle	24	0	0	1300
Ancillaries	20	0	0	892
Water	30	0	0	892
Blinds	85	0	0	892
Bolts	20	0	0	892
Total Weight	370			

Centre of Gravity : Vertical from base = 0
 : North = 0
 : East = 770

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
 Client : Exheat Ltd

Doc No. :
 Issue : 1

VQ0511
 Page : 8

Title : Operational Weight

Centre of Gravity Calculation

Description	Weight (kg)	Vertical	North	East
Shell	64	0	0	892
Cap	5	0	0	1687
Body Flange	50	0	0	60
N1	16	0	0	275
N2	16	0	0	1372
N3	16	0	0	750
Fix saddle	24	0	0	350
Sli saddle	24	0	0	1300
Ancillaries	20	0	0	892
Bundle	98	0	0	27
Bolts	17	0	0	0
Gasket	5	0	0	0
Total Weight	355			

Centre of Gravity : Vertical from base = 0
 : North = 0
 : East = 470

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
Client : Exheat Ltd

Doc No. :
Issue : 1

VQ0511
Page : 9

Explanatory notes

Calculations for Shells - Internal Pressure
=====

Calculations for cylindrical and conical shells and formed heads under internal pressure to ASME VIII Div.1 clauses UG-27, UG-32 & Appendix 1 clauses 1-2 to 1-5.

Joint efficiency E is evaluated to UW-12 for specified radiography and weld types. Thickness and diameter limits in TABLE UW-12 are checked.

Test pressures and maximum allowable working pressures are calculated to UG-99 and UG-98 respectively. Maximum allowable working pressures (MAWP) are calculated in both the new & cold and hot & corroded conditions.

Required thickness for cylindrical shells is calculated to UG-27(c), except for $P > 0.385SE$ when Appendix 1-2 is used.

For cones without a large end knuckle, required thickness of cone is calculated to UG-32(g). Reinforcement requirements at large end cone cylinder junction are calculated to Appendix 1-5(d). For a stiffener with a design stress lower than that of the shell, required stiffener area is increased by factor k - see Appendix 1-5(c) & UG-41(a).

For cones with a large end knuckle, required thickness of cone is calculated to UG-32(h). Required thickness of knuckle is calculated to Appendix 1-4(d) Formula (3). Limitations on knuckle radius in UG-32(h) are checked in the uncorroded condition.

ASME VIII Div.1 does not include rules for design of cones with a small end knuckle, so requirements for reinforcement of small end cone cylinder junction are calculated to Appendix 1-5(e) for cones with or without a small end knuckle.

Required thickness for ellipsoidal heads is calculated to Appendix 1-4(c). Requirements of footnote (1) in Appendix 1-4 are complied with when value of K exceeds 1.0.

Required thickness for hemispherical heads is calculated to UG-32(f), except for $P > 0.665SE$ when Appendix 1-3 is used.

Required thickness for torispherical heads is calculated to Appendix 1-4(d). Requirements of footnote (1) in Appendix 1-4 are complied with. Limitations on crown radius and knuckle radius in UG-32(j) are checked in the uncorroded condition.

Knuckle buckling for formed heads is checked per Appendix 1-4(f)

Calculation status
=====

The status of each individual calculation is printed at the end of each output.

Acceptable calculation: Indicates that the calculation and checks have been performed successfully and that no errors have been found.

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
Client : Exheat Ltd

Doc No. :
Issue : 1

VQ0511
Page : 10

Explanatory notes

Warnings: Indicates that one or more warning messages have been generated. These warning messages are then listed. If the messages are informative only then Acceptable calculation will be printed at the end of the list.

Explanation of all possible messages

Additional loads: Additional loads have been input but are not catered for in this module.

Applied axial comp force: May require special analysis.

Code limitations exceeded: t/L or temperature limit exceeded.

Design pressure: The design pressure limit has been exceeded. U-1(d).

Diameter limit exceeded: OD > limit in TABLE UW-12 for weld type.

Extrapolated graphs/tables: The limits of TABLE 1-4.4 exceeded.

Full radiography reqd: Thickness > 1.5" (38mm) and full radiography not specified (UW-11(a) (2)).

Inside knuckle radius: Knuckle radius is too small.

Inside spherical radius: Exceeds head OD.

Knuckle buckling: Knuckle buckling governs the design.

Large end stiffener area: Additional reinforcement required at large end as indicated.

Limit for stiffener location: The subject stiffener is located more than $0.25\sqrt{Rt_s}$ from the cone to cylinder junction.

Min reqd cone thk tr: Small end cone thickness is insufficient.

Min reqd shell thk t: Shell thickness at large or small end of cone is insufficient.

Ratio D/2h: Exceeds 3.0 (TABLE 1-4.1).

Ratio L/r: Exceeds 16.667 (TABLE 1-4.2 NOTE (1)).

See App 1-5(g): For conical shells with the half apex angle greater than 30° , special analysis may be required when the cone-to-cylinder junction at the small end is designed without a knuckle.

Small end knuckle rad: The calculation method does not include knuckles at the small end. Reinforcing requirements at the small end have been calculated in accordance with Appendix 1-5(e) for a cone without a knuckle.

Small end stiffener area: Additional reinforcement required at small end as indicated.

Stiffener on knuckle: A stiffener has been located on the knuckle region of a cone.

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
Client : Exheat Ltd

Doc No. :
Issue : 1

VQ0511
Page : 11

Explanatory notes

Straight flange: The reqd straight flange thickness of a formed head governs.

Thick shell theory reqd: $P > 0.385SE$ or thickness $> R/2$.

Thick shell theory used: Cylindrical shell or hemispherical head thickness calculated to Appendix 1-2 or 1-3.

Thickness limit exceeded: $Thk > \text{limit in TABLE UW-12 for weld type.}$

Total reqd knuckle thk: Cone large end knuckle thickness insufficient.

Total reqd thk: Thickness of shell, head or cone large end is insufficient.

UG-16(b): Min thk: Corroded thickness $< 1/16"$ (1.5mm).

UG-32(h):Knuckle reqd: Large end knuckle reqd.

Vessco Engineering Ltd

```

-----
Item   : 6" 900# Shell Line Heater          Doc No. : VQ0511
Client : Exheat Ltd                        Issue  : 1          Page : 12
-----
  
```

Title : Shell internal pressure

Design data

=====

Type	-	Cylindrical shell
Pressure	-	Design pressure
Design pressure	MPa	9.930
Design temp	deg.C	93.000
Corrosion: int	mm	1.500
Corrosion: ext	mm	0.000

Shell data

=====

Outside diameter	mm	168.300
New thickness	mm	10.970
Thinning	percent	12.500
End location 1	mm	0.000
End location 2	mm	1491.000

Material data

=====

Material spec	-	SA333-6:K03006
Longitudinal weld	-	Seamless
Radiography: TABLE UW-12	-	None
Circumferential weld	-	Type 1
Radiography: TABLE UW-12	-	Full

Output data

=====

Joint efficiency E	-	1.000
Radius R	mm	76.051
Min reqd thk t	mm	6.740
Total reqd thk	mm	9.417
Thickness	mm	8.099
Test pressure (1.3P.Sa/S)	MPa	12.909
MAWP new & cold	MPa	14.103
MAWP hot & corroded	MPa	11.811
Length	mm	1491.000
Metal SG	-	7.850
Shell weight	kg	63.462
Shell volume	m3	0.025

Material data

=====

Material spec	-	SA333-6:K03006
Allowable stress: ATM	MPa	118.0
Allowable stress: DT	MPa	118.0
Data:ASME II Part D Table 1A p14/22(M)		

Acceptable calculation

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
Client : Exheat Ltd

Doc No. :
Issue : 1

VQ0511
Page : 13

Title : End cap internal pressure

Design data

=====

Type	-	2:1 Ellipsoidal head
Pressure	-	Design pressure
Design pressure	MPa	9.930
Design temp	deg.C	93.000
Corrosion: int	mm	1.500
Corrosion: ext	mm	0.000

Head data

=====

Outside diameter	mm	168.300
New thickness	mm	10.970
Thinning	percent	12.500
Straight flange	-	Yes

Material data

=====

Material spec	-	SA420-WPL6
Head weld	-	Seamless
Radiography: TABLE UW-12	-	None
Head to shell weld	-	Type 1
Radiography: TABLE UW-12	-	Full

Vessco Engineering Ltd

```

-----
Item   : 6" 900# Shell Line Heater          Doc No. : VQ0511
Client : Exheat Ltd                        Issue  : 1          Page : 14
-----
  
```

Title : End cap internal pressure

Output data

```

=====
Outside head height          mm          42.075
Joint efficiency E           -            1.000
Diameter D                   mm          152.102
Head height h                mm          33.976
Ratio D/2h                   -            2.238
Factor K                      -            1.168
Allowable stress: DT         MPa          118.000
Min reqd thk t               mm           7.541
Total reqd thk               mm          10.333
Thickness                    mm           8.099
Test pressure (1.3P.Sa/S)    MPa          12.909
MAWP new & cold              MPa          12.408
MAWP hot & corroded          MPa          10.658
Metal SG                     -            7.850
Head weight                   kg           2.160
Head volume                   m3          3.489E-04
  
```

Material data

```

=====
Material spec                 -            SA420-WPL6
Min tensile strength          MPa          415.0
Yield: ATM                    MPa          240.0
Allowable stress: ATM         MPa          118.0
Elastic mod: ATM              MPa          202350.0
Yield: DT                     MPa          221.4
Allowable stress: DT          MPa          118.0
Elastic mod: DT               MPa          198373.3
Data:ASME II Part D Table 1A p14/29(M)
Data:ASME II Part D Table Y-1 p574/11(M)
Data:ASME II Part D Table TM-1 CS C <= 0.3%(M)
  
```

Acceptable calculation

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
Client : Exheat Ltd

Doc No. :
Issue : 1

VQ0511
Page : 15

Explanatory notes

Calculations for Shells - External Pressure

=====

Calculations for cylindrical and conical shells and formed heads under external pressure to ASME VIII Div.1 clauses UG-28, UG-29, UG-30, UG-33 & Appendix 1-8. Calculations are valid for shells or heads with an out of roundness that complies with UG-80 & UG-81. Factors A and B are evaluated from figures and tables in ASME II, PART D, Subpart 3.

Allowable external pressure Pa for cylinders is calculated to UG-28(c) and for cones to UG-33(f) & (g). For cylinders with stiffeners Pa is calculated for longer of two shell sections either side of subject stiffener. For cones with stiffeners Pa is calculated for both cone sections on either side of subject stiffener. As required by UG-33(a), Pa for dished heads is calculated as lower of maximum allowable pressure on concave side ($E = 1$) to Appendix 1-8(c) or (d) divided by 1.67, or maximum allowable pressure on convex side to UG-33(d) or (e). Pa is checked against external design pressure. When a lap joint is specified as longitudinal weld in cylinder or cone, or as head to shell weld for hemispherical head, Pa is checked against twice the external design pressure - see UG-28(g) & UG-33(h).

Joint efficiency E is evaluated to UW-12 for specified radiography and weld types. $E = 1$ for butt joints in compression - see TABLE UW-12 NOTE (5). Thickness and diameter limits in TABLE UW-12 are checked.

For cylinder or cone calculations stiffeners are specified in terms of subject stiffener (the one to be assessed) and adjacent stiffeners on either side. For cone/cylinder junctions, subject stiffener is that providing reinforcement at junction. Stiffening rings may be internal or external. Corrosion allowance is deducted from all stiffener surfaces. Moment of inertia is checked for combined ring-shell cross section. Attachment welds are checked to UG-30(c), (e) & (f).

For large or small end reinforcement calculations, cone/cylinder junction is analysed as a line of support to Appendix 1-8. Required moment of inertia is checked against available moment of inertia for combined ring-shell-cone cross section. Reinforcement of cone/cylinder junction without a knuckle is assessed, when required, to Appendix 1-8. Required area is checked against available area. If stiffener design stress is less than that of the shell, required stiffener area is increased by factor k - see Appendix 1-8(a) and UG-41(a). Distance from centre of stiffener to cone to cylinder junction is checked against limits specified in Appendix 1-8.

For cones with a large end knuckle, limitations on knuckle radius in UG-32(h) are checked in the uncorroded condition. For torispherical heads, limitations on crown radius and knuckle radius in UG-32(j) are checked in the uncorroded condition.

Calculation status

=====

The status of each individual calculation is printed at the end of each output.

Acceptable calculation: Indicates that the calculation and checks have been performed successfully and that no errors have been found.

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
Client : Exheat Ltd

Doc No. :
Issue : 1

VQ0511
Page : 16

Explanatory notes

Warnings: Indicates that one or more warning messages have been generated. These warning messages are then listed. If the messages are informative only then Acceptable calculation will be printed at the end of the list.

Explanation of all possible messages

Actual weld stress: Stiffener attachment weld stress > allowable.

Additional loads: Additional loads have been input but are not catered for in this module.

Applied axial tensile force: May require special analysis.

Diameter limit exceeded: OD > limit in TABLE UW-12 for weld type.

Extrapolated graphs/tables: Factor A is outside limits of TABLE G or the limits of TABLE 1-4.4 have been exceeded.

Fillet weld leg: Stiffener fillet weld < minimum to UG-30(f).

Full radiography reqd: Thk > 1.5" (38mm) and not full X-ray (UW-11(a)(2)).

Inside knuckle radius: Knuckle radius too small (UG-32(h) & (j)).

Inside spherical radius: Spherical radius > OD of head (UG-32(j)).

Insufficient reinforcement: Required area ArL or Ars > area available.

Insufficient thk: The shell, cone or head thickness is governed by the internal pressure calculation.

Lap joint: Pa checked against 2P for lap joint (UG-28(g) & UG-33(h)).

Limit for stiffener location: Stiffener > 0.25sqr(R.ts) from junction.

Ratio D/2h: Exceeds 3.0 (TABLE 1-4.1).

Ratio DL/te: Exceeds 1000 (TABLE 1-4.1)

Ratio Do/2ho: Exceeds 3.0 (TABLE UG-33.1).

Ratio Do/ts or Ratio DL/te: Exceeds 1000 - TABLE G extrapolated.

Ratio L/r: Exceeds 16.667 (TABLE 1-4.2 NOTE (1)).

Reqd moment of inertia Is': Exceeds available moment of inertia I'.

Space between welds: Exceeds limit (UG-30(c)).

Stiffener on knuckle: Stiffener location 1 or 2 on knuckle of cone.

Stiffener proportions: Check for buckling (UG-29(a) CAUTIONARY NOTE).

Thick shell theory reqd: Thick shell theory should be used.

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
Client : Exheat Ltd

Doc No. :
Issue : 1

VQ0511
Page : 17

Explanatory notes

Thick shell theory used: Thick shell theory has been used.

Thickness limit exceeded: Thk > limit in TABLE UW-12 for weld type.

UG-16(b): Min thk: Corroded thickness < 1/16" (1.5mm).

Unsuitable for external pressure: Pa < external design pressure.

Welded length: Length of weld segments less than minimum to UG-30(c).

Vessco Engineering Ltd

```

-----
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-----

```

Title : Shell external pressure

Design data

=====

Type	-	Cylindrical shell
External design pressure	MPa	0.103
Design pressure	MPa	9.930
Design temp	deg.C	93.000
Corrosion: int	mm	1.500
Corrosion: ext	mm	0.000

Shell data

=====

Outside diameter	mm	168.300
New thickness	mm	10.970
Thinning	percent	12.500
Stiffener	-	None
End location 1	mm	0.000
End location 2	mm	1491.000

Material data

=====

Material spec	-	SA333-6:K03006
Longitudinal weld	-	Seamless
Radiography: TABLE UW-12	-	None
Circumferential weld	-	Type 1
Radiography: TABLE UW-12	-	Full

Output data

=====

Joint efficiency E	-	1.000
Diameter Do	mm	168.300
Radius R	mm	76.051
Length L	mm	1491.000
Ratio L/Do	-	8.859
Min reqd thk t	mm	6.740
Shell thk ts	mm	8.099
Ratio Do/ts	-	20.781
Factor A (xE6)	-	2611.186
Elastic mod Es	MPa	199900.000
Factor B	MPa	108.834
Stress S	MPa	217.800
Allowable external pressure	MPa	6.983

Material data

=====

Shell		
Material spec	-	SA333-6:K03006
Allowable stress: DT	MPa	118.0
Data:ASME II Part D Table 1A p14/22 (M)		
Data:ASME II Part D Table CS-2 (M)		

Acceptable calculation

Vessco Engineering Ltd

```

-----
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-----
  
```

Title : End cap external pressure

Design data

```

=====
Type                -                2:1 Ellipsoidal head
External design pressure MPa          0.103
Design pressure     MPa          9.930
Design temp         deg.C          93.000
Corrosion: int      mm            1.500
Corrosion: ext      mm            0.000
  
```

Head data

```

=====
Outside diameter    mm            168.300
New thickness       mm            10.970
Thinning            percent        12.500
  
```

Material data

```

=====
Material spec       -                SA420-WPL6
Head weld           -                Seamless
Radiography: TABLE UW-12 -          None
Head to shell weld -                Type 1
Radiography: TABLE UW-12 -          Full
  
```

Output data

```

=====
Radius Ro          mm            151.470
Min reqd thk t    mm            7.542
Ratio Ro/ts       -                18.703
Factor A (xE6)    -                6683.460
Elastic mod Es    MPa          199900.000
Factor B          MPa          119.358
Allowable external pressure MPa      6.382
  
```

Vessco Engineering Ltd

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Title : End cap external pressure

Miscellaneous data

Joint efficiency E	-	1.000
Diameter D	mm	152.102
Head height h	mm	33.976
Ratio D/2h	-	2.238
Factor K	-	1.168
Diameter Do	mm	168.300
Ratio Do/2ho	-	2.000
Factor Ko	-	0.900

Material data

Head		
Material spec	-	SA420-WPL6
Yield: DT	MPa	221.4
Allowable stress: DT	MPa	118.0
Elastic mod: DT	MPa	198373.3
Data:ASME II Part D Table 1A p14/29(M)		
Data:ASME II Part D Table Y-1 p574/11(M)		
Data:ASME II Part D Table TM-1 CS C <= 0.3%(M)		
Data:ASME II Part D Table CS-2(M)		

Acceptable calculation

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
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Explanatory notes

Calculations for Nozzles & Openings

=====

Calculations for reinforcement of single or combined openings in cylindrical or conical shells or formed heads subject to internal pressure to ASME VIII Div.1 clauses UG-36, UG-37, UG-40, UG-41, UG-42, UG-45 and Appendix 1-7. Weld sizes are checked to UW-16 in corroded condition.

Strength calculations for attachment welds are performed to UW-15(a), (b) & (c), UG-41 and FIG UG-41.1(a) & (b), modified as necessary for various nozzle types. Weld strength calculations are not performed for nozzle types specified in UW-15(b).

Nozzle wall thickness less mill tolerance is checked to UG-45(a), and thickness less mill tolerance and corrosion is checked to UG-27(c)(1) for internal pressure using appropriate nozzle joint efficiency.

External and internal projections are measured along centre-line of nozzle from point of intersection with outside surface of vessel.

For cylindrical and conical shells reinforcement requirements are calculated for two perpendicular planes through centre of opening and normal to surface of shell. The two planes are parallel to and perpendicular to longitudinal axis of the shell. For formed heads calculations are performed for plane through centre of opening and centre of head. Calculations for combined reinforcement are performed to UG-42(a) for plane through centres of the two openings. The true pitch between openings is evaluated at mid-surface of shell or head corroded wall thickness.

Limits of reinforcement are to UG-40. Reinforcement beyond end of shell or cone, or in knuckle region of formed head, or beyond external or internal projection of nozzle is not included. For cylindrical shells where opening size exceeds limits in UG-36(b)(1), rules of Appendix 1-7 are also applied. Area available in nozzle neck is based on nominal wall thickness less corrosion with no deduction of mill tolerance.

NOTE - FIG UG-37.1 illustrates a typical nozzle configuration and this figure and equations beneath it are not necessarily correct for other nozzle types.

Shop/Site test conditions are checked if required. Output data is omitted. Warning messages are printed if calculations are unsatisfactory.

Calculation status

=====

The status of each individual calculation is printed at the end of each output.

Acceptable calculation: Indicates that the calculation and checks have been performed successfully and that no errors have been found.

Warnings: Indicates that one or more warning messages have been generated. These warning messages are then listed. If the messages are informative only then Acceptable calculation will be printed at the end of the list.

Vessco Engineering Ltd

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Explanatory notes

Explanation of all possible messages

=====

Code limitation exceeded: Nozzle OD or thk > limit in TABLE UW-12 for weld type, or nozzle thk > 1.5" (38mm) and not full X-ray (UW-11(a)(2)), or nozzle limit outside of the central 80% of an ellipsoidal head (UG-37(a)).

Diameter limit exceeded: Shell OD > limit in TABLE UW-12 for weld type.

Elliptical opening: The ratio of major to minor axis of the opening exceeds 2. See UG-36(a)(1). The program will show the effective increase in stress ratio caused by the nozzle being inclined from the normal.

Full radiography reqd: Shell thickness > 1.5" (38mm) and not full X-ray (UW-11(a)(2)).

Insufficient reinforcement: Reinforcement does not satisfy Code requirements.

Location may reduce reinforcement: Area available in shell may be limited by proximity of shell or cone end, or knuckle on head.

Min nozzle thk to UG-45: Nozzle thickness < minimum to UG-45.

Min weld thk to UW-16: Thickness of one or more attachment welds less than minimum to UW-16.

Openings do not combine: Nozzles or openings do not combine.

Reinforcement reduced by location: Area available in shell limited by proximity of shell or cone end, or knuckle on head.

Size limit to UG-36(b): Nozzle or opening dia > limit to UG-36(b). Appendix 1-7 will be applied.

Shop test fails: Further calculations may required for test condition.

Site test fails: Further calculations may required for test condition.

Strength path failure: One or more of the weld failure paths is insufficient.

Stress limit exceeded: The Appendix 1-7 stresses exceed the allowable.

Thick shell theory used: $P > 0.385SE$ or $thk > R/2$.

Thickness limit exceeded: Thickness > limit in TABLE UW-12 for welded type.

UG-16(b): Min thk: Corroded shell or head thickness < 1/16" (1.5mm).

Vessco Engineering Ltd

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Title : N1 Inlet

Design data

=====

Type	-	Cylindrical shell
Relax reinforcement limits	-	No
Design pressure	MPa	9.930
Design temp	deg.C	93.000
Corrosion: int	mm	1.500
Corrosion: ext	mm	0.000
Shop test pressure	MPa	12.900
Site test pressure	MPa	12.900

Shell data

=====

Material spec	-	SA333-6:K03006
Outside diameter	mm	168.300
New thickness	mm	10.970
Thinning	percent	12.500
End location 1	mm	0.000
End location 2	mm	1491.000

Opening or nozzle data

=====

Opening ident	-	N1
Type	-	Nozzle + single pad
Attachment	-	Set-in
Weld	-	Full penetration
Nozzle configuration	-	Radial
Pipework fitted	-	Yes
Orientation	degrees	0.000
Opening location	mm	129.000
Main weld pierced	-	Seamless
Radiography: TABLE UW-12	-	None
Longitudinal weld	-	Seamless
Radiography: TABLE UW-12	-	None
Circumferential weld	-	Type 1
Radiography: TABLE UW-12	-	Full

Nozzle data

=====

Nominal bore	-	2"
Schedule	-	XXS
Thinning	percent	12.500
Material spec	-	SA333-6:K03006
External projection	mm	200.000
Corner radius	mm	3.000
Fillet weld (noz/pad)	mm	10.000

Pad data

=====

Material spec	-	SA516-70:K02700
Pad OD	mm	120.000
Pad thk	mm	6.000
Fillet weld (pad/shell)	mm	6.000

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
 Client : Exheat Ltd

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Title : N1 Inlet

Output data

=====

Opening ident	-		N1
Nozzle OD	mm		60.325
Nozzle thk	mm		11.074
Diameter D	mm		152.102
Shell thk t	mm		8.099
Reqd thk (int.p)	mm		6.740
Reqd shell thk tr (E=1)	mm		6.740
Nozzle thk tn	mm		9.574
Reqd nozzle thk trn (E=1)	mm		1.825
Joint efficiency E1	-		1.000
Nozzle joint efficiency	-		1.000
Min nozzle thk for pressure	mm		1.947
Min nozzle thk to UG-45	mm		4.923
Stress factor fr1	-		1.000
Stress factor fr2	-		1.000
Stress factor fr3	-		1.000
Stress factor fr4	-		1.000
Size limit to UG-36(b)	mm		76.051

Reinforcement data

=====

	-	Long axis	Tran axis
Factor F	-	1.000	1.000
Diameter d	mm	41.176	41.176
Reinf limit: radial	mm	41.176	41.414
Reinf limit: normal	mm	20.247	20.247
Area A	mm2	277.537	277.537
Area A1	mm2	55.939	55.749
Area A2	mm2	312.850	313.388
Area A41	mm2	100.000	100.000
Area A42	mm2	0.000	0.000
Area A5	mm2	132.164	126.782
Area available	mm2	600.953	595.920
Reinforced both sides	-	Yes	Yes

Weld data

=====

Min weld thk tc	mm	4.200
Min weld thk tmin/2	mm	3.000
Check reqd per UG-41(b)	-	Yes

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
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Title : N1 Inlet

Weld data

=====

	-	Long axis	Tran axis
Fillet weld strength A	N	54789	54789
Nozzle wall strength B	N	63045	63045
Groove weld strength C	N	67011	67011
Fillet weld strength D	N	65393	65393
Groove weld strength E	N	49646	49646
Weld load W1	N	64312	63740
Strength path 1 (B+D)	N	128438	128438
Weld load W2	N	67016	68090
Strength path 2 (A+C+E)	N	171446	171446
Weld load W3	N	82611	83050
Strength path 3 (C+D)	N	132404	132404
Total weld load W	N	29218	29241

Material data

=====

Nozzle

Material spec	-		SA333-6:K03006
Yield: ATM	MPa		240.0
Allowable stress: ATM	MPa		118.0
Allowable stress: DT	MPa		118.0
Data:ASME II Part D Table 1A p14/22(M)			

Pad

Material spec	-		SA516-70:K02700
Yield: ATM	MPa		260.0
Allowable stress: ATM	MPa		138.0
Allowable stress: DT	MPa		138.0
Data:ASME II Part D Table 1A p22/6(M)			

Material data

=====

Shell

Material spec	-		SA333-6:K03006
Yield: ATM	MPa		240.0
Allowable stress: ATM	MPa		118.0
Allowable stress: DT	MPa		118.0
Data:ASME II Part D Table 1A p14/22(M)			

Acceptable calculation

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
 Client : Exheat Ltd

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Title : N2 Outlet

Design data

=====

Type	-	Cylindrical shell
Relax reinforcement limits	-	No
Design pressure	MPa	9.930
Design temp	deg.C	93.000
Corrosion: int	mm	1.500
Corrosion: ext	mm	0.000
Shop test pressure	MPa	12.900
Site test pressure	MPa	12.900

Shell data

=====

Material spec	-	SA333-6:K03006
Outside diameter	mm	168.300
New thickness	mm	10.970
Thinning	percent	12.500
End location 1	mm	0.000
End location 2	mm	1491.000

Opening or nozzle data

=====

Opening ident	-	N2
Type	-	Nozzle + single pad
Attachment	-	Set-in
Weld	-	Full penetration
Nozzle configuration	-	Radial
Pipework fitted	-	Yes
Orientation	degrees	0.000
Opening location	mm	1226.000
Main weld pierced	-	Seamless
Radiography: TABLE UW-12	-	None
Longitudinal weld	-	Seamless
Radiography: TABLE UW-12	-	None
Circumferential weld	-	Type 1
Radiography: TABLE UW-12	-	Full

Nozzle data

=====

Nominal bore	-	2"
Schedule	-	XXS
Thinning	percent	12.500
Material spec	-	SA333-6:K03006
External projection	mm	200.000
Corner radius	mm	3.000
Fillet weld (noz/pad)	mm	10.000

Pad data

=====

Material spec	-	SA516-70:K02700
Pad OD	mm	120.000
Pad thk	mm	6.000
Fillet weld (pad/shell)	mm	6.000

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
 Client : Exheat Ltd

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Title : N2 Outlet

Output data

=====		
Opening ident	-	N2
Nozzle OD	mm	60.325
Nozzle thk	mm	11.074
Diameter D	mm	152.102
Shell thk t	mm	8.099
Reqd thk (int.p)	mm	6.740
Reqd shell thk tr (E=1)	mm	6.740
Nozzle thk tn	mm	9.574
Reqd nozzle thk trn (E=1)	mm	1.825
Joint efficiency E1	-	1.000
Nozzle joint efficiency	-	1.000
Min nozzle thk for pressure	mm	1.947
Min nozzle thk to UG-45	mm	4.923
Stress factor fr1	-	1.000
Stress factor fr2	-	1.000
Stress factor fr3	-	1.000
Stress factor fr4	-	1.000
Size limit to UG-36(b)	mm	76.051

Reinforcement data

=====			
	-	Long axis	Tran axis
Factor F	-	1.000	1.000
Diameter d	mm	41.176	41.176
Reinf limit: radial	mm	41.176	41.414
Reinf limit: normal	mm	20.247	20.247
Area A	mm2	277.537	277.537
Area A1	mm2	55.939	55.749
Area A2	mm2	312.850	313.388
Area A41	mm2	100.000	100.000
Area A42	mm2	0.000	0.000
Area A5	mm2	132.164	126.782
Area available	mm2	600.953	595.920
Reinforced both sides	-	Yes	Yes

Weld data

=====		
Min weld thk tc	mm	4.200
Min weld thk tmin/2	mm	3.000
Check reqd per UG-41(b)	-	Yes

Vessco Engineering Ltd

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Title : N2 Outlet

Weld data

=====

	-	Long axis	Tran axis
Fillet weld strength A	N	54789	54789
Nozzle wall strength B	N	63045	63045
Groove weld strength C	N	67011	67011
Fillet weld strength D	N	65393	65393
Groove weld strength E	N	49646	49646
Weld load W1	N	64312	63740
Strength path 1 (B+D)	N	128438	128438
Weld load W2	N	67016	68090
Strength path 2 (A+C+E)	N	171446	171446
Weld load W3	N	82611	83050
Strength path 3 (C+D)	N	132404	132404
Total weld load W	N	29218	29241

Material data

=====

Nozzle

Material spec	-		SA333-6:K03006
Yield: ATM	MPa		240.0
Allowable stress: ATM	MPa		118.0
Allowable stress: DT	MPa		118.0
Data:ASME II Part D Table 1A p14/22(M)			

Pad

Material spec	-		SA516-70:K02700
Yield: ATM	MPa		260.0
Allowable stress: ATM	MPa		138.0
Allowable stress: DT	MPa		138.0
Data:ASME II Part D Table 1A p22/6(M)			

Material data

=====

Shell

Material spec	-		SA333-6:K03006
Yield: ATM	MPa		240.0
Allowable stress: ATM	MPa		118.0
Allowable stress: DT	MPa		118.0
Data:ASME II Part D Table 1A p14/22(M)			

Acceptable calculation

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
Client : Exheat Ltd

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Title : N3 Drain

Design data

Type	-	Cylindrical shell
Relax reinforcement limits	-	No
Design pressure	MPa	9.930
Design temp	deg.C	93.000
Corrosion: int	mm	1.500
Corrosion: ext	mm	0.000
Shop test pressure	MPa	12.900
Site test pressure	MPa	12.900

Shell data

Material spec	-	SA333-6:K03006
Outside diameter	mm	168.300
New thickness	mm	10.970
Thinning	percent	12.500
End location 1	mm	0.000
End location 2	mm	1491.000

Opening or nozzle data

Opening ident	-	N3
Type	-	Nozzle + single pad
Attachment	-	Set-in
Weld	-	Full penetration
Nozzle configuration	-	Radial
Pipework fitted	-	Yes
Orientation	degrees	180.000
Opening location	mm	604.000
Main weld pierced	-	Seamless
Radiography: TABLE UW-12	-	None
Longitudinal weld	-	Seamless
Radiography: TABLE UW-12	-	None
Circumferential weld	-	Type 1
Radiography: TABLE UW-12	-	Full

Nozzle data

Nominal bore	-	2"
Schedule	-	XXS
Thinning	percent	12.500
Material spec	-	SA333-6:K03006
External projection	mm	200.000
Corner radius	mm	3.000
Fillet weld (noz/pad)	mm	10.000

Pad data

Material spec	-	SA516-70:K02700
Pad OD	mm	120.000
Pad thk	mm	6.000
Fillet weld (pad/shell)	mm	6.000

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
 Client : Exheat Ltd

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Title : N3 Drain

Output data

=====

Opening ident	-		N3
Nozzle OD	mm		60.325
Nozzle thk	mm		11.074
Diameter D	mm		152.102
Shell thk t	mm		8.099
Reqd thk (int.p)	mm		6.740
Reqd shell thk tr (E=1)	mm		6.740
Nozzle thk tn	mm		9.574
Reqd nozzle thk trn (E=1)	mm		1.825
Joint efficiency E1	-		1.000
Nozzle joint efficiency	-		1.000
Min nozzle thk for pressure	mm		1.947
Min nozzle thk to UG-45	mm		4.923
Stress factor fr1	-		1.000
Stress factor fr2	-		1.000
Stress factor fr3	-		1.000
Stress factor fr4	-		1.000
Size limit to UG-36(b)	mm		76.051

Reinforcement data

=====

	-	Long axis	Tran axis
Factor F	-	1.000	1.000
Diameter d	mm	41.176	41.176
Reinf limit: radial	mm	41.176	41.414
Reinf limit: normal	mm	20.247	20.247
Area A	mm2	277.537	277.537
Area A1	mm2	55.939	55.749
Area A2	mm2	312.850	313.388
Area A41	mm2	100.000	100.000
Area A42	mm2	0.000	0.000
Area A5	mm2	132.164	126.782
Area available	mm2	600.953	595.920
Reinforced both sides	-	Yes	Yes

Weld data

=====

Min weld thk tc	mm	4.200
Min weld thk tmin/2	mm	3.000
Check reqd per UG-41(b)	-	Yes

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
 Client : Exheat Ltd

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Title : N3 Drain

Weld data

=====

	-	Long axis	Tran axis
Fillet weld strength A	N	54789	54789
Nozzle wall strength B	N	63045	63045
Groove weld strength C	N	67011	67011
Fillet weld strength D	N	65393	65393
Groove weld strength E	N	49646	49646
Weld load W1	N	64312	63740
Strength path 1 (B+D)	N	128438	128438
Weld load W2	N	67016	68090
Strength path 2 (A+C+E)	N	171446	171446
Weld load W3	N	82611	83050
Strength path 3 (C+D)	N	132404	132404
Total weld load W	N	29218	29241

Material data

=====

Nozzle

Material spec	-		SA333-6:K03006
Yield: ATM	MPa		240.0
Allowable stress: ATM	MPa		118.0
Allowable stress: DT	MPa		118.0
Data:ASME II Part D Table 1A p14/22(M)			

Pad

Material spec	-		SA516-70:K02700
Yield: ATM	MPa		260.0
Allowable stress: ATM	MPa		138.0
Allowable stress: DT	MPa		138.0
Data:ASME II Part D Table 1A p22/6(M)			

Material data

=====

Shell

Material spec	-		SA333-6:K03006
Yield: ATM	MPa		240.0
Allowable stress: ATM	MPa		118.0
Allowable stress: DT	MPa		118.0
Data:ASME II Part D Table 1A p14/22(M)			

Acceptable calculation

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
Client : Exheat Ltd

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Explanatory notes

Calculations for Local Loads on Cylinders
=====

Calculations for assessment of stresses due to local loading on cylindrical shells to ASME VIII Div.1 Appendix G-9, Welding Research Council Bulletin 107, August 1965, including March 1979 Revision; and Bulletin 297, August 1984, including Revision 1 September 1987.

Nomenclature is to WRC 107 sections 1.1 and 1.3, and WRC 297 section 1.0, except that loadings are specified for axes X, Y and Z. Axis X is parallel to shell axis, positive towards end location 1. Axis Y is tangential to and Z perpendicular to surface of shell. The right hand screw rule is applied for moments. If a standout is specified then moments acting at surface of shell are calculated taking account of moment applied by shear loads X and Y. The relation between specified loadings and those shown in WRC 297 Fig 1 is as follows (NOTE - the loadings shown in WRC 107 Fig 2 are the same except that Load P and Moment Mc have opposite signs to those in WRC 297):

Load VL = Load X	Moment Mc = Moment MX
Load Vc = Load Y	Moment ML = Moment MY
Load P = Load Z	Moment MT = Moment MZ

For a nozzle without a reinforcing pad deflection and rotations are calculated using factors from WRC 297 Figures 59 and 60. In all other cases deflection is calculated using factors derived from 'Stresses from Radial Loads in Cylindrical Pressure Vessels' by P.P.Bijlaard (Welding Journal, December 1954), Table 1, and rotations using factors from 'Stresses from Radial Loads and External Moments in Cylindrical Pressure Vessels' by P.P.Bijlaard (Welding Journal, December 1955), Figures 3 and 7. For deflection due to load P and rotation due to moment Mc a correction factor is applied dependent on ratio L/Rm. For a nozzle or solid attachment with a pad or insert plate, deflection and rotations are calculated at edge of pad or insert plate.

Provision is made for taking account of pipe and shell flexibility. Input data Free end rotn Rx, Free end rotn Ry and Free end defl Dz are rotations and deflection from piping stress analysis assuming pipe end to be free to move in Z direction and to rotate in X and Y directions. Load Z and Moments X and Y are force and moments applied assuming nozzle to be a rigid anchor. Reduced load and moments are calculated using linear interpolation of pipe and shell spring characteristics. Stresses, deflections and rotations are calculated using reduced load and moments.

Stresses in shell at edge of nozzle are calculated to WRC 297 section 3.0. Dimensionless membrane force and bending moment factors (stress resultants) are obtained from Figures 3 to 58. Stresses in nozzle at junction with shell are calculated to WRC 297 section 3.1. Stresses at edge of solid attachment and at edge of pad or insert plate are calculated to WRC 107 section 4. Dimensionless membrane force and bending moment factors are obtained from Figures 1A to 4C.

When a pad or insert plate is specified, stresses are calculated at edge of nozzle or attachment using insert plate thickness or combined shell plus pad thickness, and at edge of pad or insert plate using shell thickness.

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Explanatory notes

Membrane stresses due to internal pressure (S pr) are included with no stress concentration factor applied. When a pad or insert plate is specified, pressure stress is calculated using shell thickness only.

Summation of stresses is to WRC 107 Table 5. Column headings Au, AL, Bu, BL, etc. refer to four points around nozzle or attachment; A & B in longitudinal plane and C & D in circumferential plane. u and L refer to upper (outside) and lower (inside) surfaces of shell or nozzle.

Tensile stresses are positive, compressive stresses are negative. Total circumferential and longitudinal membrane stresses, S_{my} and S_{mx} , are combined with shear stress τ to give membrane stress intensities S_{m1} , S_{m2} and S_{m3} . Total membrane plus bending stresses, S_y and S_x , are combined with shear stress τ to give total stress intensities S_1 , S_2 and S_3 . Maximum values of shear stress, membrane stress and membrane plus bending stress are checked against corresponding allowable stresses.

Calculation status

=====

The status of each individual calculation is printed at the end of each output.

Acceptable calculation: Indicates that the calculation and checks have been performed successfully and that no errors have been found.

Warnings: Indicates that one or more warning messages have been generated. These warning messages are then listed. If the messages are informative only then Acceptable calculation will be printed at the end of the list.

Explanation of all possible messages

=====

Beta out of range: $0.01 < \beta < 0.5$. Limit used (WRC 107 Figs 1A to 4C).

Clearance to shell end: Distance to end $< R_m/2$ (WRC 107 clause 4.5.2).

Deflection: Parameters out of range for deflection calculation.

d/t out of range: $10.0 < d/t < 100.0$. Limit used (WRC 297 Figs 3-58).

Gamma out of range: $5.0 < \gamma < 300$. Limit used (WRC 107 Figs 1A-4C).

Lambda out of range: $0.01 < \lambda < 10.0$. Limit used (WRC 297 Figs 3-58).

Nozzle strength ratio: The membrane stress in the nozzle neck due to pressure and external loads exceeds the allowable design strength.

Pad OD: The pad width is less than the PD5500 recommended minimum for pressure.

Ratio d/D: Exceeds 0.5 (WRC 297 section 3.2).

Ratio d/T: Less than 5.0 (WRC 297 section 3.2).

Ratio D/T: Out of range $20.0 < D/T < 2500$ (WRC 297 section 3.2).

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Ratio d/t: Less than 20.0 (WRC 297 section 3.2).

Shell length: Ratio L/Rm < 1.0 (WRC 107 clause 4.5.1).

Stress limit exceeded: One or more of the stresses exceeds the allowable.

Table value out of range: $0.25 < \text{ratio} < 4.0$ (WRC 107 Tables 7 & 8).

T/t out of range: Ratio T/t > 10.0 (WRC 297 Figs 3 to 58).

WRC 107 graphs: Factor(s) obtained from dotted part of curves or by extrapolation in Figs 1A to 4C.

WRC 297 graphs: Factor(s) obtained by extrapolation in Figs 3 to 58.

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Title : N1 radial load +ve

Design data

=====

Pressure input	-	Design pressure
Design pressure	MPa	9.930
Design temp	deg.C	93.000
Corrosion: int	mm	1.500
Corrosion: ext	mm	0.000

Shell data

=====

Material spec	-	SA333-6:K03006
Allow pressure factor	-	3.000
Allow shear factor	-	0.600
Allow membrane factor	-	1.500
Allow memb+bend factor	-	3.000
Outside diameter	mm	168.300
New thickness	mm	10.970
Thinning	percent	12.500
End location 1	mm	0.000
End location 2	mm	1491.000

Load data

=====

Attachment	-	Nozzle
Loads at shell surface	-	Yes
Constant load	-	Yes
Pressure load	-	No
Load X (long shear)	N	2460.000
Load Y (circ shear)	N	2460.000
Load Z (radial)	N	2460.000
Moment X (circ)	N.mm	480000.000
Moment Y (long)	N.mm	480000.000
Moment Z (torsion)	N.mm	480000.000

Nozzle data

=====

Opening ident	-	N1
Opening location	mm	129.000
Type	-	Nozzle + single pad
Nozzle configuration	-	Radial
Nominal bore	-	2"
Schedule	-	XXS
Thinning	percent	12.500
Nozzle material spec	-	SA333-6:K03006
Allow shear factor	-	0.700
Allow membrane factor	-	1.000
Allow memb+bend factor	-	1.500
Calc nozzle SCF	-	Yes

Pad data

=====

Opening ident	-	N1
Pad material spec	-	SA516-70:K02700
Pad OD	mm	120.000
Pad thk	mm	6.000

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Output data

=====

Abridged output	-	No
Radius R	mm	76.051
Thickness T	mm	14.099
Diameter D	mm	166.201
Nozzle OD	mm	60.325
Nozzle thk	mm	11.074
Nozzle strength ratio	percent	54.967
Diameter d	mm	60.325
Thickness t	mm	8.190
Cross section area A	mm ²	1341.429
Section modulus Z	mm ³	15482.999
Ratio d/t	-	7.366
Ratio T/t	-	1.721
Ratio d/T	-	4.279
Ratio D/T	-	11.788
Ratio d/D	-	0.363
Factor lambda	-	1.246
Gross SCF	-	2.896

Length data

=====

Shell length	mm	1491.000
Distance to end 1	mm	129.000
Distance to end 2	mm	1362.000
Equiv length L	mm	603.429
Clearance to shell end	mm	98.838
Length 2.sqr(D.T)	mm	96.814

Deflection data

=====

Elastic mod E	MPa	198373.333
Ratio L/Rm	-	5.885
Factor beta	-	0.655
w.E.Rm/P	-	277.201
ROT.Rm ³ .beta ² .E/Mc	-	98.041
ROT.Rm ³ .beta ² .E/ML	-	37.223
Deflection Dz	mm	0.035
Rotation Rx	degrees	0.066
Rotation Ry	degrees	0.023

Load data

=====

		Z axis	X axis	Y axis
Load / Moment	N.mm	2460	480000	480000
Torsion / Shear	N.mm	480000	2460	2460

Factor data

=====

		P	Mc	ML
Stress resultant nr	-	0.120	0.175	0.119
Stress resultant mr	-	0.111	0.216	0.144
Stress resultant nt	-	0.148	0.040	0.162
Stress resultant mt	-	0.053	0.126	0.084

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Circumferential stress data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	1.8	1.8	1.8	1.8	1.5	1.5	1.5	1.5
Sb P	4.0	-4.0	4.0	-4.0	8.3	-8.3	8.3	-8.3
Sm Mc	0.0	0.0	0.0	0.0	7.0	7.0	-7.0	-7.0
Sb Mc	0.0	0.0	0.0	0.0	52.0	-52.0	-52.0	52.0
Sm ML	-6.5	-6.5	6.5	6.5	0.0	0.0	0.0	0.0
Sb ML	-20.2	20.2	20.2	-20.2	0.0	0.0	0.0	0.0
S pr	172.4	172.4	172.4	172.4	172.4	172.4	172.4	172.4
Smy	167.7	167.7	180.7	180.7	180.9	180.9	166.9	166.9
Sy	151.5	184.0	204.9	156.5	241.1	120.6	123.2	210.6

Longitudinal stress data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	1.5	1.5	1.5	1.5	1.8	1.8	1.8	1.8
Sb P	8.3	-8.3	8.3	-8.3	4.0	-4.0	4.0	-4.0
Sm Mc	0.0	0.0	0.0	0.0	1.6	1.6	-1.6	-1.6
Sb Mc	0.0	0.0	0.0	0.0	30.3	-30.3	-30.3	30.3
Sm ML	-4.8	-4.8	4.8	4.8	0.0	0.0	0.0	0.0
Sb ML	-34.6	34.6	34.6	-34.6	0.0	0.0	0.0	0.0
S pr	71.8	71.8	71.8	71.8	71.8	71.8	71.8	71.8
Smx	68.5	68.5	78.1	78.1	75.2	75.2	72.0	72.0
Sx	42.2	94.9	120.9	35.2	109.4	41.0	45.7	98.4

Shear stress data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Tau Vc	1.8	1.8	-1.8	-1.8	0.0	0.0	0.0	0.0
Tau VL	0.0	0.0	0.0	0.0	-1.8	-1.8	1.8	1.8
Tau MT	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Tau	7.8	7.8	4.1	4.1	4.1	4.1	7.8	7.8

Stress intensity data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm1	56.6	56.6	68.3	68.3	68.4	68.4	56.0	56.0
Sm2	19.8	19.8	30.6	30.6	27.8	27.8	23.1	23.1
Sm3	36.8	36.8	37.7	37.7	40.6	40.6	32.9	32.9
S1	152.0	184.6	205.1	156.7	241.2	120.8	123.9	211.1
S2	41.7	94.2	120.7	35.0	109.3	40.8	45.0	97.8
S3	110.4	90.5	84.3	121.6	131.9	80.0	79.0	113.3

Stress summary data

Pressure stress Sp	MPa	172.4
Allowable	MPa	354.0
Shear stress	MPa	7.8
Allowable	MPa	70.8
Membrane stress Sm	MPa	68.4
Allowable	MPa	177.0
Memb + bending stress Sb	MPa	241.2
Allowable	MPa	354.0
Maximum ratio	percent	68.1

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Circ stress (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Sm Mc	0.0	0.0	0.0	0.0	1.6	1.6	-1.6	-1.6
Sm ML	-6.5	-6.5	6.5	6.5	0.0	0.0	0.0	0.0
S pr	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6
Smy	27.9	27.9	40.9	40.9	36.0	36.0	32.8	32.8
Sy	27.9	27.9	40.9	40.9	36.0	36.0	32.8	32.8

Long stress (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Sb P	11.3	-11.3	11.3	-11.3	11.3	-11.3	11.3	-11.3
Sm Mc	0.0	0.0	0.0	0.0	31.0	31.0	-31.0	-31.0
Sb Mc	0.0	0.0	0.0	0.0	91.8	-91.8	-91.8	91.8
Sm ML	-31.0	-31.0	31.0	31.0	0.0	0.0	0.0	0.0
Sb ML	-60.2	60.2	60.2	-60.2	0.0	0.0	0.0	0.0
S pr	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3
Smx	-17.8	-17.8	44.2	44.2	44.2	44.2	-17.8	-17.8
Sx	-66.8	31.1	115.7	-27.3	147.3	-58.9	-98.4	62.7

Shear stress (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Tau Vc	3.2	3.2	-3.2	-3.2	0.0	0.0	0.0	0.0
Tau VL	0.0	0.0	0.0	0.0	-3.2	-3.2	3.2	3.2
Tau MT	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3
Tau	13.4	13.4	7.1	7.1	7.1	7.1	13.4	13.4

Stress intensity (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm1	31.6	31.6	49.8	49.8	48.3	48.3	36.2	36.2
Sm2	-21.5	-21.5	35.3	35.3	31.9	31.9	-21.2	-21.2
Sm3	53.1	53.1	14.5	14.5	16.3	16.3	57.3	57.3
S1	29.8	43.0	116.3	41.6	147.7	36.5	34.2	67.8
S2	-68.6	16.0	40.3	-28.0	35.6	-59.4	-99.7	27.7
S3	98.4	27.0	76.1	69.7	112.1	96.0	133.9	40.1

Stress summary (nozzle) data

Pressure stress Sp	MPa	32.6
Allowable	MPa	118.0
Shear stress	MPa	13.4
Allowable	MPa	82.6
Membrane stress Sm	MPa	57.3
Allowable	MPa	118.0
Memb + bending stress Sb	MPa	147.7
Allowable	MPa	177.0
Maximum ratio	percent	83.5

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Pad data

=====

Thickness T	mm	8.099
Radius Rm	mm	80.101
Factor gamma	-	9.890
Radius ro	mm	60.000
Factor beta	-	0.655

Radial load data

=====

		Long axis	Tran axis
Ny.Rm/P (Fig 4C/3C)	-	1.266	0.789
My/P (Fig 2C-1/1C)	-	0.022	0.039
Nx.Rm/P (Fig 3C/4C)	-	0.789	1.266
Mx/P (Fig 1C-1/2C)	-	0.040	0.023

Moment data

=====

		Mc	ML
Ny.Rm ² .beta/M (Fig 3A/3B)	-	0.460	0.992
My.Rm.beta/M (Fig 1A/1B-1)	-	0.074	0.017
Nx.Rm ² .beta/M (Fig 4A/4B)	-	1.067	0.469
Mx.Rm.beta/M (Fig 2A/2B-1)	-	0.037	0.032

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Circ stress (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	4.8	4.8	4.8	4.8	3.0	3.0	3.0	3.0
Sb P	4.9	-4.9	4.9	-4.9	8.7	-8.7	8.7	-8.7
Sm Mc	0.0	0.0	0.0	0.0	6.5	6.5	-6.5	-6.5
Sb Mc	0.0	0.0	0.0	0.0	62.2	-62.2	-62.2	62.2
Sm ML	-14.0	-14.0	14.0	14.0	0.0	0.0	0.0	0.0
Sb ML	-14.4	14.4	14.4	-14.4	0.0	0.0	0.0	0.0
S pr	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2
Smy	90.0	90.0	118.0	118.0	108.7	108.7	95.7	95.7
Sy	80.5	99.5	137.3	98.7	179.6	37.8	42.3	149.1

Long stress (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	3.0	3.0	3.0	3.0	4.8	4.8	4.8	4.8
Sb P	8.9	-8.9	8.9	-8.9	5.1	-5.1	5.1	-5.1
Sm Mc	0.0	0.0	0.0	0.0	15.0	15.0	-15.0	-15.0
Sb Mc	0.0	0.0	0.0	0.0	31.1	-31.1	-31.1	31.1
Sm ML	-6.6	-6.6	6.6	6.6	0.0	0.0	0.0	0.0
Sb ML	-26.9	26.9	26.9	-26.9	0.0	0.0	0.0	0.0
S pr	44.6	44.6	44.6	44.6	44.6	44.6	44.6	44.6
Smx	41.0	41.0	54.2	54.2	64.5	64.5	34.4	34.4
Sx	23.0	59.0	90.0	18.4	100.7	28.2	8.5	60.3

Shear stress (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Tau Vc	1.6	1.6	-1.6	-1.6	0.0	0.0	0.0	0.0
Tau VL	0.0	0.0	0.0	0.0	-1.6	-1.6	1.6	1.6
Tau MT	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Tau	4.2	4.2	1.0	1.0	1.0	1.0	4.2	4.2

Stress intensity (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm1	90.4	90.4	118.0	118.0	108.7	108.7	96.0	96.0
Sm2	40.7	40.7	54.2	54.2	64.5	64.5	34.1	34.1
Sm3	49.7	49.7	63.8	63.8	44.3	44.3	61.9	61.9
S1	80.9	99.9	137.3	98.7	179.6	37.9	42.8	149.3
S2	22.7	58.6	90.0	18.4	100.7	28.1	7.9	60.1
S3	58.1	41.4	47.3	80.3	78.9	9.8	34.8	89.2

Vessco Engineering Ltd

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```

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Stress summary (pad edge) data

=====

Pressure stress Sp	MPa	99.2
Allowable	MPa	118.0
Shear stress	MPa	4.2
Allowable	MPa	70.8
Membrane stress Sm	MPa	118.0
Allowable	MPa	177.0
Memb + bending stress Sb	MPa	179.6
Allowable	MPa	354.0
Maximum ratio	percent	84.1

Material data

=====

Shell

Material spec	-	SA333-6:K03006
Allowable stress: DT	MPa	118.0
Elastic mod: DT	MPa	198373.3

Data:ASME II Part D Table 1A p14/22(M)
Data:ASME II Part D Table TM-1 CS C <= 0.3%(M)

Nozzle

Material spec	-	SA333-6:K03006
Allowable stress: DT	MPa	118.0

Data:ASME II Part D Table 1A p14/22(M)

Pad

Material spec	-	SA516-70:K02700
Allowable stress: DT	MPa	138.0

Data:ASME II Part D Table 1A p22/6(M)

Warnings data

=====

- Beta out of range
- d/t out of range
- Deflection out of range
- Ratio d/T
- Ratio D/T
- Ratio d/t
- WRC 107 graphs
- WRC 297 graphs

Advisory messages have been reviewed, stresses are considered to be acceptable

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Design data

=====

Pressure input	-	Design pressure
Design pressure	MPa	9.930
Design temp	deg.C	93.000
Corrosion: int	mm	1.500
Corrosion: ext	mm	0.000

Shell data

=====

Material spec	-	SA333-6:K03006
Allow pressure factor	-	3.000
Allow shear factor	-	0.600
Allow membrane factor	-	1.500
Allow memb+bend factor	-	3.000
Outside diameter	mm	168.300
New thickness	mm	10.970
Thinning	percent	12.500
End location 1	mm	0.000
End location 2	mm	1491.000

Load data

=====

Attachment	-	Nozzle
Loads at shell surface	-	Yes
Constant load	-	Yes
Pressure load	-	No
Load X (long shear)	N	2460.000
Load Y (circ shear)	N	2460.000
Load Z (radial)	N	-2460.000
Moment X (circ)	N.mm	480000.000
Moment Y (long)	N.mm	480000.000
Moment Z (torsion)	N.mm	480000.000

Nozzle data

=====

Opening ident	-	N1
Opening location	mm	129.000
Type	-	Nozzle + single pad
Nozzle configuration	-	Radial
Nominal bore	-	2"
Schedule	-	XXS
Thinning	percent	12.500
Nozzle material spec	-	SA333-6:K03006
Allow shear factor	-	0.700
Allow membrane factor	-	1.000
Allow memb+bend factor	-	1.500
Calc nozzle SCF	-	Yes

Pad data

=====

Opening ident	-	N1
Pad material spec	-	SA516-70:K02700
Pad OD	mm	120.000
Pad thk	mm	6.000

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Output data

=====

Abridged output	-	No
Radius R	mm	76.051
Thickness T	mm	14.099
Diameter D	mm	166.201
Nozzle OD	mm	60.325
Nozzle thk	mm	11.074
Nozzle strength ratio	percent	53.726
Diameter d	mm	60.325
Thickness t	mm	8.190
Cross section area A	mm ²	1341.429
Section modulus Z	mm ³	15482.999
Ratio d/t	-	7.366
Ratio T/t	-	1.721
Ratio d/T	-	4.279
Ratio D/T	-	11.788
Ratio d/D	-	0.363
Factor lambda	-	1.246
Gross SCF	-	2.896

Length data

=====

Shell length	mm	1491.000
Distance to end 1	mm	129.000
Distance to end 2	mm	1362.000
Equiv length L	mm	603.429
Clearance to shell end	mm	98.838
Length 2.sqr(D.T)	mm	96.814

Deflection data

=====

Elastic mod E	MPa	198373.333
Ratio L/Rm	-	5.885
Factor beta	-	0.655
w.E.Rm/P	-	277.201
ROT.Rm ³ .beta ² .E/Mc	-	98.041
ROT.Rm ³ .beta ² .E/ML	-	37.223
Deflection Dz	mm	-0.035
Rotation Rx	degrees	0.066
Rotation Ry	degrees	0.023

Load data

=====

		Z axis	X axis	Y axis
Load / Moment	N.mm	-2460	480000	480000
Torsion / Shear	N.mm	480000	2460	2460

Factor data

=====

		P	Mc	ML
Stress resultant nr	-	0.120	0.175	0.119
Stress resultant mr	-	0.111	0.216	0.144
Stress resultant nt	-	0.148	0.040	0.162
Stress resultant mt	-	0.053	0.126	0.084

Vessco Engineering Ltd

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Title : N1 radial load -ve

Circumferential stress data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	-1.8	-1.8	-1.8	-1.8	-1.5	-1.5	-1.5	-1.5
Sb P	-4.0	4.0	-4.0	4.0	-8.3	8.3	-8.3	8.3
Sm Mc	0.0	0.0	0.0	0.0	7.0	7.0	-7.0	-7.0
Sb Mc	0.0	0.0	0.0	0.0	52.0	-52.0	-52.0	52.0
Sm ML	-6.5	-6.5	6.5	6.5	0.0	0.0	0.0	0.0
Sb ML	-20.2	20.2	20.2	-20.2	0.0	0.0	0.0	0.0
S pr	172.4	172.4	172.4	172.4	172.4	172.4	172.4	172.4
Smy	164.1	164.1	177.0	177.0	177.9	177.9	163.9	163.9
Sy	139.9	188.2	193.3	160.8	221.6	134.2	103.6	224.1

Longitudinal stress data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	-1.5	-1.5	-1.5	-1.5	-1.8	-1.8	-1.8	-1.8
Sb P	-8.3	8.3	-8.3	8.3	-4.0	4.0	-4.0	4.0
Sm Mc	0.0	0.0	0.0	0.0	1.6	1.6	-1.6	-1.6
Sb Mc	0.0	0.0	0.0	0.0	30.3	-30.3	-30.3	30.3
Sm ML	-4.8	-4.8	4.8	4.8	0.0	0.0	0.0	0.0
Sb ML	-34.6	34.6	34.6	-34.6	0.0	0.0	0.0	0.0
S pr	71.8	71.8	71.8	71.8	71.8	71.8	71.8	71.8
Smx	65.6	65.6	75.1	75.1	71.6	71.6	68.4	68.4
Sx	22.7	108.4	101.4	48.8	97.9	45.3	34.2	102.6

Shear stress data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Tau Vc	1.8	1.8	-1.8	-1.8	0.0	0.0	0.0	0.0
Tau VL	0.0	0.0	0.0	0.0	-1.8	-1.8	1.8	1.8
Tau MT	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Tau	7.8	7.8	4.1	4.1	4.1	4.1	7.8	7.8

Stress intensity data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm1	53.0	53.0	64.7	64.7	65.4	65.4	53.0	53.0
Sm2	16.8	16.8	27.6	27.6	24.1	24.1	19.4	19.4
Sm3	36.2	36.2	37.0	37.0	41.3	41.3	33.5	33.5
S1	140.4	189.0	193.5	160.9	221.7	134.4	104.5	224.6
S2	22.2	107.7	101.2	48.6	97.7	45.1	33.3	102.1
S3	118.2	81.3	92.2	112.3	124.0	89.3	71.2	122.5

Stress summary data

Pressure stress Sp	MPa	172.4
Allowable	MPa	354.0
Shear stress	MPa	7.8
Allowable	MPa	70.8
Membrane stress Sm	MPa	65.4
Allowable	MPa	177.0
Memb + bending stress Sb	MPa	224.6
Allowable	MPa	354.0
Maximum ratio	percent	63.5

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Circ stress (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8
Sm Mc	0.0	0.0	0.0	0.0	1.6	1.6	-1.6	-1.6
Sm ML	-6.5	-6.5	6.5	6.5	0.0	0.0	0.0	0.0
S pr	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6
Smy	24.3	24.3	37.3	37.3	32.4	32.4	29.2	29.2
Sy	24.3	24.3	37.3	37.3	32.4	32.4	29.2	29.2

Long stress (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8
Sb P	-11.3	11.3	-11.3	11.3	-11.3	11.3	-11.3	11.3
Sm Mc	0.0	0.0	0.0	0.0	31.0	31.0	-31.0	-31.0
Sb Mc	0.0	0.0	0.0	0.0	91.8	-91.8	-91.8	91.8
Sm ML	-31.0	-31.0	31.0	31.0	0.0	0.0	0.0	0.0
Sb ML	-60.2	60.2	60.2	-60.2	0.0	0.0	0.0	0.0
S pr	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3
Smx	-21.5	-21.5	40.5	40.5	40.5	40.5	-21.5	-21.5
Sx	-93.0	50.0	89.4	-8.4	121.0	-40.0	-124.6	81.6

Shear stress (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Tau Vc	3.2	3.2	-3.2	-3.2	0.0	0.0	0.0	0.0
Tau VL	0.0	0.0	0.0	0.0	-3.2	-3.2	3.2	3.2
Tau MT	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3
Tau	13.4	13.4	7.1	7.1	7.1	7.1	13.4	13.4

Stress intensity (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm1	27.9	27.9	46.1	46.1	44.6	44.6	32.5	32.5
Sm2	-25.1	-25.1	31.6	31.6	28.3	28.3	-24.8	-24.8
Sm3	53.1	53.1	14.5	14.5	16.3	16.3	57.3	57.3
S1	25.8	55.7	90.4	38.3	121.6	33.1	30.3	84.8
S2	-94.5	18.5	36.3	-9.5	31.8	-40.7	-125.8	25.9
S3	120.3	37.2	54.0	47.8	89.8	73.8	156.1	58.9

Stress summary (nozzle) data

Pressure stress Sp	MPa	32.6
Allowable	MPa	118.0
Shear stress	MPa	13.4
Allowable	MPa	82.6
Membrane stress Sm	MPa	57.3
Allowable	MPa	118.0
Memb + bending stress Sb	MPa	156.1
Allowable	MPa	177.0
Maximum ratio	percent	88.2

Vessco Engineering Ltd

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Title : N1 radial load -ve

Pad data

```

=====
Thickness T           mm           8.099
Radius Rm            mm           80.101
Factor gamma         -             9.890
Radius ro            mm           60.000
Factor beta         -             0.655
  
```

Radial load data

```

=====
                                     Long axis   Tran axis
Ny.Rm/P (Fig 4C/3C)         -           1.266     0.789
My/P (Fig 2C-1/1C)         -           0.022     0.039
Nx.Rm/P (Fig 3C/4C)         -           0.789     1.266
Mx/P (Fig 1C-1/2C)         -           0.040     0.023
  
```

Moment data

```

=====
                                     Mc           ML
Ny.Rm^2.beta/M (Fig 3A/3B)   -           0.460     0.992
My.Rm.beta/M (Fig 1A/1B-1)   -           0.074     0.017
Nx.Rm^2.beta/M (Fig 4A/4B)   -           1.067     0.469
Mx.Rm.beta/M (Fig 2A/2B-1)   -           0.037     0.032
  
```

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Circ stress (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	-4.8	-4.8	-4.8	-4.8	-3.0	-3.0	-3.0	-3.0
Sb P	-4.9	4.9	-4.9	4.9	-8.7	8.7	-8.7	8.7
Sm Mc	0.0	0.0	0.0	0.0	6.5	6.5	-6.5	-6.5
Sb Mc	0.0	0.0	0.0	0.0	62.2	-62.2	-62.2	62.2
Sm ML	-14.0	-14.0	14.0	14.0	0.0	0.0	0.0	0.0
Sb ML	-14.4	14.4	14.4	-14.4	0.0	0.0	0.0	0.0
S pr	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2
Smy	80.4	80.4	108.4	108.4	102.7	102.7	89.7	89.7
Sy	61.1	99.7	117.9	98.9	156.1	49.3	18.8	160.6

Long stress (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	-3.0	-3.0	-3.0	-3.0	-4.8	-4.8	-4.8	-4.8
Sb P	-8.9	8.9	-8.9	8.9	-5.1	5.1	-5.1	5.1
Sm Mc	0.0	0.0	0.0	0.0	15.0	15.0	-15.0	-15.0
Sb Mc	0.0	0.0	0.0	0.0	31.1	-31.1	-31.1	31.1
Sm ML	-6.6	-6.6	6.6	6.6	0.0	0.0	0.0	0.0
Sb ML	-26.9	26.9	26.9	-26.9	0.0	0.0	0.0	0.0
S pr	44.6	44.6	44.6	44.6	44.6	44.6	44.6	44.6
Smx	35.0	35.0	48.2	48.2	54.9	54.9	24.8	24.8
Sx	-0.7	70.8	66.2	30.3	80.8	28.9	-11.4	61.0

Shear stress (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Tau Vc	1.6	1.6	-1.6	-1.6	0.0	0.0	0.0	0.0
Tau VL	0.0	0.0	0.0	0.0	-1.6	-1.6	1.6	1.6
Tau MT	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Tau	4.2	4.2	1.0	1.0	1.0	1.0	4.2	4.2

Stress intensity (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm1	80.8	80.8	108.4	108.4	102.7	102.7	90.0	90.0
Sm2	34.7	34.7	48.2	48.2	54.9	54.9	24.5	24.5
Sm3	46.2	46.2	60.2	60.2	47.9	47.9	65.5	65.5
S1	61.4	100.3	117.9	98.9	156.2	49.3	19.4	160.8
S2	-1.0	70.2	66.2	30.2	80.8	28.9	-12.0	60.8
S3	62.4	30.1	51.7	68.7	75.4	20.4	31.4	99.9

Vessco Engineering Ltd

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Title : N1 radial load -ve

Stress summary (pad edge) data

=====

Pressure stress Sp	MPa	99.2
Allowable	MPa	118.0
Shear stress	MPa	4.2
Allowable	MPa	70.8
Membrane stress Sm	MPa	108.4
Allowable	MPa	177.0
Memb + bending stress Sb	MPa	160.8
Allowable	MPa	354.0
Maximum ratio	percent	84.1

Material data

=====

Shell

Material spec	-	SA333-6:K03006
Allowable stress: DT	MPa	118.0
Elastic mod: DT	MPa	198373.3
Data:ASME II Part D Table 1A p14/22(M)		
Data:ASME II Part D Table TM-1 CS C <= 0.3%(M)		

Nozzle

Material spec	-	SA333-6:K03006
Allowable stress: DT	MPa	118.0
Data:ASME II Part D Table 1A p14/22(M)		

Pad

Material spec	-	SA516-70:K02700
Allowable stress: DT	MPa	138.0
Data:ASME II Part D Table 1A p22/6(M)		

Warnings data

=====

- Beta out of range
- d/t out of range
- Deflection out of range
- Ratio d/T
- Ratio D/T
- Ratio d/t
- WRC 107 graphs
- WRC 297 graphs

Advisory messages have been reviewed, stresses are considered to be acceptable

Vessco Engineering Ltd

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Title : N2 radial load +ve

Design data

=====

Pressure input	-	Design pressure
Design pressure	MPa	9.930
Design temp	deg.C	93.000
Corrosion: int	mm	1.500
Corrosion: ext	mm	0.000

Shell data

=====

Material spec	-	SA333-6:K03006
Allow pressure factor	-	3.000
Allow shear factor	-	0.600
Allow membrane factor	-	1.500
Allow memb+bend factor	-	3.000
Outside diameter	mm	168.300
New thickness	mm	10.970
Thinning	percent	12.500
End location 1	mm	0.000
End location 2	mm	1491.000

Load data

=====

Attachment	-	Nozzle
Loads at shell surface	-	Yes
Constant load	-	Yes
Pressure load	-	No
Load X (long shear)	N	2460.000
Load Y (circ shear)	N	2460.000
Load Z (radial)	N	2460.000
Moment X (circ)	N.mm	480000.000
Moment Y (long)	N.mm	480000.000
Moment Z (torsion)	N.mm	480000.000

Nozzle data

=====

Opening ident	-	N2
Opening location	mm	1226.000
Type	-	Nozzle + single pad
Nozzle configuration	-	Radial
Nominal bore	-	2"
Schedule	-	XXS
Thinning	percent	12.500
Nozzle material spec	-	SA333-6:K03006
Allow shear factor	-	0.700
Allow membrane factor	-	1.000
Allow memb+bend factor	-	1.500
Calc nozzle SCF	-	Yes

Pad data

=====

Opening ident	-	N2
Pad material spec	-	SA516-70:K02700
Pad OD	mm	120.000
Pad thk	mm	6.000

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Output data

=====

Abridged output	-	No
Radius R	mm	76.051
Thickness T	mm	14.099
Diameter D	mm	166.201
Nozzle OD	mm	60.325
Nozzle thk	mm	11.074
Nozzle strength ratio	percent	54.967
Diameter d	mm	60.325
Thickness t	mm	8.190
Cross section area A	mm ²	1341.429
Section modulus Z	mm ³	15482.999
Ratio d/t	-	7.366
Ratio T/t	-	1.721
Ratio d/T	-	4.279
Ratio D/T	-	11.788
Ratio d/D	-	0.363
Factor lambda	-	1.246
Gross SCF	-	2.896

Length data

=====

Shell length	mm	1491.000
Distance to end 1	mm	1226.000
Distance to end 2	mm	265.000
Equiv length L	mm	987.890
Clearance to shell end	mm	234.838
Length 2.sqr(D.T)	mm	96.814

Deflection data

=====

Elastic mod E	MPa	198373.333
Ratio L/Rm	-	10.881
Factor beta	-	0.655
w.E.Rm/P	-	277.201
ROT.Rm ³ .beta ² .E/Mc	-	98.041
ROT.Rm ³ .beta ² .E/ML	-	37.223
Deflection Dz	mm	0.053
Rotation Rx	degrees	0.071
Rotation Ry	degrees	0.023

Load data

=====

		Z axis	X axis	Y axis
Load / Moment	N.mm	2460	480000	480000
Torsion / Shear	N.mm	480000	2460	2460

Factor data

=====

		P	Mc	ML
Stress resultant nr	-	0.120	0.175	0.119
Stress resultant mr	-	0.111	0.216	0.144
Stress resultant nt	-	0.148	0.040	0.162
Stress resultant mt	-	0.053	0.126	0.084

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Circumferential stress data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	1.8	1.8	1.8	1.8	1.5	1.5	1.5	1.5
Sb P	4.0	-4.0	4.0	-4.0	8.3	-8.3	8.3	-8.3
Sm Mc	0.0	0.0	0.0	0.0	7.0	7.0	-7.0	-7.0
Sb Mc	0.0	0.0	0.0	0.0	52.0	-52.0	-52.0	52.0
Sm ML	-6.5	-6.5	6.5	6.5	0.0	0.0	0.0	0.0
Sb ML	-20.2	20.2	20.2	-20.2	0.0	0.0	0.0	0.0
S pr	172.4	172.4	172.4	172.4	172.4	172.4	172.4	172.4
Smy	167.7	167.7	180.7	180.7	180.9	180.9	166.9	166.9
Sy	151.5	184.0	204.9	156.5	241.1	120.6	123.2	210.6

Longitudinal stress data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	1.5	1.5	1.5	1.5	1.8	1.8	1.8	1.8
Sb P	8.3	-8.3	8.3	-8.3	4.0	-4.0	4.0	-4.0
Sm Mc	0.0	0.0	0.0	0.0	1.6	1.6	-1.6	-1.6
Sb Mc	0.0	0.0	0.0	0.0	30.3	-30.3	-30.3	30.3
Sm ML	-4.8	-4.8	4.8	4.8	0.0	0.0	0.0	0.0
Sb ML	-34.6	34.6	34.6	-34.6	0.0	0.0	0.0	0.0
S pr	71.8	71.8	71.8	71.8	71.8	71.8	71.8	71.8
Smx	68.5	68.5	78.1	78.1	75.2	75.2	72.0	72.0
Sx	42.2	94.9	120.9	35.2	109.4	41.0	45.7	98.4

Shear stress data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Tau Vc	1.8	1.8	-1.8	-1.8	0.0	0.0	0.0	0.0
Tau VL	0.0	0.0	0.0	0.0	-1.8	-1.8	1.8	1.8
Tau MT	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Tau	7.8	7.8	4.1	4.1	4.1	4.1	7.8	7.8

Stress intensity data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm1	56.6	56.6	68.3	68.3	68.4	68.4	56.0	56.0
Sm2	19.8	19.8	30.6	30.6	27.8	27.8	23.1	23.1
Sm3	36.8	36.8	37.7	37.7	40.6	40.6	32.9	32.9
S1	152.0	184.6	205.1	156.7	241.2	120.8	123.9	211.1
S2	41.7	94.2	120.7	35.0	109.3	40.8	45.0	97.8
S3	110.4	90.5	84.3	121.6	131.9	80.0	79.0	113.3

Stress summary data

Pressure stress Sp	MPa	172.4
Allowable	MPa	354.0
Shear stress	MPa	7.8
Allowable	MPa	70.8
Membrane stress Sm	MPa	68.4
Allowable	MPa	177.0
Memb + bending stress Sb	MPa	241.2
Allowable	MPa	354.0
Maximum ratio	percent	68.1

Vessco Engineering Ltd

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Circ stress (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Sm Mc	0.0	0.0	0.0	0.0	1.6	1.6	-1.6	-1.6
Sm ML	-6.5	-6.5	6.5	6.5	0.0	0.0	0.0	0.0
S pr	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6
Smy	27.9	27.9	40.9	40.9	36.0	36.0	32.8	32.8
Sy	27.9	27.9	40.9	40.9	36.0	36.0	32.8	32.8

Long stress (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Sb P	11.3	-11.3	11.3	-11.3	11.3	-11.3	11.3	-11.3
Sm Mc	0.0	0.0	0.0	0.0	31.0	31.0	-31.0	-31.0
Sb Mc	0.0	0.0	0.0	0.0	91.8	-91.8	-91.8	91.8
Sm ML	-31.0	-31.0	31.0	31.0	0.0	0.0	0.0	0.0
Sb ML	-60.2	60.2	60.2	-60.2	0.0	0.0	0.0	0.0
S pr	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3
Smx	-17.8	-17.8	44.2	44.2	44.2	44.2	-17.8	-17.8
Sx	-66.8	31.1	115.7	-27.3	147.3	-58.9	-98.4	62.7

Shear stress (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Tau Vc	3.2	3.2	-3.2	-3.2	0.0	0.0	0.0	0.0
Tau VL	0.0	0.0	0.0	0.0	-3.2	-3.2	3.2	3.2
Tau MT	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3
Tau	13.4	13.4	7.1	7.1	7.1	7.1	13.4	13.4

Stress intensity (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm1	31.6	31.6	49.8	49.8	48.3	48.3	36.2	36.2
Sm2	-21.5	-21.5	35.3	35.3	31.9	31.9	-21.2	-21.2
Sm3	53.1	53.1	14.5	14.5	16.3	16.3	57.3	57.3
S1	29.8	43.0	116.3	41.6	147.7	36.5	34.2	67.8
S2	-68.6	16.0	40.3	-28.0	35.6	-59.4	-99.7	27.7
S3	98.4	27.0	76.1	69.7	112.1	96.0	133.9	40.1

Stress summary (nozzle) data

Pressure stress Sp	MPa	32.6
Allowable	MPa	118.0
Shear stress	MPa	13.4
Allowable	MPa	82.6
Membrane stress Sm	MPa	57.3
Allowable	MPa	118.0
Memb + bending stress Sb	MPa	147.7
Allowable	MPa	177.0
Maximum ratio	percent	83.5

Vessco Engineering Ltd

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```

Title : N2 radial load +ve

Pad data

=====

Thickness T	mm	8.099
Radius Rm	mm	80.101
Factor gamma	-	9.890
Radius ro	mm	60.000
Factor beta	-	0.655

Radial load data

=====

		Long axis	Tran axis
Ny.Rm/P (Fig 4C/3C)	-	1.266	0.789
My/P (Fig 2C-1/1C)	-	0.022	0.039
Nx.Rm/P (Fig 3C/4C)	-	0.789	1.266
Mx/P (Fig 1C-1/2C)	-	0.040	0.023

Moment data

=====

		Mc	ML
Ny.Rm^2.beta/M (Fig 3A/3B)	-	0.460	0.992
My.Rm.beta/M (Fig 1A/1B-1)	-	0.074	0.017
Nx.Rm^2.beta/M (Fig 4A/4B)	-	1.067	0.469
Mx.Rm.beta/M (Fig 2A/2B-1)	-	0.037	0.032

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Circ stress (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	4.8	4.8	4.8	4.8	3.0	3.0	3.0	3.0
Sb P	4.9	-4.9	4.9	-4.9	8.7	-8.7	8.7	-8.7
Sm Mc	0.0	0.0	0.0	0.0	6.5	6.5	-6.5	-6.5
Sb Mc	0.0	0.0	0.0	0.0	62.2	-62.2	-62.2	62.2
Sm ML	-14.0	-14.0	14.0	14.0	0.0	0.0	0.0	0.0
Sb ML	-14.4	14.4	14.4	-14.4	0.0	0.0	0.0	0.0
S pr	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2
Smy	90.0	90.0	118.0	118.0	108.7	108.7	95.7	95.7
Sy	80.5	99.5	137.3	98.7	179.6	37.8	42.3	149.1

Long stress (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	3.0	3.0	3.0	3.0	4.8	4.8	4.8	4.8
Sb P	8.9	-8.9	8.9	-8.9	5.1	-5.1	5.1	-5.1
Sm Mc	0.0	0.0	0.0	0.0	15.0	15.0	-15.0	-15.0
Sb Mc	0.0	0.0	0.0	0.0	31.1	-31.1	-31.1	31.1
Sm ML	-6.6	-6.6	6.6	6.6	0.0	0.0	0.0	0.0
Sb ML	-26.9	26.9	26.9	-26.9	0.0	0.0	0.0	0.0
S pr	44.6	44.6	44.6	44.6	44.6	44.6	44.6	44.6
Smx	41.0	41.0	54.2	54.2	64.5	64.5	34.4	34.4
Sx	23.0	59.0	90.0	18.4	100.7	28.2	8.5	60.3

Shear stress (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Tau Vc	1.6	1.6	-1.6	-1.6	0.0	0.0	0.0	0.0
Tau VL	0.0	0.0	0.0	0.0	-1.6	-1.6	1.6	1.6
Tau MT	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Tau	4.2	4.2	1.0	1.0	1.0	1.0	4.2	4.2

Stress intensity (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm1	90.4	90.4	118.0	118.0	108.7	108.7	96.0	96.0
Sm2	40.7	40.7	54.2	54.2	64.5	64.5	34.1	34.1
Sm3	49.7	49.7	63.8	63.8	44.3	44.3	61.9	61.9
S1	80.9	99.9	137.3	98.7	179.6	37.9	42.8	149.3
S2	22.7	58.6	90.0	18.4	100.7	28.1	7.9	60.1
S3	58.1	41.4	47.3	80.3	78.9	9.8	34.8	89.2

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Stress summary (pad edge) data

=====

Pressure stress Sp	MPa	99.2
Allowable	MPa	118.0
Shear stress	MPa	4.2
Allowable	MPa	70.8
Membrane stress Sm	MPa	118.0
Allowable	MPa	177.0
Memb + bending stress Sb	MPa	179.6
Allowable	MPa	354.0
Maximum ratio	percent	84.1

Material data

=====

Shell

Material spec	-	SA333-6:K03006
Allowable stress: DT	MPa	118.0
Elastic mod: DT	MPa	198373.3
Data:ASME II Part D Table 1A p14/22(M)		
Data:ASME II Part D Table TM-1 CS C <= 0.3%(M)		

Nozzle

Material spec	-	SA333-6:K03006
Allowable stress: DT	MPa	118.0
Data:ASME II Part D Table 1A p14/22(M)		

Pad

Material spec	-	SA516-70:K02700
Allowable stress: DT	MPa	138.0
Data:ASME II Part D Table 1A p22/6(M)		

Warnings data

=====

- Beta out of range
- d/t out of range
- Deflection out of range
- Ratio d/T
- Ratio D/T
- Ratio d/t
- WRC 107 graphs
- WRC 297 graphs

Advisory messages have been reviewed, stresses are considered to be acceptable

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Design data

=====

Pressure input	-	Design pressure
Design pressure	MPa	9.930
Design temp	deg.C	93.000
Corrosion: int	mm	1.500
Corrosion: ext	mm	0.000

Shell data

=====

Material spec	-	SA333-6:K03006
Allow pressure factor	-	3.000
Allow shear factor	-	0.600
Allow membrane factor	-	1.500
Allow memb+bend factor	-	3.000
Outside diameter	mm	168.300
New thickness	mm	10.970
Thinning	percent	12.500
End location 1	mm	0.000
End location 2	mm	1491.000

Load data

=====

Attachment	-	Nozzle
Loads at shell surface	-	Yes
Constant load	-	Yes
Pressure load	-	No
Load X (long shear)	N	2460.000
Load Y (circ shear)	N	2460.000
Load Z (radial)	N	-2460.000
Moment X (circ)	N.mm	480000.000
Moment Y (long)	N.mm	480000.000
Moment Z (torsion)	N.mm	480000.000

Nozzle data

=====

Opening ident	-	N2
Opening location	mm	1226.000
Type	-	Nozzle + single pad
Nozzle configuration	-	Radial
Nominal bore	-	2"
Schedule	-	XXS
Thinning	percent	12.500
Nozzle material spec	-	SA333-6:K03006
Allow shear factor	-	0.700
Allow membrane factor	-	1.000
Allow memb+bend factor	-	1.500
Calc nozzle SCF	-	Yes

Pad data

=====

Opening ident	-	N2
Pad material spec	-	SA516-70:K02700
Pad OD	mm	120.000
Pad thk	mm	6.000

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Output data

=====

Abridged output	-	No
Radius R	mm	76.051
Thickness T	mm	14.099
Diameter D	mm	166.201
Nozzle OD	mm	60.325
Nozzle thk	mm	11.074
Nozzle strength ratio	percent	53.726
Diameter d	mm	60.325
Thickness t	mm	8.190
Cross section area A	mm ²	1341.429
Section modulus Z	mm ³	15482.999
Ratio d/t	-	7.366
Ratio T/t	-	1.721
Ratio d/T	-	4.279
Ratio D/T	-	11.788
Ratio d/D	-	0.363
Factor lambda	-	1.246
Gross SCF	-	2.896

Length data

=====

Shell length	mm	1491.000
Distance to end 1	mm	1226.000
Distance to end 2	mm	265.000
Equiv length L	mm	987.890
Clearance to shell end	mm	234.838
Length 2.sqr(D.T)	mm	96.814

Deflection data

=====

Elastic mod E	MPa	198373.333
Ratio L/Rm	-	10.881
Factor beta	-	0.655
w.E.Rm/P	-	277.201
ROT.Rm ³ .beta ² .E/Mc	-	98.041
ROT.Rm ³ .beta ² .E/ML	-	37.223
Deflection Dz	mm	-0.053
Rotation Rx	degrees	0.071
Rotation Ry	degrees	0.023

Load data

=====

		Z axis	X axis	Y axis
Load / Moment	N.mm	-2460	480000	480000
Torsion / Shear	N.mm	480000	2460	2460

Factor data

=====

		P	Mc	ML
Stress resultant nr	-	0.120	0.175	0.119
Stress resultant mr	-	0.111	0.216	0.144
Stress resultant nt	-	0.148	0.040	0.162
Stress resultant mt	-	0.053	0.126	0.084

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Circumferential stress data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	-1.8	-1.8	-1.8	-1.8	-1.5	-1.5	-1.5	-1.5
Sb P	-4.0	4.0	-4.0	4.0	-8.3	8.3	-8.3	8.3
Sm Mc	0.0	0.0	0.0	0.0	7.0	7.0	-7.0	-7.0
Sb Mc	0.0	0.0	0.0	0.0	52.0	-52.0	-52.0	52.0
Sm ML	-6.5	-6.5	6.5	6.5	0.0	0.0	0.0	0.0
Sb ML	-20.2	20.2	20.2	-20.2	0.0	0.0	0.0	0.0
S pr	172.4	172.4	172.4	172.4	172.4	172.4	172.4	172.4
Smy	164.1	164.1	177.0	177.0	177.9	177.9	163.9	163.9
Sy	139.9	188.2	193.3	160.8	221.6	134.2	103.6	224.1

Longitudinal stress data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	-1.5	-1.5	-1.5	-1.5	-1.8	-1.8	-1.8	-1.8
Sb P	-8.3	8.3	-8.3	8.3	-4.0	4.0	-4.0	4.0
Sm Mc	0.0	0.0	0.0	0.0	1.6	1.6	-1.6	-1.6
Sb Mc	0.0	0.0	0.0	0.0	30.3	-30.3	-30.3	30.3
Sm ML	-4.8	-4.8	4.8	4.8	0.0	0.0	0.0	0.0
Sb ML	-34.6	34.6	34.6	-34.6	0.0	0.0	0.0	0.0
S pr	71.8	71.8	71.8	71.8	71.8	71.8	71.8	71.8
Smx	65.6	65.6	75.1	75.1	71.6	71.6	68.4	68.4
Sx	22.7	108.4	101.4	48.8	97.9	45.3	34.2	102.6

Shear stress data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Tau Vc	1.8	1.8	-1.8	-1.8	0.0	0.0	0.0	0.0
Tau VL	0.0	0.0	0.0	0.0	-1.8	-1.8	1.8	1.8
Tau MT	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Tau	7.8	7.8	4.1	4.1	4.1	4.1	7.8	7.8

Stress intensity data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm1	53.0	53.0	64.7	64.7	65.4	65.4	53.0	53.0
Sm2	16.8	16.8	27.6	27.6	24.1	24.1	19.4	19.4
Sm3	36.2	36.2	37.0	37.0	41.3	41.3	33.5	33.5
S1	140.4	189.0	193.5	160.9	221.7	134.4	104.5	224.6
S2	22.2	107.7	101.2	48.6	97.7	45.1	33.3	102.1
S3	118.2	81.3	92.2	112.3	124.0	89.3	71.2	122.5

Stress summary data

Pressure stress Sp	MPa	172.4
Allowable	MPa	354.0
Shear stress	MPa	7.8
Allowable	MPa	70.8
Membrane stress Sm	MPa	65.4
Allowable	MPa	177.0
Memb + bending stress Sb	MPa	224.6
Allowable	MPa	354.0
Maximum ratio	percent	63.5

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Circ stress (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8
Sm Mc	0.0	0.0	0.0	0.0	1.6	1.6	-1.6	-1.6
Sm ML	-6.5	-6.5	6.5	6.5	0.0	0.0	0.0	0.0
S pr	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6
Smy	24.3	24.3	37.3	37.3	32.4	32.4	29.2	29.2
Sy	24.3	24.3	37.3	37.3	32.4	32.4	29.2	29.2

Long stress (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8
Sb P	-11.3	11.3	-11.3	11.3	-11.3	11.3	-11.3	11.3
Sm Mc	0.0	0.0	0.0	0.0	31.0	31.0	-31.0	-31.0
Sb Mc	0.0	0.0	0.0	0.0	91.8	-91.8	-91.8	91.8
Sm ML	-31.0	-31.0	31.0	31.0	0.0	0.0	0.0	0.0
Sb ML	-60.2	60.2	60.2	-60.2	0.0	0.0	0.0	0.0
S pr	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3
Smx	-21.5	-21.5	40.5	40.5	40.5	40.5	-21.5	-21.5
Sx	-93.0	50.0	89.4	-8.4	121.0	-40.0	-124.6	81.6

Shear stress (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Tau Vc	3.2	3.2	-3.2	-3.2	0.0	0.0	0.0	0.0
Tau VL	0.0	0.0	0.0	0.0	-3.2	-3.2	3.2	3.2
Tau MT	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3
Tau	13.4	13.4	7.1	7.1	7.1	7.1	13.4	13.4

Stress intensity (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm1	27.9	27.9	46.1	46.1	44.6	44.6	32.5	32.5
Sm2	-25.1	-25.1	31.6	31.6	28.3	28.3	-24.8	-24.8
Sm3	53.1	53.1	14.5	14.5	16.3	16.3	57.3	57.3
S1	25.8	55.7	90.4	38.3	121.6	33.1	30.3	84.8
S2	-94.5	18.5	36.3	-9.5	31.8	-40.7	-125.8	25.9
S3	120.3	37.2	54.0	47.8	89.8	73.8	156.1	58.9

Stress summary (nozzle) data

Pressure stress Sp	MPa	32.6
Allowable	MPa	118.0
Shear stress	MPa	13.4
Allowable	MPa	82.6
Membrane stress Sm	MPa	57.3
Allowable	MPa	118.0
Memb + bending stress Sb	MPa	156.1
Allowable	MPa	177.0
Maximum ratio	percent	88.2

Vessco Engineering Ltd

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Title : N2 radial load -ve

Pad data

=====

Thickness T	mm	8.099
Radius Rm	mm	80.101
Factor gamma	-	9.890
Radius ro	mm	60.000
Factor beta	-	0.655

Radial load data

=====

		Long axis	Tran axis
Ny.Rm/P (Fig 4C/3C)	-	1.266	0.789
My/P (Fig 2C-1/1C)	-	0.022	0.039
Nx.Rm/P (Fig 3C/4C)	-	0.789	1.266
Mx/P (Fig 1C-1/2C)	-	0.040	0.023

Moment data

=====

		Mc	ML
Ny.Rm^2.beta/M (Fig 3A/3B)	-	0.460	0.992
My.Rm.beta/M (Fig 1A/1B-1)	-	0.074	0.017
Nx.Rm^2.beta/M (Fig 4A/4B)	-	1.067	0.469
Mx.Rm.beta/M (Fig 2A/2B-1)	-	0.037	0.032

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Circ stress (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	-4.8	-4.8	-4.8	-4.8	-3.0	-3.0	-3.0	-3.0
Sb P	-4.9	4.9	-4.9	4.9	-8.7	8.7	-8.7	8.7
Sm Mc	0.0	0.0	0.0	0.0	6.5	6.5	-6.5	-6.5
Sb Mc	0.0	0.0	0.0	0.0	62.2	-62.2	-62.2	62.2
Sm ML	-14.0	-14.0	14.0	14.0	0.0	0.0	0.0	0.0
Sb ML	-14.4	14.4	14.4	-14.4	0.0	0.0	0.0	0.0
S pr	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2
Smy	80.4	80.4	108.4	108.4	102.7	102.7	89.7	89.7
Sy	61.1	99.7	117.9	98.9	156.1	49.3	18.8	160.6

Long stress (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	-3.0	-3.0	-3.0	-3.0	-4.8	-4.8	-4.8	-4.8
Sb P	-8.9	8.9	-8.9	8.9	-5.1	5.1	-5.1	5.1
Sm Mc	0.0	0.0	0.0	0.0	15.0	15.0	-15.0	-15.0
Sb Mc	0.0	0.0	0.0	0.0	31.1	-31.1	-31.1	31.1
Sm ML	-6.6	-6.6	6.6	6.6	0.0	0.0	0.0	0.0
Sb ML	-26.9	26.9	26.9	-26.9	0.0	0.0	0.0	0.0
S pr	44.6	44.6	44.6	44.6	44.6	44.6	44.6	44.6
Smx	35.0	35.0	48.2	48.2	54.9	54.9	24.8	24.8
Sx	-0.7	70.8	66.2	30.3	80.8	28.9	-11.4	61.0

Shear stress (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Tau Vc	1.6	1.6	-1.6	-1.6	0.0	0.0	0.0	0.0
Tau VL	0.0	0.0	0.0	0.0	-1.6	-1.6	1.6	1.6
Tau MT	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Tau	4.2	4.2	1.0	1.0	1.0	1.0	4.2	4.2

Stress intensity (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm1	80.8	80.8	108.4	108.4	102.7	102.7	90.0	90.0
Sm2	34.7	34.7	48.2	48.2	54.9	54.9	24.5	24.5
Sm3	46.2	46.2	60.2	60.2	47.9	47.9	65.5	65.5
S1	61.4	100.3	117.9	98.9	156.2	49.3	19.4	160.8
S2	-1.0	70.2	66.2	30.2	80.8	28.9	-12.0	60.8
S3	62.4	30.1	51.7	68.7	75.4	20.4	31.4	99.9

Vessco Engineering Ltd

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-----
  
```

Title : N2 radial load -ve

Stress summary (pad edge) data

=====

Pressure stress Sp	MPa	99.2
Allowable	MPa	118.0
Shear stress	MPa	4.2
Allowable	MPa	70.8
Membrane stress Sm	MPa	108.4
Allowable	MPa	177.0
Memb + bending stress Sb	MPa	160.8
Allowable	MPa	354.0
Maximum ratio	percent	84.1

Material data

=====

Shell

Material spec	-	SA333-6:K03006
Allowable stress: DT	MPa	118.0
Elastic mod: DT	MPa	198373.3
Data:ASME II Part D Table 1A p14/22(M)		
Data:ASME II Part D Table TM-1 CS C <= 0.3%(M)		

Nozzle

Material spec	-	SA333-6:K03006
Allowable stress: DT	MPa	118.0
Data:ASME II Part D Table 1A p14/22(M)		

Pad

Material spec	-	SA516-70:K02700
Allowable stress: DT	MPa	138.0
Data:ASME II Part D Table 1A p22/6(M)		

Warnings data

=====

- Beta out of range
- d/t out of range
- Deflection out of range
- Ratio d/T
- Ratio D/T
- Ratio d/t
- WRC 107 graphs
- WRC 297 graphs

Advisory messages have been reviewed, stresses are considered to be acceptable

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater	Doc No. : VQ0511	
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Title : N3 radial load +ve

Design data

=====

Pressure input	-	Design pressure
Design pressure	MPa	9.930
Design temp	deg.C	93.000
Corrosion: int	mm	1.500
Corrosion: ext	mm	0.000

Shell data

=====

Material spec	-	SA333-6:K03006
Allow pressure factor	-	3.000
Allow shear factor	-	0.600
Allow membrane factor	-	1.500
Allow memb+bend factor	-	3.000
Outside diameter	mm	168.300
New thickness	mm	10.970
Thinning	percent	12.500
End location 1	mm	0.000
End location 2	mm	1491.000

Load data

=====

Attachment	-	Nozzle
Loads at shell surface	-	Yes
Constant load	-	Yes
Pressure load	-	No
Load X (long shear)	N	2460.000
Load Y (circ shear)	N	2460.000
Load Z (radial)	N	2460.000
Moment X (circ)	N.mm	480000.000
Moment Y (long)	N.mm	480000.000
Moment Z (torsion)	N.mm	480000.000

Nozzle data

=====

Opening ident	-	N3
Opening location	mm	604.000
Type	-	Nozzle + single pad
Nozzle configuration	-	Radial
Nominal bore	-	2"
Schedule	-	XXS
Thinning	percent	12.500
Nozzle material spec	-	SA333-6:K03006
Allow shear factor	-	0.700
Allow membrane factor	-	1.000
Allow memb+bend factor	-	1.500
Calc nozzle SCF	-	Yes

Pad data

=====

Opening ident	-	N3
Pad material spec	-	SA516-70:K02700
Pad OD	mm	120.000
Pad thk	mm	6.000

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
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Title : N3 radial load +ve

Output data

=====

Abridged output	-	No
Radius R	mm	76.051
Thickness T	mm	14.099
Diameter D	mm	166.201
Nozzle OD	mm	60.325
Nozzle thk	mm	11.074
Nozzle strength ratio	percent	54.967
Diameter d	mm	60.325
Thickness t	mm	8.190
Cross section area A	mm ²	1341.429
Section modulus Z	mm ³	15482.999
Ratio d/t	-	7.366
Ratio T/t	-	1.721
Ratio d/T	-	4.279
Ratio D/T	-	11.788
Ratio d/D	-	0.363
Factor lambda	-	1.246
Gross SCF	-	2.896

Length data

=====

Shell length	mm	1491.000
Distance to end 1	mm	604.000
Distance to end 2	mm	887.000
Equiv length L	mm	1450.469
Clearance to shell end	mm	573.837
Length 2.sqr(D.T)	mm	96.814

Deflection data

=====

Elastic mod E	MPa	198373.333
Ratio L/Rm	-	17.943
Factor beta	-	0.655
w.E.Rm/P	-	277.201
ROT.Rm ³ .beta ² .E/Mc	-	98.041
ROT.Rm ³ .beta ² .E/ML	-	37.223
Deflection Dz	mm	0.074
Rotation Rx	degrees	0.077
Rotation Ry	degrees	0.023

Load data

=====

		Z axis	X axis	Y axis
Load / Moment	N.mm	2460	480000	480000
Torsion / Shear	N.mm	480000	2460	2460

Factor data

=====

		P	Mc	ML
Stress resultant nr	-	0.120	0.175	0.119
Stress resultant mr	-	0.111	0.216	0.144
Stress resultant nt	-	0.148	0.040	0.162
Stress resultant mt	-	0.053	0.126	0.084

Vessco Engineering Ltd

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Circumferential stress data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	1.8	1.8	1.8	1.8	1.5	1.5	1.5	1.5
Sb P	4.0	-4.0	4.0	-4.0	8.3	-8.3	8.3	-8.3
Sm Mc	0.0	0.0	0.0	0.0	7.0	7.0	-7.0	-7.0
Sb Mc	0.0	0.0	0.0	0.0	52.0	-52.0	-52.0	52.0
Sm ML	-6.5	-6.5	6.5	6.5	0.0	0.0	0.0	0.0
Sb ML	-20.2	20.2	20.2	-20.2	0.0	0.0	0.0	0.0
S pr	172.4	172.4	172.4	172.4	172.4	172.4	172.4	172.4
Smy	167.7	167.7	180.7	180.7	180.9	180.9	166.9	166.9
Sy	151.5	184.0	204.9	156.5	241.1	120.6	123.2	210.6

Longitudinal stress data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	1.5	1.5	1.5	1.5	1.8	1.8	1.8	1.8
Sb P	8.3	-8.3	8.3	-8.3	4.0	-4.0	4.0	-4.0
Sm Mc	0.0	0.0	0.0	0.0	1.6	1.6	-1.6	-1.6
Sb Mc	0.0	0.0	0.0	0.0	30.3	-30.3	-30.3	30.3
Sm ML	-4.8	-4.8	4.8	4.8	0.0	0.0	0.0	0.0
Sb ML	-34.6	34.6	34.6	-34.6	0.0	0.0	0.0	0.0
S pr	71.8	71.8	71.8	71.8	71.8	71.8	71.8	71.8
Smx	68.5	68.5	78.1	78.1	75.2	75.2	72.0	72.0
Sx	42.2	94.9	120.9	35.2	109.4	41.0	45.7	98.4

Shear stress data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Tau Vc	1.8	1.8	-1.8	-1.8	0.0	0.0	0.0	0.0
Tau VL	0.0	0.0	0.0	0.0	-1.8	-1.8	1.8	1.8
Tau MT	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Tau	7.8	7.8	4.1	4.1	4.1	4.1	7.8	7.8

Stress intensity data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm1	56.6	56.6	68.3	68.3	68.4	68.4	56.0	56.0
Sm2	19.8	19.8	30.6	30.6	27.8	27.8	23.1	23.1
Sm3	36.8	36.8	37.7	37.7	40.6	40.6	32.9	32.9
S1	152.0	184.6	205.1	156.7	241.2	120.8	123.9	211.1
S2	41.7	94.2	120.7	35.0	109.3	40.8	45.0	97.8
S3	110.4	90.5	84.3	121.6	131.9	80.0	79.0	113.3

Stress summary data

Pressure stress Sp	MPa	172.4
Allowable	MPa	354.0
Shear stress	MPa	7.8
Allowable	MPa	70.8
Membrane stress Sm	MPa	68.4
Allowable	MPa	177.0
Memb + bending stress Sb	MPa	241.2
Allowable	MPa	354.0
Maximum ratio	percent	68.1

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
 Client : Exheat Ltd

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Title : N3 radial load +ve

Circ stress (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Sm Mc	0.0	0.0	0.0	0.0	1.6	1.6	-1.6	-1.6
Sm ML	-6.5	-6.5	6.5	6.5	0.0	0.0	0.0	0.0
S pr	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6
Smy	27.9	27.9	40.9	40.9	36.0	36.0	32.8	32.8
Sy	27.9	27.9	40.9	40.9	36.0	36.0	32.8	32.8

Long stress (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Sb P	11.3	-11.3	11.3	-11.3	11.3	-11.3	11.3	-11.3
Sm Mc	0.0	0.0	0.0	0.0	31.0	31.0	-31.0	-31.0
Sb Mc	0.0	0.0	0.0	0.0	91.8	-91.8	-91.8	91.8
Sm ML	-31.0	-31.0	31.0	31.0	0.0	0.0	0.0	0.0
Sb ML	-60.2	60.2	60.2	-60.2	0.0	0.0	0.0	0.0
S pr	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3
Smx	-17.8	-17.8	44.2	44.2	44.2	44.2	-17.8	-17.8
Sx	-66.8	31.1	115.7	-27.3	147.3	-58.9	-98.4	62.7

Shear stress (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Tau Vc	3.2	3.2	-3.2	-3.2	0.0	0.0	0.0	0.0
Tau VL	0.0	0.0	0.0	0.0	-3.2	-3.2	3.2	3.2
Tau MT	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3
Tau	13.4	13.4	7.1	7.1	7.1	7.1	13.4	13.4

Stress intensity (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm1	31.6	31.6	49.8	49.8	48.3	48.3	36.2	36.2
Sm2	-21.5	-21.5	35.3	35.3	31.9	31.9	-21.2	-21.2
Sm3	53.1	53.1	14.5	14.5	16.3	16.3	57.3	57.3
S1	29.8	43.0	116.3	41.6	147.7	36.5	34.2	67.8
S2	-68.6	16.0	40.3	-28.0	35.6	-59.4	-99.7	27.7
S3	98.4	27.0	76.1	69.7	112.1	96.0	133.9	40.1

Stress summary (nozzle) data

Pressure stress Sp	MPa	32.6
Allowable	MPa	118.0
Shear stress	MPa	13.4
Allowable	MPa	82.6
Membrane stress Sm	MPa	57.3
Allowable	MPa	118.0
Memb + bending stress Sb	MPa	147.7
Allowable	MPa	177.0
Maximum ratio	percent	83.5

Vessco Engineering Ltd

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-----

```

Title : N3 radial load +ve

Pad data

=====

Thickness T	mm	8.099
Radius Rm	mm	80.101
Factor gamma	-	9.890
Radius ro	mm	60.000
Factor beta	-	0.655

Radial load data

=====

		Long axis	Tran axis
Ny.Rm/P (Fig 4C/3C)	-	1.266	0.789
My/P (Fig 2C-1/1C)	-	0.022	0.039
Nx.Rm/P (Fig 3C/4C)	-	0.789	1.266
Mx/P (Fig 1C-1/2C)	-	0.040	0.023

Moment data

=====

		Mc	ML
Ny.Rm ² .beta/M (Fig 3A/3B)	-	0.460	0.992
My.Rm.beta/M (Fig 1A/1B-1)	-	0.074	0.017
Nx.Rm ² .beta/M (Fig 4A/4B)	-	1.067	0.469
Mx.Rm.beta/M (Fig 2A/2B-1)	-	0.037	0.032

Vessco Engineering Ltd

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Title : N3 radial load +ve

Circ stress (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	4.8	4.8	4.8	4.8	3.0	3.0	3.0	3.0
Sb P	4.9	-4.9	4.9	-4.9	8.7	-8.7	8.7	-8.7
Sm Mc	0.0	0.0	0.0	0.0	6.5	6.5	-6.5	-6.5
Sb Mc	0.0	0.0	0.0	0.0	62.2	-62.2	-62.2	62.2
Sm ML	-14.0	-14.0	14.0	14.0	0.0	0.0	0.0	0.0
Sb ML	-14.4	14.4	14.4	-14.4	0.0	0.0	0.0	0.0
S pr	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2
Smy	90.0	90.0	118.0	118.0	108.7	108.7	95.7	95.7
Sy	80.5	99.5	137.3	98.7	179.6	37.8	42.3	149.1

Long stress (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	3.0	3.0	3.0	3.0	4.8	4.8	4.8	4.8
Sb P	8.9	-8.9	8.9	-8.9	5.1	-5.1	5.1	-5.1
Sm Mc	0.0	0.0	0.0	0.0	15.0	15.0	-15.0	-15.0
Sb Mc	0.0	0.0	0.0	0.0	31.1	-31.1	-31.1	31.1
Sm ML	-6.6	-6.6	6.6	6.6	0.0	0.0	0.0	0.0
Sb ML	-26.9	26.9	26.9	-26.9	0.0	0.0	0.0	0.0
S pr	44.6	44.6	44.6	44.6	44.6	44.6	44.6	44.6
Smx	41.0	41.0	54.2	54.2	64.5	64.5	34.4	34.4
Sx	23.0	59.0	90.0	18.4	100.7	28.2	8.5	60.3

Shear stress (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Tau Vc	1.6	1.6	-1.6	-1.6	0.0	0.0	0.0	0.0
Tau VL	0.0	0.0	0.0	0.0	-1.6	-1.6	1.6	1.6
Tau MT	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Tau	4.2	4.2	1.0	1.0	1.0	1.0	4.2	4.2

Stress intensity (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm1	90.4	90.4	118.0	118.0	108.7	108.7	96.0	96.0
Sm2	40.7	40.7	54.2	54.2	64.5	64.5	34.1	34.1
Sm3	49.7	49.7	63.8	63.8	44.3	44.3	61.9	61.9
S1	80.9	99.9	137.3	98.7	179.6	37.9	42.8	149.3
S2	22.7	58.6	90.0	18.4	100.7	28.1	7.9	60.1
S3	58.1	41.4	47.3	80.3	78.9	9.8	34.8	89.2

Vessco Engineering Ltd

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```

Title : N3 radial load +ve

Stress summary (pad edge) data

=====

Pressure stress Sp	MPa	99.2
Allowable	MPa	118.0
Shear stress	MPa	4.2
Allowable	MPa	70.8
Membrane stress Sm	MPa	118.0
Allowable	MPa	177.0
Memb + bending stress Sb	MPa	179.6
Allowable	MPa	354.0
Maximum ratio	percent	84.1

Material data

=====

Shell

Material spec	-	SA333-6:K03006
Allowable stress: DT	MPa	118.0
Elastic mod: DT	MPa	198373.3

Data:ASME II Part D Table 1A p14/22(M)
Data:ASME II Part D Table TM-1 CS C <= 0.3%(M)

Nozzle

Material spec	-	SA333-6:K03006
Allowable stress: DT	MPa	118.0

Data:ASME II Part D Table 1A p14/22(M)

Pad

Material spec	-	SA516-70:K02700
Allowable stress: DT	MPa	138.0

Data:ASME II Part D Table 1A p22/6(M)

Warnings data

=====

- Beta out of range
- d/t out of range
- Deflection out of range
- Ratio d/T
- Ratio D/T
- Ratio d/t
- WRC 107 graphs
- WRC 297 graphs

Advisory messages have been reviewed, stresses are considered to be acceptable

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
 Client : Exheat Ltd

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Title : N3 radial load -ve

Design data

=====

Pressure input	-	Design pressure
Design pressure	MPa	9.930
Design temp	deg.C	93.000
Corrosion: int	mm	1.500
Corrosion: ext	mm	0.000

Shell data

=====

Material spec	-	SA333-6:K03006
Allow pressure factor	-	3.000
Allow shear factor	-	0.600
Allow membrane factor	-	1.500
Allow memb+bend factor	-	3.000
Outside diameter	mm	168.300
New thickness	mm	10.970
Thinning	percent	12.500
End location 1	mm	0.000
End location 2	mm	1491.000

Load data

=====

Attachment	-	Nozzle
Loads at shell surface	-	Yes
Constant load	-	Yes
Pressure load	-	No
Load X (long shear)	N	2460.000
Load Y (circ shear)	N	2460.000
Load Z (radial)	N	-2460.000
Moment X (circ)	N.mm	480000.000
Moment Y (long)	N.mm	480000.000
Moment Z (torsion)	N.mm	480000.000

Nozzle data

=====

Opening ident	-	N3
Opening location	mm	604.000
Type	-	Nozzle + single pad
Nozzle configuration	-	Radial
Nominal bore	-	2"
Schedule	-	XXS
Thinning	percent	12.500
Nozzle material spec	-	SA333-6:K03006
Allow shear factor	-	0.700
Allow membrane factor	-	1.000
Allow memb+bend factor	-	1.500
Calc nozzle SCF	-	Yes

Pad data

=====

Opening ident	-	N3
Pad material spec	-	SA516-70:K02700
Pad OD	mm	120.000
Pad thk	mm	6.000

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
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Output data

=====

Abridged output	-	No
Radius R	mm	76.051
Thickness T	mm	14.099
Diameter D	mm	166.201
Nozzle OD	mm	60.325
Nozzle thk	mm	11.074
Nozzle strength ratio	percent	53.726
Diameter d	mm	60.325
Thickness t	mm	8.190
Cross section area A	mm ²	1341.429
Section modulus Z	mm ³	15482.999
Ratio d/t	-	7.366
Ratio T/t	-	1.721
Ratio d/T	-	4.279
Ratio D/T	-	11.788
Ratio d/D	-	0.363
Factor lambda	-	1.246
Gross SCF	-	2.896

Length data

=====

Shell length	mm	1491.000
Distance to end 1	mm	604.000
Distance to end 2	mm	887.000
Equiv length L	mm	1450.469
Clearance to shell end	mm	573.837
Length 2.sqr(D.T)	mm	96.814

Deflection data

=====

Elastic mod E	MPa	198373.333
Ratio L/Rm	-	17.943
Factor beta	-	0.655
w.E.Rm/P	-	277.201
ROT.Rm ³ .beta ² .E/Mc	-	98.041
ROT.Rm ³ .beta ² .E/ML	-	37.223
Deflection Dz	mm	-0.074
Rotation Rx	degrees	0.077
Rotation Ry	degrees	0.023

Load data

=====

		Z axis	X axis	Y axis
Load / Moment	N.mm	-2460	480000	480000
Torsion / Shear	N.mm	480000	2460	2460

Factor data

=====

		P	Mc	ML
Stress resultant nr	-	0.120	0.175	0.119
Stress resultant mr	-	0.111	0.216	0.144
Stress resultant nt	-	0.148	0.040	0.162
Stress resultant mt	-	0.053	0.126	0.084

Vessco Engineering Ltd

Item : 6" 900# Shell Line Heater
 Client : Exheat Ltd

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Title : N3 radial load -ve

Circumferential stress data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	-1.8	-1.8	-1.8	-1.8	-1.5	-1.5	-1.5	-1.5
Sb P	-4.0	4.0	-4.0	4.0	-8.3	8.3	-8.3	8.3
Sm Mc	0.0	0.0	0.0	0.0	7.0	7.0	-7.0	-7.0
Sb Mc	0.0	0.0	0.0	0.0	52.0	-52.0	-52.0	52.0
Sm ML	-6.5	-6.5	6.5	6.5	0.0	0.0	0.0	0.0
Sb ML	-20.2	20.2	20.2	-20.2	0.0	0.0	0.0	0.0
S pr	172.4	172.4	172.4	172.4	172.4	172.4	172.4	172.4
Smy	164.1	164.1	177.0	177.0	177.9	177.9	163.9	163.9
Sy	139.9	188.2	193.3	160.8	221.6	134.2	103.6	224.1

Longitudinal stress data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	-1.5	-1.5	-1.5	-1.5	-1.8	-1.8	-1.8	-1.8
Sb P	-8.3	8.3	-8.3	8.3	-4.0	4.0	-4.0	4.0
Sm Mc	0.0	0.0	0.0	0.0	1.6	1.6	-1.6	-1.6
Sb Mc	0.0	0.0	0.0	0.0	30.3	-30.3	-30.3	30.3
Sm ML	-4.8	-4.8	4.8	4.8	0.0	0.0	0.0	0.0
Sb ML	-34.6	34.6	34.6	-34.6	0.0	0.0	0.0	0.0
S pr	71.8	71.8	71.8	71.8	71.8	71.8	71.8	71.8
Smx	65.6	65.6	75.1	75.1	71.6	71.6	68.4	68.4
Sx	22.7	108.4	101.4	48.8	97.9	45.3	34.2	102.6

Shear stress data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Tau Vc	1.8	1.8	-1.8	-1.8	0.0	0.0	0.0	0.0
Tau VL	0.0	0.0	0.0	0.0	-1.8	-1.8	1.8	1.8
Tau MT	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Tau	7.8	7.8	4.1	4.1	4.1	4.1	7.8	7.8

Stress intensity data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm1	53.0	53.0	64.7	64.7	65.4	65.4	53.0	53.0
Sm2	16.8	16.8	27.6	27.6	24.1	24.1	19.4	19.4
Sm3	36.2	36.2	37.0	37.0	41.3	41.3	33.5	33.5
S1	140.4	189.0	193.5	160.9	221.7	134.4	104.5	224.6
S2	22.2	107.7	101.2	48.6	97.7	45.1	33.3	102.1
S3	118.2	81.3	92.2	112.3	124.0	89.3	71.2	122.5

Stress summary data

Pressure stress Sp	MPa	172.4
Allowable	MPa	354.0
Shear stress	MPa	7.8
Allowable	MPa	70.8
Membrane stress Sm	MPa	65.4
Allowable	MPa	177.0
Memb + bending stress Sb	MPa	224.6
Allowable	MPa	354.0
Maximum ratio	percent	63.5

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Circ stress (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8
Sm Mc	0.0	0.0	0.0	0.0	1.6	1.6	-1.6	-1.6
Sm ML	-6.5	-6.5	6.5	6.5	0.0	0.0	0.0	0.0
S pr	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6
Smy	24.3	24.3	37.3	37.3	32.4	32.4	29.2	29.2
Sy	24.3	24.3	37.3	37.3	32.4	32.4	29.2	29.2

Long stress (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8
Sb P	-11.3	11.3	-11.3	11.3	-11.3	11.3	-11.3	11.3
Sm Mc	0.0	0.0	0.0	0.0	31.0	31.0	-31.0	-31.0
Sb Mc	0.0	0.0	0.0	0.0	91.8	-91.8	-91.8	91.8
Sm ML	-31.0	-31.0	31.0	31.0	0.0	0.0	0.0	0.0
Sb ML	-60.2	60.2	60.2	-60.2	0.0	0.0	0.0	0.0
S pr	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3
Smx	-21.5	-21.5	40.5	40.5	40.5	40.5	-21.5	-21.5
Sx	-93.0	50.0	89.4	-8.4	121.0	-40.0	-124.6	81.6

Shear stress (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Tau Vc	3.2	3.2	-3.2	-3.2	0.0	0.0	0.0	0.0
Tau VL	0.0	0.0	0.0	0.0	-3.2	-3.2	3.2	3.2
Tau MT	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3
Tau	13.4	13.4	7.1	7.1	7.1	7.1	13.4	13.4

Stress intensity (nozzle) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm1	27.9	27.9	46.1	46.1	44.6	44.6	32.5	32.5
Sm2	-25.1	-25.1	31.6	31.6	28.3	28.3	-24.8	-24.8
Sm3	53.1	53.1	14.5	14.5	16.3	16.3	57.3	57.3
S1	25.8	55.7	90.4	38.3	121.6	33.1	30.3	84.8
S2	-94.5	18.5	36.3	-9.5	31.8	-40.7	-125.8	25.9
S3	120.3	37.2	54.0	47.8	89.8	73.8	156.1	58.9

Stress summary (nozzle) data

Pressure stress Sp	MPa	32.6
Allowable	MPa	118.0
Shear stress	MPa	13.4
Allowable	MPa	82.6
Membrane stress Sm	MPa	57.3
Allowable	MPa	118.0
Memb + bending stress Sb	MPa	156.1
Allowable	MPa	177.0
Maximum ratio	percent	88.2

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Pad data

=====

Thickness T	mm	8.099
Radius Rm	mm	80.101
Factor gamma	-	9.890
Radius ro	mm	60.000
Factor beta	-	0.655

Radial load data

=====

		Long axis	Tran axis
Ny.Rm/P (Fig 4C/3C)	-	1.266	0.789
My/P (Fig 2C-1/1C)	-	0.022	0.039
Nx.Rm/P (Fig 3C/4C)	-	0.789	1.266
Mx/P (Fig 1C-1/2C)	-	0.040	0.023

Moment data

=====

		Mc	ML
Ny.Rm ² .beta/M (Fig 3A/3B)	-	0.460	0.992
My.Rm.beta/M (Fig 1A/1B-1)	-	0.074	0.017
Nx.Rm ² .beta/M (Fig 4A/4B)	-	1.067	0.469
Mx.Rm.beta/M (Fig 2A/2B-1)	-	0.037	0.032

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Circ stress (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	-4.8	-4.8	-4.8	-4.8	-3.0	-3.0	-3.0	-3.0
Sb P	-4.9	4.9	-4.9	4.9	-8.7	8.7	-8.7	8.7
Sm Mc	0.0	0.0	0.0	0.0	6.5	6.5	-6.5	-6.5
Sb Mc	0.0	0.0	0.0	0.0	62.2	-62.2	-62.2	62.2
Sm ML	-14.0	-14.0	14.0	14.0	0.0	0.0	0.0	0.0
Sb ML	-14.4	14.4	14.4	-14.4	0.0	0.0	0.0	0.0
S pr	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2
Smy	80.4	80.4	108.4	108.4	102.7	102.7	89.7	89.7
Sy	61.1	99.7	117.9	98.9	156.1	49.3	18.8	160.6

Long stress (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm P	-3.0	-3.0	-3.0	-3.0	-4.8	-4.8	-4.8	-4.8
Sb P	-8.9	8.9	-8.9	8.9	-5.1	5.1	-5.1	5.1
Sm Mc	0.0	0.0	0.0	0.0	15.0	15.0	-15.0	-15.0
Sb Mc	0.0	0.0	0.0	0.0	31.1	-31.1	-31.1	31.1
Sm ML	-6.6	-6.6	6.6	6.6	0.0	0.0	0.0	0.0
Sb ML	-26.9	26.9	26.9	-26.9	0.0	0.0	0.0	0.0
S pr	44.6	44.6	44.6	44.6	44.6	44.6	44.6	44.6
Smx	35.0	35.0	48.2	48.2	54.9	54.9	24.8	24.8
Sx	-0.7	70.8	66.2	30.3	80.8	28.9	-11.4	61.0

Shear stress (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Tau Vc	1.6	1.6	-1.6	-1.6	0.0	0.0	0.0	0.0
Tau VL	0.0	0.0	0.0	0.0	-1.6	-1.6	1.6	1.6
Tau MT	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Tau	4.2	4.2	1.0	1.0	1.0	1.0	4.2	4.2

Stress intensity (pad edge) data

	Au	AL	Bu	BL	Cu	CL	Du	DL
Sm1	80.8	80.8	108.4	108.4	102.7	102.7	90.0	90.0
Sm2	34.7	34.7	48.2	48.2	54.9	54.9	24.5	24.5
Sm3	46.2	46.2	60.2	60.2	47.9	47.9	65.5	65.5
S1	61.4	100.3	117.9	98.9	156.2	49.3	19.4	160.8
S2	-1.0	70.2	66.2	30.2	80.8	28.9	-12.0	60.8
S3	62.4	30.1	51.7	68.7	75.4	20.4	31.4	99.9

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Title : N3 radial load -ve

Stress summary (pad edge) data

=====

Pressure stress Sp	MPa	99.2
Allowable	MPa	118.0
Shear stress	MPa	4.2
Allowable	MPa	70.8
Membrane stress Sm	MPa	108.4
Allowable	MPa	177.0
Memb + bending stress Sb	MPa	160.8
Allowable	MPa	354.0
Maximum ratio	percent	84.1

Material data

=====

Shell

Material spec	-	SA333-6:K03006
Allowable stress: DT	MPa	118.0
Elastic mod: DT	MPa	198373.3

Data:ASME II Part D Table 1A p14/22(M)
 Data:ASME II Part D Table TM-1 CS C <= 0.3%(M)

Nozzle

Material spec	-	SA333-6:K03006
Allowable stress: DT	MPa	118.0

Data:ASME II Part D Table 1A p14/22(M)

Pad

Material spec	-	SA516-70:K02700
Allowable stress: DT	MPa	138.0

Data:ASME II Part D Table 1A p22/6(M)

Warnings data

=====

- Beta out of range
- d/t out of range
- Deflection out of range
- Ratio d/T
- Ratio D/T
- Ratio d/t
- WRC 107 graphs
- WRC 297 graphs

Advisory messages have been reviewed, stresses are considered to be acceptable

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Explanatory notes

Calculations for External Loads on Horizontal Vessels

=====

Calculations for the stresses in horizontal vessels subject to triaxial loading supported on two saddle supports located either symmetrically or asymmetrically in the longitudinal direction, in accordance with ASME VIII Div.1 Appendix G-6 and G-9, and 'Stresses in Large Horizontal Cylindrical Pressure Vessels on Two Saddle Supports' by L.P.Zick and additionally to British Standard PD5500 Annex G.3.3 with reference to BSI document PD 6497.

The vessel may be subject to triaxial accelerations X, Y and Z resulting in reactions Rx, Ry and Rz acting through the centre of the vessel at the saddles.

Saddles are considered to be totally restrained such that translation is only possible at the sliding end in the X direction. Saddles may be asymmetrically located.

Shear stresses are calculated by combining the reactions in the Y and Z directions vectorially.

Circumferential stresses on plain saddles and rings where applicable are calculated by considering the vertical and lateral shear forces causing bending.

Circumferential stresses in saddles with rings are determined by the superposition of the bending due to reactions Rz and Ry.

Longitudinal stresses are calculated by considering the effective shell section at the saddles.

The location of maximum stress between supports is found by iteration.

Membrane stresses due to internal and/or external pressures are included.

The maximum allowable longitudinal compressive stress for the shell is calculated in accordance with UG-23.

Calculation status

=====

The status of each individual calculation is printed at the end of each output.

Acceptable calculation: Indicates that the calculation and checks have been performed successfully and that no errors have been found.

Warnings: Indicates that one or more warning messages have been generated. These warning messages are then listed. If the messages are informative only then Acceptable calculation will be printed at the end of the list.

Explanation of all possible messages

=====

A > L/4: Saddle beyond 1/4 point of vessel.

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Explanatory notes

Accelerations: The accelerations in the vertical direction has been input as less than 1.0 or one of the three accelerations has been input greater than 2.0 or the specific gravity is outside of the range $2.0 < SG < 10.0$.

Diameter limit exceeded: $OD > \text{limit in TABLE UW-12 for weld type.}$

Distance between supports: For a ring support $\phi < 30 \text{ deg}$ (PD5500 Table G.3.3.3).

Code limitations exceeded: One or more of the head dimensions is outside of the limitations of the code.

Extrapolated graphs/tables: For the calculation of Kz the wrapper or saddle angle is greater than 150 degrees.

Full radiography reqd: Thickness $> 1.5"$ (38mm) and full radiography not specified (UW-11(a)(2)).

Saddle angle < 120 or > 150 : (G-6).

Saddle welded to shell: The loadings are such that movement of the saddle, relative to the vessel at the sliding end, may occur if the saddles are not welded to the shell, eg: the vessel may lift out of the saddle.

Stress limit exceeded: One or more of the calculated stresses exceeds the corresponding allowable stress.

Thickness limit exceeded: Thickness $> \text{limit in TABLE UW-12 for weld type.}$

Wrapper plate angle: Wrapper angle $< r/10$ above horn of saddle or $> 180 \text{ deg}$.

Wrapper plate thk : The wrapper plate thickness is less than the shell thickness.

Wrapper plate width: Wrapper width $< (\text{saddle width} + 10t)$.

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```

Title : Saddles: operating + seismic

Design data

=====

Longitudinal weld	-	Seamless
Radiography: TABLE UW-12	-	None
Circumferential weld	-	Type 1
Radiography: TABLE UW-12	-	Full
Pressure input	-	Design pressure
Design pressure	MPa	9.93
Liquid SG	-	1.00
External design pressure	MPa	0.10
Design temp	deg.C	93.00
Corrosion: int	mm	1.50
Corrosion: ext	mm	0.00
Liquid level	mm	168.30
Live Loads	-	Yes
Weight increment	percent	100.00
Acceleration X (long)	-	0.12
Acceleration Y (vert)	-	1.00
Acceleration Z (trans)	-	0.12

Head data

=====

Head	-	Yes
Type	-	2:1 Ellipsoidal head
Location	mm	1491.00
Outside diameter	mm	168.30
New thickness	mm	10.97
Thinning	percent	12.50
Material spec	-	SA420-WPL6

Shell data

=====

Location	mm	0.00
Outside diameter	mm	168.30
New thickness	mm	10.97
Thinning	percent	12.50
Material spec	-	SA333-6:K03006

Head data

=====

Head	-	No
Location	mm	0.00

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Support data

=====

Type	-	Plain saddle
Material spec	-	SA516-70:K02700
Saddle welded to shell	-	Yes
Saddle angle	degrees	120.00
Saddle width	mm	90.00
Extended wrapper fitted	-	No
Saddle location : fixed	mm	350.00
Saddle location : slide	mm	1300.00
Line of action	mm	477.00

Additional loads data

=====

Location	mm	1372.00	1300.00	750.00	350.00	275.00	60.00	27.00
Mass	kg	16.00	24.00	16.00	24.00	16.00	50.00	98.00
Load X (shear)	N	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Load Y (shear)	N	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Load Z (shear)	N	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Moment Y	N.mm	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Moment Z	N.mm	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Output data

=====

Abridged output	-	Yes
-----------------	---	-----

Reaction data

=====

Location	mm	1300	350
X axis	N	0	394
Y axis	N	571	2715
Z axis	N	45	350

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```

Title : Saddles: operating + seismic

Longitudinal stress data

=====

Location	mm	1300.0	350.0
Stress 1	MPa	1.5	28.7
Stress 2	MPa	-0.9	-15.9
Stress 3	MPa	0.0	-0.9
Stress 4	MPa	0.0	-9.73E-02
Internal			
Stress Pr	MPa	49.1	49.1
Stress Max	MPa	50.7	78.8
Stress Min	MPa	48.3	33.1
Stress intensity	MPa	98.2	98.2
External			
Stress Pr	MPa	-0.5	-0.5
Stress Max	MPa	1.1	29.1
Stress Min	MPa	-1.4	-16.5
Stress intensity	MPa	2.1	30.2
Allowable	MPa	141.6	141.6
Allowable comp stress	MPa	141.6	141.6
Maximum ratio	percent	69.4	69.4

Stress data

=====

Location	mm	1300.0
Shear		
Stress S2	MPa	0.7
Allowable	MPa	94.4
Pressure stress in head	MPa	109.9
Allowable	MPa	118.0
Maximum ratio	percent	93.2
Circumferential		
Stress S5	MPa	-0.3
Allowable	MPa	118.0
Stress S3	MPa	-1.0
Allowable	MPa	147.5
Maximum ratio	percent	0.7

Stress data

=====

Location	mm	350.0
Shear		
Stress S2	MPa	2.6
Allowable	MPa	94.4
Maximum ratio	percent	2.8
Circumferential		
Stress S5	MPa	-1.5
Allowable	MPa	118.0
Stress S3	MPa	-5.2
Allowable	MPa	147.5
Maximum ratio	percent	3.5

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Longitudinal stress data

=====

Location	mm	347.0
Stress 1	MPa	17.5
Stress 2	MPa	-12.0
Stress 3	MPa	-0.8
Stress 4	MPa	-9.73E-02
Internal		
Stress Pr	MPa	49.1
Stress Max	MPa	67.4
Stress Min	MPa	37.0
Stress intensity	MPa	98.2
External		
Stress Pr	MPa	-0.5
Stress Max	MPa	17.8
Stress Min	MPa	-12.6
Stress intensity	MPa	18.8
Allowable	MPa	141.6
Allowable comp stress	MPa	141.6
Maximum ratio	percent	69.4

Material data

=====

Shell		
Material spec	-	SA333-6:K03006
Allowable stress: DT	MPa	118.00
Elastic mod: DT	MPa	199900.00
Material SG	-	7.85

Material data

=====

Head		
Location	mm	1491.0
Material spec	-	SA420-WPL6
Allowable stress: DT	MPa	118.0

Material data

=====

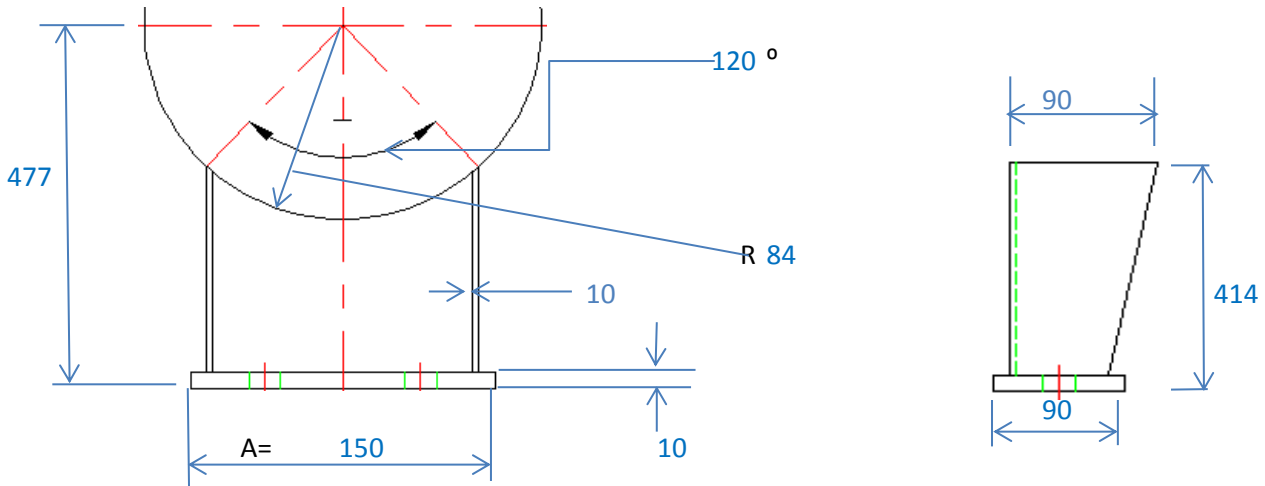
Saddle		
Material spec	-	SA516-70:K02700
Allowable stress: DT	MPa	138.0
Data:ASME II Part D Table 1A p22/6(M)		

Acceptable calculation

DESIGN OF SADDLE SUPPORTS - Generally in accordance with the Zick analysis method

With reference to Pressure Vessel Design Manual 3rd Edition by Dennis Moss, Procedure 3-11

Material SA516 Gr70
Minimum yield stress $R_e = 240 \text{ N/mm}^2$
Stress factor $S_f = 1$



Saddle centres $L_s = 950 \text{ mm}$ Width of saddle at bottom $G_b = 70 \text{ mm}$
No of ribs $n = 2$ Width of saddle at top $G_t = 90 \text{ mm}$
Web and rib thk, $J = 10 \text{ mm}$ Line of action, $B = 477 \text{ mm}$

Operating weight $W_o = 355 \text{ Kg}$ Hydrotest weight $W_T = 370 \text{ Kg}$
Load per saddle $Q_o = 1.741 \text{ KN}$ Load per saddle $Q_T = 1.815 \text{ KN}$
Maximum longitudinal force due to wind, seismic, transport or blast, $F_L = 0.418 \text{ KN}$
Maximum transverse force due to wind, seismic, transport or blast, $F_T = 0.418 \text{ KN}$
Vertical load acting on saddle due to max longitudinal load, $Q_L = F_L B / L_s = 0.210 \text{ KN}$
Vertical load acting on saddle due to max transverse load, $Q_R = 3 F_T B / A = 3.988 \text{ KN}$

Maximum Loads

Vertical: greater of Q_1 , Q_2 or Q_T

$Q_1 = Q_o + Q_R = 5.7 \text{ KN}$

$Q_2 = Q_o + Q_L = 2.0 \text{ KN}$

$Q_T = 1.8 \text{ KN}$

Therefore maximum load Q per saddle = **5.7 KN**

Longitudinal: $F_L = 0.418 \text{ KN}$

Cross Sectional Properties of the Saddles

	Area, A mm ²	y mm	Ay mm ³	Ay ² mm ⁴	I _o mm ⁴
Wrapper plate	0	0	0	0	0.0
Web	4140	217	898380	194948460	59131620
Base plate	900	5	4500	22500	7500
Σ	5040		902880	194970960	59139120

$C_1 = \Sigma Ay / \Sigma A = 179.1 \text{ mm}$ $C_2 = h - C_1 = 244.9 \text{ mm}$

$I = \Sigma Ay^2 + \Sigma I_o - C_1 \Sigma Ay = 92365577.1 \text{ mm}^4$



Web Design

Contact angle, $2\theta =$	120 °
Contact angle θ in radians =	1.047 rads
Angle $\beta =$	120 °
Saddle coefficient K_1 (from Table 3-27) =	0.19
Saddle splitting force, $f_h = K_1 \times Q =$	1088.5 N

Tensile Stress in the Saddle

CSA of saddle, $A_s =$	5040 mm ²
Tensile stress in web, $f_t = f_h / A_s =$	0.22 N/mm ²
Allowable stress, $F_t = 0.6 \times R_e \times S_f =$	144 N/mm ²

Therefore acceptable

Bending Stress in the Saddle

$d = B - (R \sin \theta / \theta) =$	407.5 mm
Bending moment, $M = f_h d =$	443597.239 Nmm
Distance from shell to centroid, $C_1 =$	179.1 mm
Bending stress, $f_b = MC_1 / I =$	0.9 N/mm ²
Allowable stress, $F_b = 0.66 \times R_e \times S_f =$	158.4 N/mm ²

Therefore acceptable

Base Plate Design

Area, $A_b = A \times F =$	13500 mm ²
Bearing Pressure $B_p = Q / A_b =$	0.42 N/mm ²

Bending Stress in Base Plate

$f_b = 3QF / 4At_b^2 =$	25.78 N/mm ²
Allowable stress, $F_b = 0.66 \times R_e \times S_f =$	158.4 N/mm ²

Therefore acceptable



Outside Rib

Rib spacing, $e =$	60 mm
Rib height, $L_1 =$	414 mm
Cross sectional area of rib + web, $A_r =$	1300 mm ²
Pressure area on rib, $A_p = 0.5 \times F \times e =$	2700 mm ²

Compressive Stress

Moment of Inertia $I_1 = J / 12(G_t/2 + G_b/2)^3 =$	426666.6667 mm ⁴
Radius of gyration, $r = \sqrt{I_1/A_r} =$	18.1 mm
Slenderness ratio $= L_1/r =$	22.9
Axial load $P = B_p \times A_p =$	1145.8 N
Compressive stress $f_a = P/A_r =$	0.9 N/mm ²
Allowable stress $F_a = 0.6 \times R_e \times S_f =$	144 N/mm ²

Therefore acceptable

Bending Stress

Unit force $f_u = F_L / 2A =$	1.39 N
Bending moment $M = 0.5 \times f_u \times e \times L_1 =$	17305.2 Nmm
Action of force, $C_1 = (G_T + G_b)/4 =$	40 mm
Bending stress $f_b = (M \times C_1)/I =$	0.01 N/mm ²
Allowable stress $F_b = 0.66 \times R_e \times S_f =$	158.4 N/mm ²

Therefore acceptable

Combined Stress

$f_a/F_a + f_b/F_b < 1$	$f_c =$	0.01
-------------------------	---------	------

Inside Rib

N/A

Rib spacing, $e =$	mm
Rib height, $L_2 =$	mm
Cross sectional area of rib + web, $A_r =$	mm ²
Pressure area on rib, $A_p = F \times e =$	mm ²

Compressive Stress

Moment of Inertia $I_2 = (J \times G_b^3) / 12 =$	mm ⁴
Radius of gyration, $r = \sqrt{I_2/A_r} =$	mm
Slenderness ratio $= L_2/r =$	
Axial load $P = B_p \times A_p =$	N
Compressive stress $f_a = P/A_r =$	N/mm ²
Allowable stress $F_a = 0.6 \times R_e \times S_f =$	N/mm ²

Bending Stress

Unit force $f_u = F_L / 2A =$	N
Position of centroid $= 0.5 \times G_b =$	mm
Bending moment $M = f_u \times L_2 \times e$	Nmm
Action of force, $C_2 = 0.5 \times G_b =$	mm
Bending stress $f_b = (M \times C_2)/I =$	N/mm ²
Allowable stress $F_b = 0.6 \times R_e \times S_f =$	N/mm ²

Combined Stress

$f_a/F_a + f_b/F_b < 1$	$f_c =$	
-------------------------	---------	--

Anchor Bolts

Number of anchor bolts in the fixed saddle $N = 2$

Anchor bolts are governed by one of the three following load cases:

1) Longitudinal Load

$$Q_o = 1741.3 \text{ N} \quad Q_L = 209.9 \text{ N}$$

If $Q_o > Q_L$ then no uplift occurs and the minimum number and size of bolts from table 3-28 should be used.

$$\text{Load per bolt} = Q_L - Q_o / N = -765.7 \text{ N}$$

2) Shear

Assume the fixed saddle takes the entire shear load.

$$\text{Shear per bolt} = F_L / N = 209 \text{ N}$$

3) Transverse Load

Determine uplift and overturning moment:

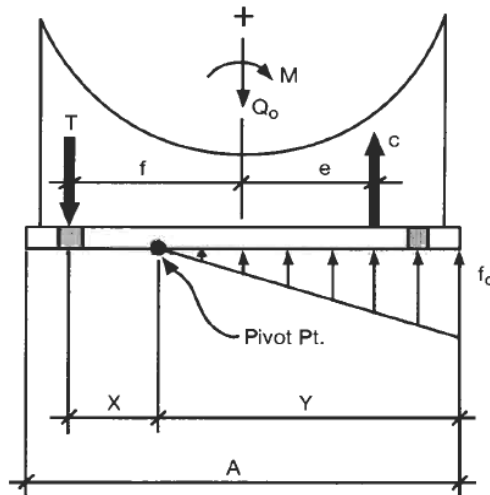
$$\text{Overturning moment } M = F_T \times B = 199386 \text{ Nmm}$$

$$e = M / Q_o = 114.5 \text{ mm}$$

$$A/6 = 25.0 \text{ mm}$$

If $e < A/6$ then there is no uplift

However, $e > A/6$ so there is uplift and the tension force, T in the outermost bolt needs to be determined



Bolt size:

M 16

$$\text{Bolt cross sectional area in tension, } a_t = 201.0 \text{ mm}^2$$

$$\text{Modular ratio, steel to concrete, } n_1 = 10.0$$

$$\text{Distance from C/L to outermost bolt, } f = 32.5 \text{ mm}$$

$$\text{Factor } K_1 = 3(e - 0.5A) = 118.5$$

$$\text{Factor } K_2 = (6n_1a_t/F) * (f + e) = 19694.9$$

$$\text{Factor } K_3 = (-)K_2[(A/2) + f] = -2117196.41$$

Substitute K_1 , K_2 , K_3 into the following equation to determine the effective bearing length Y by iterating:

$$Y^3 + K_1Y^2 + K_2Y + K_3 = 0 \quad Y = 66.3 \text{ mm}$$



Tension force, T in the outermost bolt or bolts

$$T = (-)Q_o \left[\frac{((A/2)-(Y/3)-e)}{((A/2)-(Y/3)+f)} \right]$$

$$T = 1255.88 \text{ N}$$

Anchor bolts material: SA320 L7

Size of bolts for anchoring: M16

Check the size and material of the bolts from Table 3-28

Table 3-28 : Allowable Tension Loads on Bolts to BS5950-Pt1

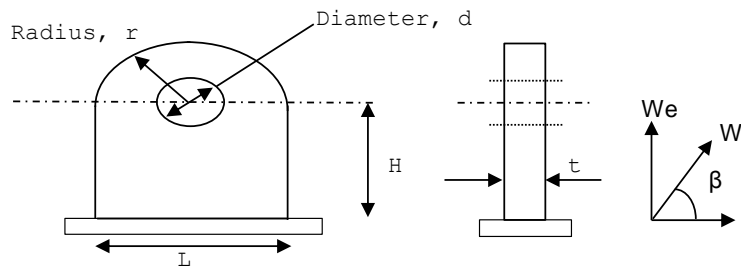
Nominal							
Bolt size	M10	M12	M16	M20	M24	M30	M36
A-320							
N	13900	20200	37700	58800	84700	135000	196000

Bolting is acceptable

DESIGN OF LIFTING LUGS - provided to lift vessel c/w bundle inside

DESIGN INFORMATION

Material	SA516-70
Yield Strength, S_y	240 N/mm ²
Allow. Stress (Shear), $S_s = 0.4 * S_y$	96 N/mm ²
Allow. Stress (Bending), $S_b = 0.6 * S_y$	144 N/mm ²
Young's Modulus, E	191000 N/mm ²
Erection Weight, W_e (approx.)	355 kg
Impact Factor, I	2
Number of Lugs, n	2
Design Lifting Weight, $W = W_e * I$	710 kg
Design Lifting Weight per lug, $W_l = W / n-1$	710 kg
Lifting angle, β	45 deg



LUG DIMENSIONS

Diameter of hole, d	25.00 mm
Outer radius, r	30.00 mm
Width of lug, L	100.00 mm
Height of hole, H	100.00 mm
Shackle type	3.5t Crosby G-2130
Diameter of shackle pin, d_p	22.00 mm

MINIMUM REQUIRED THICKNESS OF LUG

Radial Load, $P_r = (W_l * 9.81)$	6965.10 N
Tangential Load, $P_t = (W_l * 9.81) / \beta$	9850.14 N
Maximum Load, $P = \max(P_r \text{ or } P_t)$	9850.14 N
Required thickness (Shear), $t_s = P / (S_s * (r - d/2))$	5.86 mm
Required thickness (Bending), $t_b = (6 * P * H / (S_b * L^2))$	4.10 mm

Actual Thickness of lug assigned, t **10.00 mm**

Note:

1. All load assumed carried by one lug
2. All load cases analyzed independently
3. Contour lug to fit vessel
4. Important: Do not move or support vessel with this lug when full or pressurized

DESIGN OF WELDED JOINTS

Length of welds, $A_w = 2 * L + 2 * t$	220.00 mm
Section Modulus Weld Line, $S_w = L^2 / 3$	3333.33 mm ²
Shear Force, $W_s = P / A_w$	44.77 N/mm
Bending Force, $W_b = (P * h) / S_w$	295.50 N/mm
Resultant Force, $W = \text{sqrt}(W_s^2 + W_b^2)$	298.88 N/mm
Allowable Load on Weld, f	66.20 N/mm ²
Minimum Fillet Weld size, $w = W / f$	4.51 mm

Weld size 10mm Full Penetration Weld



SAP2000 Analysis Report

Prepared by

ENS CANADA INC. JOHN SARSU, P.ENG, P.E.

Model Name: 338716-Shell.sdb

26 May 2015

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1. Model geometry

This section provides model geometry information, including items such as joint coordinates, joint restraints, and element connectivity.

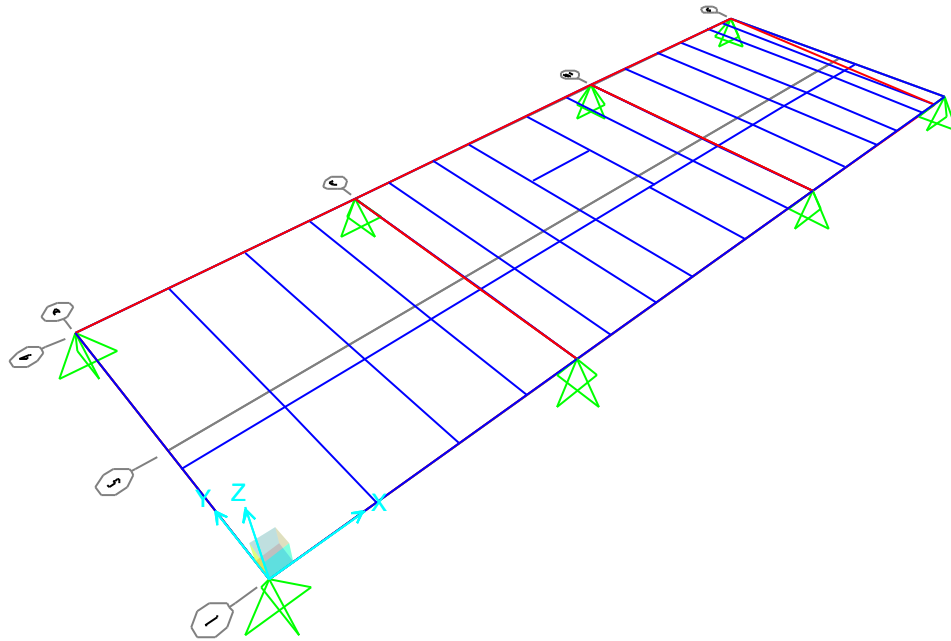


Figure 1: Finite element model

1.1. Joint coordinates

Table 1: Joint Coordinates, Part 1 of 2

Table 1: Joint Coordinates, Part 1 of 2							
Joint	CoordSys	CoordType	XorR m	Y m	Z m	SpecialJt	GlobalX m
1	GLOBAL	Cartesian	0.00000	0.00000	0.00000	No	0.00000
2	GLOBAL	Cartesian	0.00000	3.45500	0.00000	No	0.00000
3	GLOBAL	Cartesian	9.67500	0.00000	0.00000	No	9.67500
4	GLOBAL	Cartesian	9.67500	3.45500	0.00000	No	9.67500
5	GLOBAL	Cartesian	3.00100	3.45500	0.00000	No	3.00100
6	GLOBAL	Cartesian	6.20000	3.45500	0.00000	No	6.20000
7	GLOBAL	Cartesian	3.00100	0.00000	0.00000	No	3.00100
8	GLOBAL	Cartesian	6.20000	0.00000	0.00000	No	6.20000
11	GLOBAL	Cartesian	6.67500	0.00000	0.00000	No	6.67500
12	GLOBAL	Cartesian	6.67500	3.45500	0.00000	No	6.67500
13	GLOBAL	Cartesian	0.89000	0.00000	0.00000	No	0.89000
14	GLOBAL	Cartesian	0.89000	1.32100	0.00000	No	0.89000
15	GLOBAL	Cartesian	0.89000	3.45500	0.00000	No	0.89000
19	GLOBAL	Cartesian	2.41400	0.00000	0.00000	No	2.41400
20	GLOBAL	Cartesian	2.41400	1.32100	0.00000	No	2.41400
21	GLOBAL	Cartesian	2.41400	3.45500	0.00000	No	2.41400

Table 1: Joint Coordinates, Part 1 of 2

Joint	CoordSys	CoordType	XorR m	Y m	Z m	SpecialJt	GlobalX m
22	GLOBAL	Cartesian	4.05500	0.00000	0.00000	No	4.05500
23	GLOBAL	Cartesian	4.05500	1.32100	0.00000	No	4.05500
24	GLOBAL	Cartesian	4.05500	3.45500	0.00000	No	4.05500
25	GLOBAL	Cartesian	3.43300	0.00000	0.00000	No	3.43300
26	GLOBAL	Cartesian	3.43300	1.32100	0.00000	No	3.43300
27	GLOBAL	Cartesian	3.43300	3.45500	0.00000	No	3.43300
31	GLOBAL	Cartesian	5.51000	1.32100	0.00000	No	5.51000
32	GLOBAL	Cartesian	5.51000	3.45500	0.00000	No	5.51000
33	GLOBAL	Cartesian	5.43700	0.00000	0.00000	No	5.43700
34	GLOBAL	Cartesian	5.43700	1.32100	0.00000	No	5.43700
37	GLOBAL	Cartesian	4.59800	2.33700	0.00000	No	4.59800
38	GLOBAL	Cartesian	5.51000	2.33700	0.00000	No	5.51000
39	GLOBAL	Cartesian	9.42100	0.00000	0.00000	No	9.42100
40	GLOBAL	Cartesian	9.42100	1.32100	0.00000	No	9.42100
41	GLOBAL	Cartesian	9.42100	3.45500	0.00000	No	9.42100
57	GLOBAL	Cartesian	6.20000	1.32100	0.00000	No	6.20000
64	GLOBAL	Cartesian	8.50200	0.00000	0.00000	No	8.50200
65	GLOBAL	Cartesian	8.50200	1.32100	0.00000	No	8.50200
66	GLOBAL	Cartesian	8.50200	3.45500	0.00000	No	8.50200
67	GLOBAL	Cartesian	9.11100	0.00000	0.00000	No	9.11100
68	GLOBAL	Cartesian	9.11100	1.32100	0.00000	No	9.11100
69	GLOBAL	Cartesian	9.11100	3.45500	0.00000	No	9.11100
73	GLOBAL	Cartesian	7.33650	0.00000	0.00000	No	7.33650
74	GLOBAL	Cartesian	7.33650	1.32100	0.00000	No	7.33650
75	GLOBAL	Cartesian	7.33650	3.45500	0.00000	No	7.33650
76	GLOBAL	Cartesian	1.67700	0.00000	0.00000	No	1.67700
77	GLOBAL	Cartesian	1.67700	3.45500	0.00000	No	1.67700
78	GLOBAL	Cartesian	7.99800	0.00000	0.00000	No	7.99800
79	GLOBAL	Cartesian	7.99800	3.45500	0.00000	No	7.99800
80	GLOBAL	Cartesian	0.00000	1.32100	0.00000	No	0.00000
81	GLOBAL	Cartesian	1.67700	1.32100	0.00000	No	1.67700
82	GLOBAL	Cartesian	7.99800	1.32100	0.00000	No	7.99800
83	GLOBAL	Cartesian	9.67500	1.32100	0.00000	No	9.67500
84	GLOBAL	Cartesian	4.59800	0.00000	0.00000	No	4.59800
85	GLOBAL	Cartesian	4.59800	3.45500	0.00000	No	4.59800
86	GLOBAL	Cartesian	4.59800	1.32100	0.00000	No	4.59800
87	GLOBAL	Cartesian	3.00100	1.32100	0.00000	No	3.00100
88	GLOBAL	Cartesian	6.67500	1.32100	0.00000	No	6.67500

Table 1: Joint Coordinates, Part 2 of 2

Table 1: Joint Coordinates, Part 2 of 2

Joint	GlobalY m	GlobalZ m	GUID
1	0.00000	0.00000	
2	3.45500	0.00000	
3	0.00000	0.00000	
4	3.45500	0.00000	
5	3.45500	0.00000	
6	3.45500	0.00000	
7	0.00000	0.00000	
8	0.00000	0.00000	
11	0.00000	0.00000	

Table 1: Joint Coordinates, Part 2 of 2

Joint	GlobalY m	GlobalZ m	GUID
12	3.45500	0.00000	
13	0.00000	0.00000	
14	1.32100	0.00000	
15	3.45500	0.00000	
19	0.00000	0.00000	
20	1.32100	0.00000	
21	3.45500	0.00000	
22	0.00000	0.00000	
23	1.32100	0.00000	
24	3.45500	0.00000	
25	0.00000	0.00000	
26	1.32100	0.00000	
27	3.45500	0.00000	
31	1.32100	0.00000	
32	3.45500	0.00000	
33	0.00000	0.00000	
34	1.32100	0.00000	
37	2.33700	0.00000	
38	2.33700	0.00000	
39	0.00000	0.00000	
40	1.32100	0.00000	
41	3.45500	0.00000	
57	1.32100	0.00000	
64	0.00000	0.00000	
65	1.32100	0.00000	
66	3.45500	0.00000	
67	0.00000	0.00000	
68	1.32100	0.00000	
69	3.45500	0.00000	
73	0.00000	0.00000	
74	1.32100	0.00000	
75	3.45500	0.00000	
76	0.00000	0.00000	
77	3.45500	0.00000	
78	0.00000	0.00000	
79	3.45500	0.00000	
80	1.32100	0.00000	
81	1.32100	0.00000	
82	1.32100	0.00000	
83	1.32100	0.00000	
84	0.00000	0.00000	
85	3.45500	0.00000	
86	1.32100	0.00000	
87	1.32100	0.00000	
88	1.32100	0.00000	

1.2. Joint restraints

Table 2: Joint Restraint Assignments

Table 2: Joint Restraint Assignments						
Joint	U1	U2	U3	R1	R2	R3
1	Yes	Yes	Yes	No	No	No
2	Yes	Yes	Yes	No	No	No
3	Yes	Yes	Yes	No	No	No
4	Yes	Yes	Yes	No	No	No
5	Yes	Yes	Yes	No	No	No
7	Yes	Yes	Yes	No	No	No
11	Yes	Yes	Yes	No	No	No
12	Yes	Yes	Yes	No	No	No

1.3. Element connectivity

Table 3: Connectivity - Frame, Part 1 of 2

Table 3: Connectivity - Frame, Part 1 of 2							
Frame	JointI	JointJ	IsCurved	Length m	CentroidX m	CentroidY m	CentroidZ m
1	1	2	No	3.45500	0.00000	1.72750	0.00000
2	3	4	No	3.45500	9.67500	1.72750	0.00000
3	2	5	No	3.00100	1.50050	3.45500	0.00000
7	1	7	No	3.00100	1.50050	0.00000	0.00000
14	13	14	No	1.32100	0.89000	0.66050	0.00000
15	14	15	No	2.13400	0.89000	2.38800	0.00000
18	19	20	No	1.32100	2.41400	0.66050	0.00000
19	20	21	No	2.13400	2.41400	2.38800	0.00000
20	22	23	No	1.32100	4.05500	0.66050	0.00000
21	23	24	No	2.13400	4.05500	2.38800	0.00000
22	25	26	No	1.32100	3.43300	0.66050	0.00000
23	26	27	No	2.13400	3.43300	2.38800	0.00000
26	31	32	No	2.13400	5.51000	2.38800	0.00000
27	33	34	No	1.32100	5.43700	0.66050	0.00000
29	37	38	No	0.91200	5.05400	2.33700	0.00000
30	39	40	No	1.32100	9.42100	0.66050	0.00000
31	40	41	No	2.13400	9.42100	2.38800	0.00000
42	8	57	No	1.32100	6.20000	0.66050	0.00000
43	57	6	No	2.13400	6.20000	2.38800	0.00000
44	5	12	No	3.67400	4.83800	3.45500	0.00000
45	12	4	No	3.00000	8.17500	3.45500	0.00000
46	7	11	No	3.67400	4.83800	0.00000	0.00000
47	11	3	No	3.00000	8.17500	0.00000	0.00000
52	64	65	No	1.32100	8.50200	0.66050	0.00000
53	65	66	No	2.13400	8.50200	2.38800	0.00000
54	67	68	No	1.32100	9.11100	0.66050	0.00000
55	68	69	No	2.13400	9.11100	2.38800	0.00000
58	73	74	No	1.32100	7.33650	0.66050	0.00000
59	74	75	No	2.13400	7.33650	2.38800	0.00000
60	76	77	No	3.45500	1.67700	1.72750	0.00000
61	78	79	No	3.45500	7.99800	1.72750	0.00000
62	80	81	No	1.67700	0.83850	1.32100	0.00000
63	82	83	No	1.67700	8.83650	1.32100	0.00000

Table 3: Connectivity - Frame, Part 1 of 2

Frame	JointI	JointJ	IsCurved	Length m	CentroidX m	CentroidY m	CentroidZ m
64	84	85	No	3.45500	4.59800	1.72750	0.00000
65	81	86	No	2.92100	3.13750	1.32100	0.00000
66	86	82	No	3.40000	6.29800	1.32100	0.00000
67	7	87	No	1.32100	3.00100	0.66050	0.00000
68	87	5	No	2.13400	3.00100	2.38800	0.00000
69	11	88	No	1.32100	6.67500	0.66050	0.00000
70	88	12	No	2.13400	6.67500	2.38800	0.00000

Table 3: Connectivity - Frame, Part 2 of 2

Table 3: Connectivity - Frame, Part 2 of 2

Frame	GUID
1	
2	
3	
7	
14	
15	
18	
19	
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68	
69	
70	

Table 4: Frame Section Assignments

Table 4: Frame Section Assignments					
Frame	SectionType	AutoSelect	AnalSect	DesignSect	MatProp
1	I / Wide Flange	N.A.	W250X33	N.A.	Default
2	I / Wide Flange	N.A.	W250X33	N.A.	Default
3	I / Wide Flange	N.A.	W250X33	N.A.	Default
7	I / Wide Flange	N.A.	W250X33	N.A.	Default
14	Channel	N.A.	C150X12	N.A.	Default
15	Channel	N.A.	C150X12	N.A.	Default
18	Channel	N.A.	C150X12	N.A.	Default
19	Channel	N.A.	C150X12	N.A.	Default
20	Channel	N.A.	C150X12	N.A.	Default
21	Channel	N.A.	C150X12	N.A.	Default
22	I / Wide Flange	N.A.	W150X22	N.A.	Default
23	I / Wide Flange	N.A.	W150X22	N.A.	Default
26	I / Wide Flange	N.A.	W150X22	N.A.	Default
27	Channel	N.A.	C150X12	N.A.	Default
29	I / Wide Flange	N.A.	W150X22	N.A.	Default
30	I / Wide Flange	N.A.	W100X19	N.A.	Default
31	I / Wide Flange	N.A.	W100X19	N.A.	Default
42	Channel	N.A.	C150X12	N.A.	Default
43	Channel	N.A.	C150X12	N.A.	Default
44	I / Wide Flange	N.A.	W250X33	N.A.	Default
45	I / Wide Flange	N.A.	W250X33	N.A.	Default
46	I / Wide Flange	N.A.	W250X33	N.A.	Default
47	I / Wide Flange	N.A.	W250X33	N.A.	Default
52	Channel	N.A.	C150X12	N.A.	Default
53	Channel	N.A.	C150X12	N.A.	Default
54	Channel	N.A.	C150X12	N.A.	Default
55	Channel	N.A.	C150X12	N.A.	Default
58	Channel	N.A.	C150X12	N.A.	Default
59	Channel	N.A.	C150X12	N.A.	Default
60	I / Wide Flange	N.A.	W250X33	N.A.	Default
61	I / Wide Flange	N.A.	W250X33	N.A.	Default
62	I / Wide Flange	N.A.	W150X22	N.A.	Default
63	I / Wide Flange	N.A.	W150X22	N.A.	Default
64	I / Wide Flange	N.A.	W250X33	N.A.	Default
65	I / Wide Flange	N.A.	W150X22	N.A.	Default
66	I / Wide Flange	N.A.	W150X22	N.A.	Default
67	Channel	N.A.	C150X12	N.A.	Default
68	Channel	N.A.	C150X12	N.A.	Default
69	Channel	N.A.	C150X12	N.A.	Default
70	Channel	N.A.	C150X12	N.A.	Default

Table 5: Connectivity - Area, Part 1 of 2

Table 5: Connectivity - Area, Part 1 of 2							
Area	NumJoints	Joint1	Joint2	Joint3	Joint4	Perimeter m	AreaArea m2
1	4	2	5	7	1	12.912000	10.368455
2	4	7	5	12	11	14.258000	12.693670

Table 5: Connectivity - Area, Part 1 of 2

Area	NumJoints	Joint1	Joint2	Joint3	Joint4	Perimeter m	AreaArea m2
3	4	11	12	4	39	12.665324	9.926215

Table 5: Connectivity - Area, Part 2 of 2

Table 5: Connectivity - Area, Part 2 of 2

Area	Volume m3	CentroidX m	CentroidY m	CentroidZ m	GUID
1	1.036846	1.50050	1.72750	0.00000	
2	1.269367	4.83800	1.72750	0.00000	
3	0.992622	8.11244	1.75295	0.00000	

Table 6: Area Section Assignments

Table 6: Area Section Assignments

Area	Section	MatProp
1	Floor	Default
2	Floor	Default
3	Floor	Default

2. Material properties

This section provides material property information for materials used in the model.

Table 7: Material Properties 02 - Basic Mechanical Properties

Table 7: Material Properties 02 - Basic Mechanical Properties

Material	UnitWeight KN/m3	UnitMass KN-s2/m4	E1 KN/m2	G12 KN/m2	U12	A1 1/C
4000Psi	2.3563E+01	2.4028E+00	24855578.06	10356490.86	0.200000	9.9000E-06
A992Fy50	7.6973E+01	7.8490E+00	199947978.8	76903068.77	0.300000	1.1700E-05

Table 8: Material Properties 03a - Steel Data, Part 1 of 2

Table 8: Material Properties 03a - Steel Data, Part 1 of 2

Material	Fy KN/m2	Fu KN/m2	EffFy KN/m2	EffFu KN/m2	SSCurveOpt	SSHysType	SHard	SMax
A992Fy50	344737.89	448159.26	379211.68	492975.19	Simple	Kinematic	0.015000	0.110000

Table 8: Material Properties 03a - Steel Data, Part 2 of 2

Table 8: Material Properties 03a - Steel Data, Part 2 of 2

Material	SRup	FinalSlope
A992Fy50	0.170000	-0.100000

Table 9: Material Properties 03b - Concrete Data, Part 1 of 2

Table 9: Material Properties 03b - Concrete Data, Part 1 of 2

Material	Fc KN/m2	LtWtConc	SSCurveOpt	SSHysType	SFc	SCap	FinalSlope	FAngle Degrees
4000Psi	27579.03	No	Mander	Takeda	0.002219	0.005000	-0.100000	0.000

Table 9: Material Properties 03b - Concrete Data, Part 2 of 2

Table 9: Material Properties 03b - Concrete Data, Part 2 of 2

Material	DAngle Degrees
4000Psi	0.000

3. Section properties

This section provides section property information for objects used in the model.

3.1. Frames

Table 10: Frame Section Properties 01 - General, Part 1 of 7

Table 10: Frame Section Properties 01 - General, Part 1 of 7

SectionName	Material	Shape	t3 m	t2 m	tf m	tw m
C150X12	A992Fy50	Channel	0.152000	0.048000	0.008700	0.005100
FSEC1	A992Fy50	I/Wide Flange	0.304800	0.127000	0.009652	0.006350
L76X76X6.4	A992Fy50	Angle	0.076200	0.076200	0.006350	0.006350
W100X19	A992Fy50	I/Wide Flange	0.106000	0.103000	0.008800	0.007100
W150X22	A992Fy50	I/Wide Flange	0.152000	0.152000	0.006600	0.005800
W250X33	A992Fy50	I/Wide Flange	0.258000	0.146000	0.009100	0.006100

Table 10: Frame Section Properties 01 - General, Part 2 of 7

Table 10: Frame Section Properties 01 - General, Part 2 of 7

SectionName	t2b m	tfb m	Area m2	TorsConst m4	I33 m4	I22 m4	I23 m4
C150X12			0.001530	3.060E-08	5.360E-06	2.780E-07	0.000000
FSEC1	0.127000	0.009652	0.004265	9.651E-08	0.000066	3.301E-06	0.000000
L76X76X6.4			0.000927	1.250E-08	5.180E-07	5.180E-07	3.079E-07
W100X19	0.103000	0.008800	0.002480	6.360E-08	4.770E-06	1.610E-06	0.000000
W150X22	0.152000	0.006600	0.002850	4.200E-08	0.000012	3.870E-06	0.000000
W250X33	0.146000	0.009100	0.004170	9.850E-08	0.000049	4.730E-06	0.000000

Table 10: Frame Section Properties 01 - General, Part 3 of 7

Table 10: Frame Section Properties 01 - General, Part 3 of 7

SectionName	AS2 m2	AS3 m2	S33 m3	S22 m3	Z33 m3	Z22 m3	R33 m
C150X12	0.000775	0.000835	0.000071	7.920E-06	0.000071	7.930E-06	0.059188
FSEC1	0.001935	0.002043	0.000431	0.000052	0.000491	0.000081	0.124145
L76X76X6.4	0.000484	0.000484	9.453E-06	9.453E-06	9.450E-06	9.450E-06	0.023639
W100X19	0.000753	0.001511	0.000090	0.000031	0.000103	0.000048	0.043856
W150X22	0.000882	0.001672	0.000159	0.000051	0.000176	0.000078	0.065158
W250X33	0.001574	0.002214	0.000379	0.000065	0.000424	0.000100	0.108290

Table 10: Frame Section Properties 01 - General, Part 4 of 7

Table 10: Frame Section Properties 01 - General, Part 4 of 7

SectionName	R22 m	EccV2 m	ConcCol	ConcBeam	Color	TotalWt KN	TotalMass KN-s2/m
C150X12	0.013480	0.027509	No	No	Red	3.818	0.39
FSEC1	0.027823		No	No	Green	0.000	0.00
L76X76X6.4	0.023639		No	No	Magenta	0.000	0.00
W100X19	0.025479		No	No	Orange	0.660	6.725E-02
W150X22	0.036850		No	No	Yellow	3.549	0.36
W250X33	0.033679		No	No	Blue	11.756	1.20

Table 10: Frame Section Properties 01 - General, Part 5 of 7

Table 10: Frame Section Properties 01 - General, Part 5 of 7

SectionName	FromFile	AMod	A2Mod	A3Mod	JMod	I2Mod	I3Mod
C150X12	Yes	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
FSEC1	No	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
L76X76X6.4	Yes	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
W100X19	Yes	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
W150X22	Yes	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
W250X33	Yes	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000

Table 10: Frame Section Properties 01 - General, Part 6 of 7

Table 10: Frame Section Properties 01 - General, Part 6 of 7

SectionName	MMod	WMod	SectInFile	FileName	GUID
C150X12	1.000000	1.000000	C150X12	c:\program files (x86)\computers and structures\sap2000 16\cisc10.pro	
FSEC1	1.000000	1.000000			
L76X76X6.4	1.000000	1.000000	L76X76X6.4	c:\program files (x86)\computers and structures\sap2000 16\cisc10.pro	
W100X19	1.000000	1.000000	W100X19	c:\program files (x86)\computers and structures\sap2000 16\cisc10.pro	
W150X22	1.000000	1.000000	W150X22	c:\program files (x86)\computers and structures\sap2000 16\cisc10.pro	
W250X33	1.000000	1.000000	W250X33	c:\program files (x86)\computers and structures\sap2000 16\cisc10.pro	

Table 10: Frame Section Properties 01 - General, Part 7 of 7

Table 10: Frame Section Properties 01 - General, Part 7 of 7

SectionName	Notes
C150X12	Imported 30/09/2014 12:33:38 AM from CISC10.pro
FSEC1	Added 30/09/2014 12:29:29 AM
L76X76X6.4	Imported 30/09/2014 12:34:12 AM from CISC10.pro
W100X19	Imported 30/09/2014 12:33:01 AM from CISC10.pro
W150X22	Imported 30/09/2014 12:32:36 AM from CISC10.pro
W250X33	Imported 30/09/2014 12:31:57 AM from CISC10.pro

3.2. Areas

Table 11: Area Section Properties, Part 1 of 4

Table 11: Area Section Properties, Part 1 of 4

Section	Material	MatAngle Degrees	AreaType	Type	DrillDOF	Thickness m	BendThick m	Arc Degrees
Floor	A992Fy50	0.000	Shell	Shell-Thin	Yes	0.100000	0.100000	
Panel	A992Fy50	0.000	Shell	Shell-Thin	Yes	0.100000	0.100000	

Table 11: Area Section Properties, Part 2 of 4

Table 11: Area Section Properties, Part 2 of 4

Section	InComp	CoordSys	Color	TotalWt KN	TotalMass KN-s2/m	F11Mod	F22Mod
Floor			16744703	0.000	0.00	1.000000	1.000000
Panel			8388863	0.000	0.00	1.000000	1.000000

Table 11: Area Section Properties, Part 3 of 4

Table 11: Area Section Properties, Part 3 of 4

Section	F12Mod	M11Mod	M22Mod	M12Mod	V13Mod	V23Mod	MMod	WMod
Floor	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	0.000000	0.000000
Panel	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	0.000000	0.000000

Table 11: Area Section Properties, Part 4 of 4

Table 11: Area Section Properties, Part 4 of 4

Section	GUID	Notes
Floor		Added 30/09/2014 2:36:34 PM
Panel		Added 30/09/2014 2:37:01 PM

4. Load patterns

This section provides loading information as applied to the model.

4.1. Definitions

Table 12: Load Pattern Definitions

LoadPat	DesignType	SelfWtMult	AutoLoad	GUID	Notes
DEAD	DEAD	1.000000			
Checker Plate	DEAD	0.000000			
misc.	DEAD	0.000000			
pipng	DEAD	0.000000			
pipng support	DEAD	0.000000			
Live	LIVE	0.000000			
wind	WIND	0.000000	None		
snow	SNOW	0.000000			
building load	SNOW	0.000000			

5. Load cases

This section provides load case information.

5.1. Definitions

Table 13: Load Case Definitions, Part 1 of 2

Case	Type	InitialCond	ModalCase	BaseCase	DesTypeOpt	DesignType	DesActOpt
DEAD	LinStatic	Zero			Prog Det	DEAD	Prog Det
Checker Plate	LinStatic	Zero			Prog Det	DEAD	Prog Det
misc.	LinStatic	Zero			Prog Det	DEAD	Prog Det
pipng	LinStatic	Zero			Prog Det	DEAD	Prog Det
pipng support	LinStatic	Zero			Prog Det	DEAD	Prog Det
Live	LinStatic	Zero			Prog Det	LIVE	Prog Det
wind	LinStatic	Zero			Prog Det	WIND	Prog Det
snow	LinStatic	Zero			Prog Det	SNOW	Prog Det
building load	LinStatic	Zero			Prog Det	SNOW	Prog Det

Table 13: Load Case Definitions, Part 2 of 2

Table 13: Load Case Definitions, Part 2 of 2						
Case	DesignAct	AutoType	RunCase	CaseStatus	GUID	Notes
DEAD	Non-Composite	None	Yes	Finished		
Checker Plate	Non-Composite	None	Yes	Finished		
misc.	Non-Composite	None	Yes	Finished		
pipng	Non-Composite	None	Yes	Finished		
pipng support	Non-Composite	None	Yes	Finished		
Live	Short-Term Composite	None	Yes	Finished		
wind	Short-Term Composite	None	Yes	Finished		
snow	Short-Term Composite	None	Yes	Finished		
building load	Short-Term Composite	None	Yes	Finished		

5.2. Static case load assignments

Table 14: Case - Static 1 - Load Assignments

Table 14: Case - Static 1 - Load Assignments			
Case	LoadType	LoadName	LoadSF
DEAD	Load pattern	DEAD	1.000000
Checker Plate	Load pattern	Checker Plate	1.000000
misc.	Load pattern	misc.	1.000000
pipng	Load pattern	pipng	1.000000
pipng support	Load pattern	pipng support	1.000000
Live	Load pattern	Live	1.000000
wind	Load pattern	wind	1.000000
snow	Load pattern	snow	1.000000
building load	Load pattern	building load	1.000000

5.3. Response spectrum case load assignments

Table 15: Function - Response Spectrum - User

Table 15: Function - Response Spectrum - User			
Name	Period Sec	Accel	FuncDamp
UNIFRS	0.000000	1.000000	0.050000
UNIFRS	1.000000	1.000000	

6. Load combinations

This section provides load combination information.

Table 16: Combination Definitions, Part 1 of 3

Table 16: Combination Definitions, Part 1 of 3						
ComboName	ComboType	AutoDesign	CaseType	CaseName	ScaleFactor	SteelDesign
COM1	Linear Add	No	Linear Static	building load	1.400000	None
COM1			Linear Static	Checker Plate	1.400000	
COM1			Linear Static	DEAD	1.400000	
COM1			Linear Static	misc.	1.400000	
COM1			Linear Static	pipng	1.400000	
COM1			Linear Static	pipng support	1.400000	
COM2	Linear Add	No	Linear Static	building load	1.250000	None
COM2			Linear Static	Checker Plate	1.250000	
COM2			Linear Static	DEAD	1.250000	
COM2			Linear Static	misc.	1.250000	
COM2			Linear Static	pipng	1.250000	
COM2			Linear Static	pipng support	1.250000	
COM2			Linear Static	Live	1.500000	
COM3	Linear Add	No	Linear Static	building load	1.250000	None
COM3			Linear Static	Checker Plate	1.250000	
COM3			Linear Static	DEAD	1.250000	
COM3			Linear Static	misc.	1.250000	
COM3			Linear Static	pipng	1.250000	
COM3			Linear Static	pipng support	1.250000	
COM3			Linear Static	snow	1.500000	
LIFTLUG	Linear Add	No	Linear Static	building load	1.000000	None
LIFTLUG			Linear Static	Checker Plate	1.000000	
LIFTLUG			Linear Static	DEAD	1.000000	
LIFTLUG			Linear Static	Live	1.000000	
LIFTLUG			Linear Static	misc.	1.000000	
LIFTLUG			Linear Static	pipng	1.000000	
LIFTLUG			Linear Static	pipng support	1.000000	

Table 16: Combination Definitions, Part 2 of 3

Table 16: Combination Definitions, Part 2 of 3					
ComboName	CaseName	ConcDesign	AlumDesign	ColdDesign	GUID
COM1	building load	None	None	None	
COM1	Checker Plate				
COM1	DEAD				
COM1	misc.				
COM1	pipng				
COM1	pipng support				
COM2	building load	None	None	None	
COM2	Checker Plate				
COM2	DEAD				
COM2	misc.				
COM2	pipng				
COM2	pipng support				
COM2	Live				

Table 16: Combination Definitions, Part 2 of 3

ComboName	CaseName	ConcDesign	AlumDesign	ColdDesign	GUID
COM3	building load	None	None	None	
COM3	Checker Plate				
COM3	DEAD				
COM3	misc.				
COM3	pipng				
COM3	pipng support				
COM3	snow				
LIFTLUG	building load	None	None	None	
LIFTLUG	Checker Plate				
LIFTLUG	DEAD				
LIFTLUG	Live				
LIFTLUG	misc.				
LIFTLUG	pipng				
LIFTLUG	pipng support				

Table 16: Combination Definitions, Part 3 of 3

Table 16: Combination Definitions, Part 3 of 3

ComboName	CaseName	Notes
COM1	building load	
COM1	Checker Plate	
COM1	DEAD	
COM1	misc.	
COM1	pipng	
COM1	pipng support	
COM2	building load	
COM2	Checker Plate	
COM2	DEAD	
COM2	misc.	
COM2	pipng	
COM2	pipng support	
COM2	Live	
COM3	building load	
COM3	Checker Plate	
COM3	DEAD	
COM3	misc.	
COM3	pipng	
COM3	pipng support	
COM3	snow	
LIFTLUG	building load	
LIFTLUG	Checker Plate	
LIFTLUG	DEAD	
LIFTLUG	Live	
LIFTLUG	misc.	
LIFTLUG	pipng	
LIFTLUG	pipng support	

7. Structure results

This section provides structure results, including items such as structural periods and base reactions.

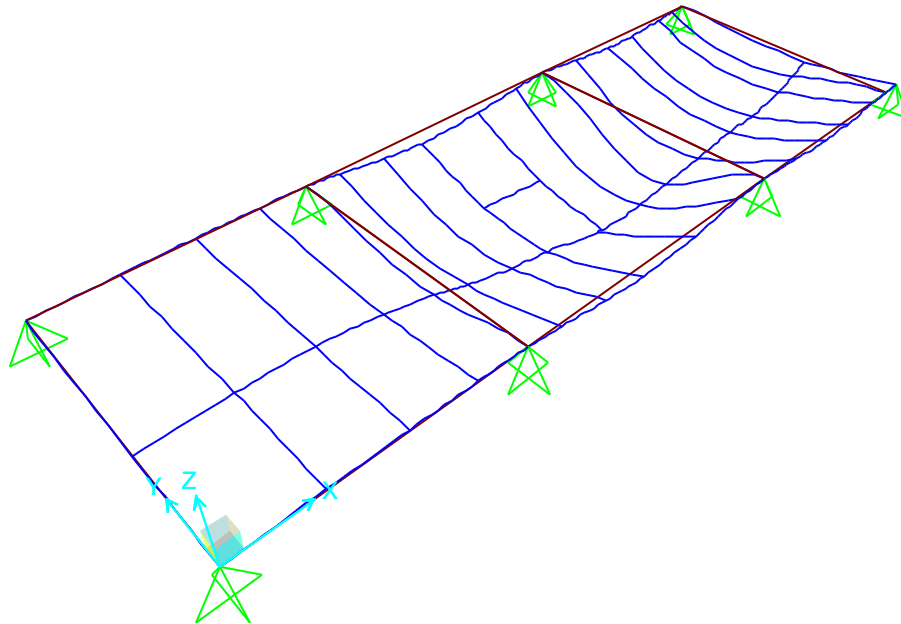


Figure 2: Deformed shape

7.1. Mass summary

Table 17: Assembled Joint Masses

Table 17: Assembled Joint Masses							
Joint	MassSource	U1	U2	U3	R1	R2	R3
		KN-s2/m	KN-s2/m	KN-s2/m	KN-m-s2	KN-m-s2	KN-m-s2
1	MSSSRC1	3.618E-02	3.618E-02	3.618E-02	0.0000	0.0000	0.0000
2	MSSSRC1	4.949E-02	4.949E-02	4.949E-02	0.0000	0.0000	0.0000
3	MSSSRC1	2.578E-02	2.578E-02	2.578E-02	0.0000	0.0000	0.0000
4	MSSSRC1	3.908E-02	3.908E-02	3.908E-02	0.0000	0.0000	0.0000
5	MSSSRC1	2.949E-02	2.949E-02	2.949E-02	0.0000	0.0000	0.0000
6	MSSSRC1	3.188E-02	3.188E-02	3.188E-02	0.0000	0.0000	0.0000
7	MSSSRC1	2.461E-02	2.461E-02	2.461E-02	0.0000	0.0000	0.0000
8	MSSSRC1	2.819E-02	2.819E-02	2.819E-02	0.0000	0.0000	0.0000
11	MSSSRC1	2.653E-02	2.653E-02	2.653E-02	0.0000	0.0000	0.0000
12	MSSSRC1	3.141E-02	3.141E-02	3.141E-02	0.0000	0.0000	0.0000
13	MSSSRC1	3.538E-02	3.538E-02	3.538E-02	0.0000	0.0000	0.0000
14	MSSSRC1	3.950E-02	3.950E-02	3.950E-02	0.0000	0.0000	0.0000
15	MSSSRC1	4.026E-02	4.026E-02	4.026E-02	0.0000	0.0000	0.0000
19	MSSSRC1	2.960E-02	2.960E-02	2.960E-02	0.0000	0.0000	0.0000
20	MSSSRC1	3.555E-02	3.555E-02	3.555E-02	0.0000	0.0000	0.0000
21	MSSSRC1	3.448E-02	3.448E-02	3.448E-02	0.0000	0.0000	0.0000
22	MSSSRC1	2.700E-02	2.700E-02	2.700E-02	0.0000	0.0000	0.0000

Table 17: Assembled Joint Masses

Joint	MassSource	U1	U2	U3	R1	R2	R3
		KN-s2/m	KN-s2/m	KN-s2/m	KN-m-s2	KN-m-s2	KN-m-s2
23	MSSSRC1	3.378E-02	3.378E-02	3.378E-02	0.0000	0.0000	0.0000
24	MSSSRC1	3.188E-02	3.188E-02	3.188E-02	0.0000	0.0000	0.0000
25	MSSSRC1	3.202E-02	3.202E-02	3.202E-02	0.0000	0.0000	0.0000
26	MSSSRC1	5.043E-02	5.043E-02	5.043E-02	0.0000	0.0000	0.0000
27	MSSSRC1	4.112E-02	4.112E-02	4.112E-02	0.0000	0.0000	0.0000
31	MSSSRC1	1.990E-02	1.990E-02	1.990E-02	0.0000	0.0000	0.0000
32	MSSSRC1	3.872E-02	3.872E-02	3.872E-02	0.0000	0.0000	0.0000
33	MSSSRC1	3.415E-02	3.415E-02	3.415E-02	0.0000	0.0000	0.0000
34	MSSSRC1	1.813E-02	1.813E-02	1.813E-02	0.0000	0.0000	0.0000
37	MSSSRC1	4.512E-02	4.512E-02	4.512E-02	0.0000	0.0000	0.0000
38	MSSSRC1	3.407E-02	3.407E-02	3.407E-02	0.0000	0.0000	0.0000
39	MSSSRC1	2.209E-02	2.209E-02	2.209E-02	0.0000	0.0000	0.0000
40	MSSSRC1	3.994E-02	3.994E-02	3.994E-02	0.0000	0.0000	0.0000
41	MSSSRC1	3.000E-02	3.000E-02	3.000E-02	0.0000	0.0000	0.0000
57	MSSSRC1	3.378E-02	3.378E-02	3.378E-02	0.0000	0.0000	0.0000
64	MSSSRC1	2.615E-02	2.615E-02	2.615E-02	0.0000	0.0000	0.0000
65	MSSSRC1	3.319E-02	3.319E-02	3.319E-02	0.0000	0.0000	0.0000
66	MSSSRC1	3.103E-02	3.103E-02	3.103E-02	0.0000	0.0000	0.0000
67	MSSSRC1	2.297E-02	2.297E-02	2.297E-02	0.0000	0.0000	0.0000
68	MSSSRC1	3.102E-02	3.102E-02	3.102E-02	0.0000	0.0000	0.0000
69	MSSSRC1	2.785E-02	2.785E-02	2.785E-02	0.0000	0.0000	0.0000
73	MSSSRC1	2.958E-02	2.958E-02	2.958E-02	0.0000	0.0000	0.0000
74	MSSSRC1	3.554E-02	3.554E-02	3.554E-02	0.0000	0.0000	0.0000
75	MSSSRC1	3.446E-02	3.446E-02	3.446E-02	0.0000	0.0000	0.0000
76	MSSSRC1	4.656E-02	4.656E-02	4.656E-02	0.0000	0.0000	0.0000
77	MSSSRC1	5.986E-02	5.986E-02	5.986E-02	0.0000	0.0000	0.0000
78	MSSSRC1	4.069E-02	4.069E-02	4.069E-02	0.0000	0.0000	0.0000
79	MSSSRC1	5.400E-02	5.400E-02	5.400E-02	0.0000	0.0000	0.0000
80	MSSSRC1	6.650E-02	6.650E-02	6.650E-02	0.0000	0.0000	0.0000
81	MSSSRC1	7.359E-02	7.359E-02	7.359E-02	0.0000	0.0000	0.0000
82	MSSSRC1	6.958E-02	6.958E-02	6.958E-02	0.0000	0.0000	0.0000
83	MSSSRC1	5.938E-02	5.938E-02	5.938E-02	0.0000	0.0000	0.0000
84	MSSSRC1	4.424E-02	4.424E-02	4.424E-02	0.0000	0.0000	0.0000
85	MSSSRC1	4.211E-02	4.211E-02	4.211E-02	0.0000	0.0000	0.0000
86	MSSSRC1	5.370E-02	5.370E-02	5.370E-02	0.0000	0.0000	0.0000
87	MSSSRC1	3.214E-02	3.214E-02	3.214E-02	0.0000	0.0000	0.0000
88	MSSSRC1	3.346E-02	3.346E-02	3.346E-02	0.0000	0.0000	0.0000

7.2. Base reactions

Table 18: Base Reactions, Part 1 of 3

Table 18: Base Reactions, Part 1 of 3

OutputCase	CaseType	GlobalFX KN	GlobalFY KN	GlobalFZ KN	GlobalMX KN-m	GlobalMY KN-m	GlobalMZ KN-m	GlobalX m
COM1	Combination	0.000	0.000	273.168	471.4143	-1458.7929	0.0000	0.00000
COM2	Combination	0.000	0.000	837.690	1451.2261	-4137.4149	0.0000	0.00000
COM3	Combination	0.000	0.000	421.155	727.1137	-2159.9647	0.0000	0.00000
LIFTLUG	Combination	0.000	0.000	590.980	1023.6048	-2931.9424	0.0000	0.00000

Table 18: Base Reactions, Part 2 of 3

Table 18: Base Reactions, Part 2 of 3

OutputCase	GlobalY	GlobalZ	XCentroidF X	YCentroidF X	ZCentroidF X	XCentroidF Y	YCentroidF Y	ZCentroidF Y
	m	m	m	m	m	m	m	m
COM1	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
COM2	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
COM3	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LIFTLUG	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Table 18: Base Reactions, Part 3 of 3

Table 18: Base Reactions, Part 3 of 3

OutputCase	XCentroidF Z	YCentroidF Z	ZCentroidFZ
	m	m	m
COM1	5.34028	1.72573	0.00000
COM2	4.93908	1.73241	0.00000
COM3	5.12867	1.72648	0.00000
LIFTLUG	4.96115	1.73205	0.00000

8. Joint results

This section provides joint results, including items such as displacements and reactions.

Table 19: Joint Displacements

Table 19: Joint Displacements

Joint	OutputCase	CaseType	U1	U2	U3	R1	R2	R3
			m	m	m	Radians	Radians	Radians
1	COM1	Combination	0.000000	0.000000	0.000000	-0.000233	0.000054	0.000000
1	COM2	Combination	0.000000	0.000000	0.000000	-0.000826	0.000244	0.000000
1	COM3	Combination	0.000000	0.000000	0.000000	-0.000580	0.000101	0.000000
1	LIFTLUG	Combination	0.000000	0.000000	0.000000	-0.000578	0.000169	0.000000
2	COM1	Combination	0.000000	0.000000	0.000000	0.000223	0.000062	0.000000
2	COM2	Combination	0.000000	0.000000	0.000000	0.000760	0.000333	0.000000
2	COM3	Combination	0.000000	0.000000	0.000000	0.000569	0.000106	0.000000
2	LIFTLUG	Combination	0.000000	0.000000	0.000000	0.000533	0.000229	0.000000
3	COM1	Combination	0.000000	0.000000	0.000000	-0.000845	-0.000245	0.000000
3	COM2	Combination	0.000000	0.000000	0.000000	-0.001591	-0.000668	0.000000
3	COM3	Combination	0.000000	0.000000	0.000000	-0.001466	-0.000344	0.000000
3	LIFTLUG	Combination	0.000000	0.000000	0.000000	-0.001161	-0.000475	0.000000
4	COM1	Combination	0.000000	0.000000	0.000000	0.000342	-0.000136	0.000000
4	COM2	Combination	0.000000	0.000000	0.000000	0.000513	-0.000435	0.000000
4	COM3	Combination	0.000000	0.000000	0.000000	0.000676	-0.000151	0.000000
4	LIFTLUG	Combination	0.000000	0.000000	0.000000	0.000383	-0.000306	0.000000
5	COM1	Combination	0.000000	0.000000	0.000000	0.000098	0.000068	0.000000
5	COM2	Combination	0.000000	0.000000	0.000000	0.000453	0.000117	0.000000
5	COM3	Combination	0.000000	0.000000	0.000000	0.000052	0.000074	0.000000
5	LIFTLUG	Combination	0.000000	0.000000	0.000000	0.000314	0.000086	0.000000
6	COM1	Combination	0.000000	0.000000	-0.000204	0.003416	-0.000460	0.000000
6	COM2	Combination	0.000000	0.000000	-0.000631	0.012713	-0.001428	0.000000
6	COM3	Combination	0.000000	0.000000	-0.000294	0.003074	-0.000651	0.000000

Table 19: Joint Displacements

Joint	OutputCase	CaseType	U1 m	U2 m	U3 m	R1 Radians	R2 Radians	R3 Radians
6	LIFTLUG	Combination	0.000000	0.000000	-0.000445	0.008882	-0.001007	0.000000
7	COM1	Combination	0.000000	0.000000	0.000000	-0.000092	0.000066	0.000000
7	COM2	Combination	0.000000	0.000000	0.000000	-0.000444	0.000150	0.000000
7	COM3	Combination	0.000000	0.000000	0.000000	-0.000035	0.000065	0.000000
7	LIFTLUG	Combination	0.000000	0.000000	0.000000	-0.000307	0.000108	0.000000
8	COM1	Combination	0.000000	0.000000	-0.000185	-0.003011	-0.000433	0.000000
8	COM2	Combination	0.000000	0.000000	-0.000575	-0.011303	-0.001358	0.000000
8	COM3	Combination	0.000000	0.000000	-0.000268	-0.002722	-0.000612	0.000000
8	LIFTLUG	Combination	0.000000	0.000000	-0.000405	-0.007894	-0.000957	0.000000
11	COM1	Combination	0.000000	0.000000	0.000000	-0.000260	0.000024	0.000000
11	COM2	Combination	0.000000	0.000000	0.000000	-0.000969	0.000049	0.000000
11	COM3	Combination	0.000000	0.000000	0.000000	-0.000238	0.000026	0.000000
11	LIFTLUG	Combination	0.000000	0.000000	0.000000	-0.000677	0.000036	0.000000
12	COM1	Combination	0.000000	0.000000	0.000000	0.000190	-1.994E-06	0.000000
12	COM2	Combination	0.000000	0.000000	0.000000	0.000789	-7.229E-06	0.000000
12	COM3	Combination	0.000000	0.000000	0.000000	0.000127	-0.000014	0.000000
12	LIFTLUG	Combination	0.000000	0.000000	0.000000	0.000548	-5.056E-06	0.000000
13	COM1	Combination	0.000000	0.000000	-0.000210	-0.000848	0.000187	0.000000
13	COM2	Combination	0.000000	0.000000	-0.000841	-0.004852	0.000786	0.000000
13	COM3	Combination	0.000000	0.000000	-0.000363	-0.000927	0.000304	0.000000
13	LIFTLUG	Combination	0.000000	0.000000	-0.000586	-0.003335	0.000546	0.000000
14	COM1	Combination	0.000000	0.000000	-0.001055	-0.000491	0.000481	0.000000
14	COM2	Combination	0.000000	0.000000	-0.005653	-0.002982	0.002875	0.000000
14	COM3	Combination	0.000000	0.000000	-0.001302	-0.000487	0.000188	0.000000
14	LIFTLUG	Combination	0.000000	0.000000	-0.003894	-0.002046	0.001974	0.000000
15	COM1	Combination	0.000000	0.000000	-0.000218	0.001352	0.000184	0.000000
15	COM2	Combination	0.000000	0.000000	-0.000936	0.008135	0.000803	0.000000
15	COM3	Combination	0.000000	0.000000	-0.000368	0.001354	0.000299	0.000000
15	LIFTLUG	Combination	0.000000	0.000000	-0.000650	0.005584	0.000557	0.000000
19	COM1	Combination	0.000000	0.000000	-0.000118	-0.001491	-0.000204	0.000000
19	COM2	Combination	0.000000	0.000000	-0.000501	-0.007087	-0.000861	0.000000
19	COM3	Combination	0.000000	0.000000	-0.000206	-0.001348	-0.000340	0.000000
19	LIFTLUG	Combination	0.000000	0.000000	-0.000348	-0.004902	-0.000598	0.000000
20	COM1	Combination	0.000000	0.000000	-0.001622	-0.000657	0.000445	0.000000
20	COM2	Combination	0.000000	0.000000	-0.007669	-0.003328	0.000821	0.000000
20	COM3	Combination	0.000000	0.000000	-0.001563	-0.000591	0.000335	0.000000
20	LIFTLUG	Combination	0.000000	0.000000	-0.005306	-0.002297	0.000600	0.000000
21	COM1	Combination	0.000000	0.000000	-0.000119	0.001844	-0.000202	0.000000
21	COM2	Combination	0.000000	0.000000	-0.000538	0.009274	-0.000894	0.000000
21	COM3	Combination	0.000000	0.000000	-0.000204	0.001662	-0.000335	0.000000
21	LIFTLUG	Combination	0.000000	0.000000	-0.000373	0.006402	-0.000620	0.000000
22	COM1	Combination	0.000000	0.000000	-0.000635	-0.001818	0.000519	0.000000
22	COM2	Combination	0.000000	0.000000	-0.001995	-0.007011	0.001666	0.000000
22	COM3	Combination	0.000000	0.000000	-0.000849	-0.001577	0.000696	0.000000
22	LIFTLUG	Combination	0.000000	0.000000	-0.001405	-0.004890	0.001173	0.000000
23	COM1	Combination	0.000000	0.000000	-0.002478	-0.000864	0.000433	0.000000
23	COM2	Combination	0.000000	0.000000	-0.009107	-0.003257	0.001129	0.000000
23	COM3	Combination	0.000000	0.000000	-0.002451	-0.000761	0.000509	0.000000
23	LIFTLUG	Combination	0.000000	0.000000	-0.006366	-0.002274	0.000804	0.000000
24	COM1	Combination	0.000000	0.000000	-0.000640	0.002422	0.000516	0.000000
24	COM2	Combination	0.000000	0.000000	-0.001972	0.009196	0.001636	0.000000
24	COM3	Combination	0.000000	0.000000	-0.000867	0.002116	0.000705	0.000000
24	LIFTLUG	Combination	0.000000	0.000000	-0.001391	0.006419	0.001152	0.000000
25	COM1	Combination	0.000000	0.000000	-0.000213	-0.001865	0.000495	0.000000

Table 19: Joint Displacements

Joint	OutputCase	CaseType	U1 m	U2 m	U3 m	R1 Radians	R2 Radians	R3 Radians
25	COM2	Combination	0.000000	0.000000	-0.000655	-0.007422	0.001542	0.000000
25	COM3	Combination	0.000000	0.000000	-0.000283	-0.001719	0.000658	0.000000
25	LIFTLUG	Combination	0.000000	0.000000	-0.000462	-0.005170	0.001087	0.000000
26	COM1	Combination	0.000000	0.000000	-0.002146	-0.000697	0.000591	0.000000
26	COM2	Combination	0.000000	0.000000	-0.008364	-0.002675	0.001120	0.000000
26	COM3	Combination	0.000000	0.000000	-0.002066	-0.000639	0.000646	0.000000
26	LIFTLUG	Combination	0.000000	0.000000	-0.005831	-0.001866	0.000817	0.000000
27	COM1	Combination	0.000000	0.000000	-0.000217	0.001987	0.000499	0.000000
27	COM2	Combination	0.000000	0.000000	-0.000649	0.007674	0.001518	0.000000
27	COM3	Combination	0.000000	0.000000	-0.000291	0.001817	0.000674	0.000000
27	LIFTLUG	Combination	0.000000	0.000000	-0.000458	0.005352	0.001071	0.000000
31	COM1	Combination	0.000000	0.000000	-0.003330	0.000505	0.000336	0.000000
31	COM2	Combination	0.000000	0.000000	-0.012342	0.001677	0.001391	0.000000
31	COM3	Combination	0.000000	0.000000	-0.003200	0.000405	0.000182	0.000000
31	LIFTLUG	Combination	0.000000	0.000000	-0.008624	0.001178	0.000967	0.000000
32	COM1	Combination	0.000000	0.000000	-0.000638	0.002004	-0.000482	0.000000
32	COM2	Combination	0.000000	0.000000	-0.001986	0.007974	-0.001508	0.000000
32	COM3	Combination	0.000000	0.000000	-0.000897	0.001741	-0.000652	0.000000
32	LIFTLUG	Combination	0.000000	0.000000	-0.001400	0.005555	-0.001063	0.000000
33	COM1	Combination	0.000000	0.000000	-0.000650	-0.002408	-0.000468	0.000000
33	COM2	Combination	0.000000	0.000000	-0.002042	-0.009450	-0.001493	0.000000
33	COM3	Combination	0.000000	0.000000	-0.000909	-0.002081	-0.000613	0.000000
33	LIFTLUG	Combination	0.000000	0.000000	-0.001439	-0.006587	-0.001051	0.000000
34	COM1	Combination	0.000000	0.000000	-0.003299	-0.001616	0.000429	0.000000
34	COM2	Combination	0.000000	0.000000	-0.012212	-0.005998	0.001762	0.000000
34	COM3	Combination	0.000000	0.000000	-0.003181	-0.001376	0.000269	0.000000
34	LIFTLUG	Combination	0.000000	0.000000	-0.008534	-0.004191	0.001226	0.000000
37	COM1	Combination	0.000000	0.000000	-0.002419	0.000874	0.000182	0.000000
37	COM2	Combination	0.000000	0.000000	-0.008721	0.003391	0.001021	0.000000
37	COM3	Combination	0.000000	0.000000	-0.002474	0.000724	0.000118	0.000000
37	LIFTLUG	Combination	0.000000	0.000000	-0.006102	0.002365	0.000703	0.000000
38	COM1	Combination	0.000000	0.000000	-0.002581	0.001211	0.000173	0.000000
38	COM2	Combination	0.000000	0.000000	-0.009648	0.004639	0.001012	0.000000
38	COM3	Combination	0.000000	0.000000	-0.002578	0.001034	0.000110	0.000000
38	LIFTLUG	Combination	0.000000	0.000000	-0.006739	0.003237	0.000695	0.000000
39	COM1	Combination	0.000000	0.000000	-0.000090	-0.000126	-0.000193	0.000000
39	COM2	Combination	0.000000	0.000000	-0.000239	-0.000095	-0.000541	0.000000
39	COM3	Combination	0.000000	0.000000	-0.000130	-0.000264	-0.000265	0.000000
39	LIFTLUG	Combination	0.000000	0.000000	-0.000170	-0.000079	-0.000384	0.000000
40	COM1	Combination	0.000000	0.000000	-0.001308	-0.001021	-0.001472	0.000000
40	COM2	Combination	0.000000	0.000000	-0.003227	-0.002506	-0.005570	0.000000
40	COM3	Combination	0.000000	0.000000	-0.001772	-0.001185	-0.000860	0.000000
40	LIFTLUG	Combination	0.000000	0.000000	-0.002307	-0.001792	-0.003889	0.000000
41	COM1	Combination	0.000000	0.000000	-0.000099	0.002055	-0.000310	0.000000
41	COM2	Combination	0.000000	0.000000	-0.000282	0.004860	-0.000915	0.000000
41	COM3	Combination	0.000000	0.000000	-0.000129	0.002353	-0.000397	0.000000
41	LIFTLUG	Combination	0.000000	0.000000	-0.000200	0.003485	-0.000647	0.000000
57	COM1	Combination	0.000000	0.000000	-0.003265	-0.001212	-0.000439	0.000000
57	COM2	Combination	0.000000	0.000000	-0.012107	-0.004480	-0.001724	0.000000
57	COM3	Combination	0.000000	0.000000	-0.003051	-0.001094	-0.000503	0.000000
57	LIFTLUG	Combination	0.000000	0.000000	-0.008460	-0.003131	-0.001202	0.000000
64	COM1	Combination	0.000000	0.000000	-0.000436	-0.001705	-0.000210	0.000000
64	COM2	Combination	0.000000	0.000000	-0.001243	-0.005516	-0.000644	0.000000
64	COM3	Combination	0.000000	0.000000	-0.000590	-0.001609	-0.000260	0.000000

Table 19: Joint Displacements

Joint	OutputCase	CaseType	U1	U2	U3	R1	R2	R3
			m	m	m	Radians	Radians	Radians
64	LIFTLUG	Combination	0.000000	0.000000	-0.000881	-0.003880	-0.000455	0.000000
65	COM1	Combination	0.000000	0.000000	-0.002170	-0.000837	-0.000407	0.000000
65	COM2	Combination	0.000000	0.000000	-0.006872	-0.002821	-0.002256	0.000000
65	COM3	Combination	0.000000	0.000000	-0.002218	-0.000772	-0.000113	0.000000
65	LIFTLUG	Combination	0.000000	0.000000	-0.004840	-0.001980	-0.001552	0.000000
66	COM1	Combination	0.000000	0.000000	-0.000480	0.002298	-0.000194	0.000000
66	COM2	Combination	0.000000	0.000000	-0.001408	0.007708	-0.000594	0.000000
66	COM3	Combination	0.000000	0.000000	-0.000631	0.002125	-0.000248	0.000000
66	LIFTLUG	Combination	0.000000	0.000000	-0.000996	0.005412	-0.000419	0.000000
67	COM1	Combination	0.000000	0.000000	-0.000208	-0.001475	-0.000310	0.000000
67	COM2	Combination	0.000000	0.000000	-0.000569	-0.004138	-0.000892	0.000000
67	COM3	Combination	0.000000	0.000000	-0.000292	-0.001682	-0.000418	0.000000
67	LIFTLUG	Combination	0.000000	0.000000	-0.000404	-0.002934	-0.000632	0.000000
68	COM1	Combination	0.000000	0.000000	-0.001735	-0.000766	-0.001123	0.000000
68	COM2	Combination	0.000000	0.000000	-0.004881	-0.002273	-0.004537	0.000000
68	COM3	Combination	0.000000	0.000000	-0.002020	-0.000792	-0.000618	0.000000
68	LIFTLUG	Combination	0.000000	0.000000	-0.003460	-0.001606	-0.003159	0.000000
69	COM1	Combination	0.000000	0.000000	-0.000245	0.002096	-0.000375	0.000000
69	COM2	Combination	0.000000	0.000000	-0.000707	0.006171	-0.001106	0.000000
69	COM3	Combination	0.000000	0.000000	-0.000323	0.002190	-0.000492	0.000000
69	LIFTLUG	Combination	0.000000	0.000000	-0.000501	0.004363	-0.000782	0.000000
73	COM1	Combination	0.000000	0.000000	-0.000256	-0.002302	0.000362	0.000000
73	COM2	Combination	0.000000	0.000000	-0.000740	-0.008433	0.001055	0.000000
73	COM3	Combination	0.000000	0.000000	-0.000342	-0.002041	0.000476	0.000000
73	LIFTLUG	Combination	0.000000	0.000000	-0.000524	-0.005896	0.000746	0.000000
74	COM1	Combination	0.000000	0.000000	-0.002628	-0.001018	-0.000534	0.000000
74	COM2	Combination	0.000000	0.000000	-0.009430	-0.003831	-0.002495	0.000000
74	COM3	Combination	0.000000	0.000000	-0.002447	-0.000903	-0.000410	0.000000
74	LIFTLUG	Combination	0.000000	0.000000	-0.006599	-0.002675	-0.001727	0.000000
75	COM1	Combination	0.000000	0.000000	-0.000261	0.002855	0.000376	0.000000
75	COM2	Combination	0.000000	0.000000	-0.000774	0.010709	0.001114	0.000000
75	COM3	Combination	0.000000	0.000000	-0.000343	0.002538	0.000488	0.000000
75	LIFTLUG	Combination	0.000000	0.000000	-0.000547	0.007479	0.000787	0.000000
76	COM1	Combination	0.000000	0.000000	-0.000290	-0.000920	-0.000072	0.000000
76	COM2	Combination	0.000000	0.000000	-0.001217	-0.005068	-0.000269	0.000000
76	COM3	Combination	0.000000	0.000000	-0.000477	-0.000807	-0.000123	0.000000
76	LIFTLUG	Combination	0.000000	0.000000	-0.000846	-0.003488	-0.000188	0.000000
77	COM1	Combination	0.000000	0.000000	-0.000287	0.000863	-0.000077	0.000000
77	COM2	Combination	0.000000	0.000000	-0.001258	0.004731	-0.000308	0.000000
77	COM3	Combination	0.000000	0.000000	-0.000471	0.000760	-0.000127	0.000000
77	LIFTLUG	Combination	0.000000	0.000000	-0.000873	0.003257	-0.000215	0.000000
78	COM1	Combination	0.000000	0.000000	-0.000493	-0.001632	0.000099	0.000000
78	COM2	Combination	0.000000	0.000000	-0.001437	-0.005709	0.000267	0.000000
78	COM3	Combination	0.000000	0.000000	-0.000648	-0.001430	0.000140	0.000000
78	LIFTLUG	Combination	0.000000	0.000000	-0.001016	-0.004000	0.000190	0.000000
79	COM1	Combination	0.000000	0.000000	-0.000511	0.001490	0.000131	0.000000
79	COM2	Combination	0.000000	0.000000	-0.001517	0.005203	0.000374	0.000000
79	COM3	Combination	0.000000	0.000000	-0.000664	0.001308	0.000172	0.000000
79	LIFTLUG	Combination	0.000000	0.000000	-0.001072	0.003646	0.000265	0.000000
80	COM1	Combination	0.000000	0.000000	-0.000415	-0.000143	0.000797	0.000000
80	COM2	Combination	0.000000	0.000000	-0.001537	-0.000506	0.005183	0.000000
80	COM3	Combination	0.000000	0.000000	-0.000974	-0.000344	0.000429	0.000000
80	LIFTLUG	Combination	0.000000	0.000000	-0.001074	-0.000355	0.003550	0.000000
81	COM1	Combination	0.000000	0.000000	-0.001287	-0.000296	0.000351	0.000000

Table 19: Joint Displacements

Joint	OutputCase	CaseType	U1	U2	U3	R1	R2	R3
			m	m	m	Radians	Radians	Radians
81	COM2	Combination	0.000000	0.000000	-0.006712	-0.001643	0.001172	0.000000
81	COM3	Combination	0.000000	0.000000	-0.001351	-0.000259	0.000153	0.000000
81	LIFTLUG	Combination	0.000000	0.000000	-0.004628	-0.001131	0.000823	0.000000
82	COM1	Combination	0.000000	0.000000	-0.002266	-0.000518	-0.000355	0.000000
82	COM2	Combination	0.000000	0.000000	-0.007644	-0.001816	-0.002085	0.000000
82	COM3	Combination	0.000000	0.000000	-0.002202	-0.000455	-0.000152	0.000000
82	LIFTLUG	Combination	0.000000	0.000000	-0.005366	-0.001273	-0.001432	0.000000
83	COM1	Combination	0.000000	0.000000	-0.000886	-0.000186	-0.001580	0.000000
83	COM2	Combination	0.000000	0.000000	-0.001677	-0.000310	-0.005871	0.000000
83	COM3	Combination	0.000000	0.000000	-0.001521	-0.000359	-0.000932	0.000000
83	LIFTLUG	Combination	0.000000	0.000000	-0.001223	-0.000229	-0.004102	0.000000
84	COM1	Combination	0.000000	0.000000	-0.000871	-0.001664	0.000133	0.000000
84	COM2	Combination	0.000000	0.000000	-0.002768	-0.006415	0.000423	0.000000
84	COM3	Combination	0.000000	0.000000	-0.001163	-0.001396	0.000204	0.000000
84	LIFTLUG	Combination	0.000000	0.000000	-0.001949	-0.004474	0.000298	0.000000
85	COM1	Combination	0.000000	0.000000	-0.000870	0.001536	0.000143	0.000000
85	COM2	Combination	0.000000	0.000000	-0.002718	0.005953	0.000463	0.000000
85	COM3	Combination	0.000000	0.000000	-0.001182	0.001285	0.000219	0.000000
85	LIFTLUG	Combination	0.000000	0.000000	-0.001916	0.004152	0.000326	0.000000
86	COM1	Combination	0.000000	0.000000	-0.002679	-0.000528	0.000577	0.000000
86	COM2	Combination	0.000000	0.000000	-0.009736	-0.002029	0.002138	0.000000
86	COM3	Combination	0.000000	0.000000	-0.002680	-0.000449	0.000542	0.000000
86	LIFTLUG	Combination	0.000000	0.000000	-0.006810	-0.001416	0.001494	0.000000
87	COM1	Combination	0.000000	0.000000	-0.001874	-0.000842	0.000520	0.000000
87	COM2	Combination	0.000000	0.000000	-0.007905	-0.003605	0.000667	0.000000
87	COM3	Combination	0.000000	0.000000	-0.001781	-0.000801	0.000513	0.000000
87	LIFTLUG	Combination	0.000000	0.000000	-0.005493	-0.002504	0.000507	0.000000
88	COM1	Combination	0.000000	0.000000	-0.002957	-0.001298	-0.000596	0.000000
88	COM2	Combination	0.000000	0.000000	-0.010888	-0.004777	-0.002451	0.000000
88	COM3	Combination	0.000000	0.000000	-0.002734	-0.001185	-0.000580	0.000000
88	LIFTLUG	Combination	0.000000	0.000000	-0.007611	-0.003339	-0.001705	0.000000

Table 20: Joint Reactions

Table 20: Joint Reactions

Joint	OutputCase	CaseType	F1	F2	F3	M1	M2	M3
			KN	KN	KN	KN-m	KN-m	KN-m
1	COM1	Combination	0.000	0.000	14.209	0.0000	0.0000	0.0000
1	COM2	Combination	0.000	0.000	49.227	0.0000	0.0000	0.0000
1	COM3	Combination	0.000	0.000	31.994	0.0000	0.0000	0.0000
1	LIFTLUG	Combination	0.000	0.000	34.510	0.0000	0.0000	0.0000
2	COM1	Combination	0.000	0.000	14.120	0.0000	0.0000	0.0000
2	COM2	Combination	0.000	0.000	49.112	0.0000	0.0000	0.0000
2	COM3	Combination	0.000	0.000	31.925	0.0000	0.0000	0.0000
2	LIFTLUG	Combination	0.000	0.000	34.422	0.0000	0.0000	0.0000
3	COM1	Combination	0.000	0.000	24.824	0.0000	0.0000	0.0000
3	COM2	Combination	0.000	0.000	54.148	0.0000	0.0000	0.0000
3	COM3	Combination	0.000	0.000	41.282	0.0000	0.0000	0.0000
3	LIFTLUG	Combination	0.000	0.000	39.054	0.0000	0.0000	0.0000
4	COM1	Combination	0.000	0.000	25.052	0.0000	0.0000	0.0000
4	COM2	Combination	0.000	0.000	56.879	0.0000	0.0000	0.0000
4	COM3	Combination	0.000	0.000	41.678	0.0000	0.0000	0.0000

Table 20: Joint Reactions

Joint	OutputCase	CaseType	F1 KN	F2 KN	F3 KN	M1 KN-m	M2 KN-m	M3 KN-m
4	LIFTLUG	Combination	0.000	0.000	40.902	0.0000	0.0000	0.0000
5	COM1	Combination	0.000	0.000	44.086	0.0000	0.0000	0.0000
5	COM2	Combination	0.000	0.000	153.640	0.0000	0.0000	0.0000
5	COM3	Combination	0.000	0.000	64.289	0.0000	0.0000	0.0000
5	LIFTLUG	Combination	0.000	0.000	107.675	0.0000	0.0000	0.0000
7	COM1	Combination	0.000	0.000	44.411	0.0000	0.0000	0.0000
7	COM2	Combination	0.000	0.000	154.154	0.0000	0.0000	0.0000
7	COM3	Combination	0.000	0.000	64.581	0.0000	0.0000	0.0000
7	LIFTLUG	Combination	0.000	0.000	108.056	0.0000	0.0000	0.0000
11	COM1	Combination	0.000	0.000	53.280	0.0000	0.0000	0.0000
11	COM2	Combination	0.000	0.000	160.124	0.0000	0.0000	0.0000
11	COM3	Combination	0.000	0.000	72.846	0.0000	0.0000	0.0000
11	LIFTLUG	Combination	0.000	0.000	113.093	0.0000	0.0000	0.0000
12	COM1	Combination	0.000	0.000	53.186	0.0000	0.0000	0.0000
12	COM2	Combination	0.000	0.000	160.406	0.0000	0.0000	0.0000
12	COM3	Combination	0.000	0.000	72.561	0.0000	0.0000	0.0000
12	LIFTLUG	Combination	0.000	0.000	113.269	0.0000	0.0000	0.0000

9. Frame results

This section provides frame force results.

Table 21: Element Forces - Frames, Part 1 of 2

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
1	0.00000	COM1	Combination	0.000	-8.007	0.000	0.0043	0.0000
1	0.44033	COM1	Combination	0.000	-6.301	0.000	0.0043	0.0000
1	0.88067	COM1	Combination	0.000	-4.596	0.000	0.0043	0.0000
1	1.32100	COM1	Combination	0.000	-2.891	0.000	0.0043	0.0000
1	1.32100	COM1	Combination	0.000	-0.851	0.000	-0.0026	0.0000
1	1.74780	COM1	Combination	0.000	0.802	0.000	-0.0026	0.0000
1	2.17460	COM1	Combination	0.000	2.455	0.000	-0.0026	0.0000
1	2.60140	COM1	Combination	0.000	4.108	0.000	-0.0026	0.0000
1	3.02820	COM1	Combination	0.000	5.760	0.000	-0.0026	0.0000
1	3.45500	COM1	Combination	0.000	7.413	0.000	-0.0026	0.0000
1	0.00000	COM2	Combination	0.000	-29.062	0.000	0.0283	0.0000
1	0.44033	COM2	Combination	0.000	-24.013	0.000	0.0283	0.0000
1	0.88067	COM2	Combination	0.000	-18.963	0.000	0.0283	0.0000
1	1.32100	COM2	Combination	0.000	-13.914	0.000	0.0283	0.0000
1	1.32100	COM2	Combination	0.000	0.368	0.000	-0.0172	0.0000
1	1.74780	COM2	Combination	0.000	5.263	0.000	-0.0172	0.0000
1	2.17460	COM2	Combination	0.000	10.157	0.000	-0.0172	0.0000
1	2.60140	COM2	Combination	0.000	15.051	0.000	-0.0172	0.0000
1	3.02820	COM2	Combination	0.000	19.946	0.000	-0.0172	0.0000
1	3.45500	COM2	Combination	0.000	24.840	0.000	-0.0172	0.0000
1	0.00000	COM3	Combination	0.000	-18.622	0.000	0.0019	0.0000
1	0.44033	COM3	Combination	0.000	-14.128	0.000	0.0019	0.0000
1	0.88067	COM3	Combination	0.000	-9.633	0.000	0.0019	0.0000
1	1.32100	COM3	Combination	0.000	-5.138	0.000	0.0019	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
1	1.32100	COM3	Combination	0.000	-3.579	0.000	-0.0011	0.0000
1	1.74780	COM3	Combination	0.000	0.778	0.000	-0.0011	0.0000
1	2.17460	COM3	Combination	0.000	5.134	0.000	-0.0011	0.0000
1	2.60140	COM3	Combination	0.000	9.491	0.000	-0.0011	0.0000
1	3.02820	COM3	Combination	0.000	13.847	0.000	-0.0011	0.0000
1	3.45500	COM3	Combination	0.000	18.204	0.000	-0.0011	0.0000
1	0.00000	LIFTLUG	Combination	0.000	-20.328	0.000	0.0194	0.0000
1	0.44033	LIFTLUG	Combination	0.000	-16.759	0.000	0.0194	0.0000
1	0.88067	LIFTLUG	Combination	0.000	-13.189	0.000	0.0194	0.0000
1	1.32100	LIFTLUG	Combination	0.000	-9.620	0.000	0.0194	0.0000
1	1.32100	LIFTLUG	Combination	0.000	0.144	0.000	-0.0118	0.0000
1	1.74780	LIFTLUG	Combination	0.000	3.604	0.000	-0.0118	0.0000
1	2.17460	LIFTLUG	Combination	0.000	7.064	0.000	-0.0118	0.0000
1	2.60140	LIFTLUG	Combination	0.000	10.523	0.000	-0.0118	0.0000
1	3.02820	LIFTLUG	Combination	0.000	13.983	0.000	-0.0118	0.0000
1	3.45500	LIFTLUG	Combination	0.000	17.443	0.000	-0.0118	0.0000
2	0.00000	COM1	Combination	0.000	-8.839	0.000	-0.0077	0.0000
2	0.44033	COM1	Combination	0.000	-7.409	0.000	-0.0077	0.0000
2	0.88067	COM1	Combination	0.000	-5.978	0.000	-0.0077	0.0000
2	1.32100	COM1	Combination	0.000	-4.547	0.000	-0.0077	0.0000
2	1.32100	COM1	Combination	0.000	3.697	0.000	0.0051	0.0000
2	1.74780	COM1	Combination	0.000	5.084	0.000	0.0051	0.0000
2	2.17460	COM1	Combination	0.000	6.471	0.000	0.0051	0.0000
2	2.60140	COM1	Combination	0.000	7.858	0.000	0.0051	0.0000
2	3.02820	COM1	Combination	0.000	9.245	0.000	0.0051	0.0000
2	3.45500	COM1	Combination	0.000	10.632	0.000	0.0051	0.0000
2	0.00000	COM2	Combination	0.000	-15.691	0.000	-0.0298	0.0000
2	0.44033	COM2	Combination	0.000	-14.414	0.000	-0.0298	0.0000
2	0.88067	COM2	Combination	0.000	-13.136	0.000	-0.0298	0.0000
2	1.32100	COM2	Combination	0.000	-11.859	0.000	-0.0298	0.0000
2	1.32100	COM2	Combination	0.000	11.438	0.000	0.0193	0.0000
2	1.74780	COM2	Combination	0.000	12.676	0.000	0.0193	0.0000
2	2.17460	COM2	Combination	0.000	13.914	0.000	0.0193	0.0000
2	2.60140	COM2	Combination	0.000	15.153	0.000	0.0193	0.0000
2	3.02820	COM2	Combination	0.000	16.391	0.000	0.0193	0.0000
2	3.45500	COM2	Combination	0.000	17.629	0.000	0.0193	0.0000
2	0.00000	COM3	Combination	0.000	-16.712	0.000	-0.0034	0.0000
2	0.44033	COM3	Combination	0.000	-12.463	0.000	-0.0034	0.0000
2	0.88067	COM3	Combination	0.000	-8.213	0.000	-0.0034	0.0000
2	1.32100	COM3	Combination	0.000	-3.963	0.000	-0.0034	0.0000
2	1.32100	COM3	Combination	0.000	1.466	0.000	0.0028	0.0000
2	1.74780	COM3	Combination	0.000	5.585	0.000	0.0028	0.0000
2	2.17460	COM3	Combination	0.000	9.705	0.000	0.0028	0.0000
2	2.60140	COM3	Combination	0.000	13.824	0.000	0.0028	0.0000
2	3.02820	COM3	Combination	0.000	17.943	0.000	0.0028	0.0000
2	3.45500	COM3	Combination	0.000	22.062	0.000	0.0028	0.0000
2	0.00000	LIFTLUG	Combination	0.000	-11.513	0.000	-0.0208	0.0000
2	0.44033	LIFTLUG	Combination	0.000	-10.491	0.000	-0.0208	0.0000
2	0.88067	LIFTLUG	Combination	0.000	-9.469	0.000	-0.0208	0.0000
2	1.32100	LIFTLUG	Combination	0.000	-8.447	0.000	-0.0208	0.0000
2	1.32100	LIFTLUG	Combination	0.000	8.065	0.000	0.0135	0.0000
2	1.74780	LIFTLUG	Combination	0.000	9.056	0.000	0.0135	0.0000
2	2.17460	LIFTLUG	Combination	0.000	10.047	0.000	0.0135	0.0000
2	2.60140	LIFTLUG	Combination	0.000	11.037	0.000	0.0135	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
2	3.02820	LIFTLUG	Combination	0.000	12.028	0.000	0.0135	0.0000
2	3.45500	LIFTLUG	Combination	0.000	13.018	0.000	0.0135	0.0000
3	0.00000	COM1	Combination	0.000	-9.558	0.000	0.0096	0.0000
3	0.44500	COM1	Combination	0.000	-8.112	0.000	0.0096	0.0000
3	0.89000	COM1	Combination	0.000	-6.666	0.000	0.0096	0.0000
3	0.89000	COM1	Combination	0.000	-3.837	0.000	-0.0047	0.0000
3	1.28350	COM1	Combination	0.000	-2.559	0.000	-0.0047	0.0000
3	1.67700	COM1	Combination	0.000	-1.280	0.000	-0.0047	0.0000
3	1.67700	COM1	Combination	0.000	5.758	0.000	0.0101	0.0000
3	2.04550	COM1	Combination	0.000	6.955	0.000	0.0101	0.0000
3	2.41400	COM1	Combination	0.000	8.153	0.000	0.0101	0.0000
3	2.41400	COM1	Combination	0.000	11.132	0.000	-0.0225	0.0000
3	2.70750	COM1	Combination	0.000	12.086	0.000	-0.0225	0.0000
3	3.00100	COM1	Combination	0.000	13.040	0.000	-0.0225	0.0000
3	0.00000	COM2	Combination	0.000	-33.495	0.000	0.0628	0.0000
3	0.44500	COM2	Combination	0.000	-32.204	0.000	0.0628	0.0000
3	0.89000	COM2	Combination	0.000	-30.913	0.000	0.0628	0.0000
3	0.89000	COM2	Combination	0.000	-13.115	0.000	-0.0328	0.0000
3	1.28350	COM2	Combination	0.000	-11.974	0.000	-0.0328	0.0000
3	1.67700	COM2	Combination	0.000	-10.832	0.000	-0.0328	0.0000
3	1.67700	COM2	Combination	0.000	28.071	0.000	0.0467	0.0000
3	2.04550	COM2	Combination	0.000	29.140	0.000	0.0467	0.0000
3	2.41400	COM2	Combination	0.000	30.210	0.000	0.0467	0.0000
3	2.41400	COM2	Combination	0.000	46.351	0.000	-0.1138	0.0000
3	2.70750	COM2	Combination	0.000	47.202	0.000	-0.1138	0.0000
3	3.00100	COM2	Combination	0.000	48.054	0.000	-0.1138	0.0000
3	0.00000	COM3	Combination	0.000	-18.335	0.000	0.0067	0.0000
3	0.44500	COM3	Combination	0.000	-14.040	0.000	0.0067	0.0000
3	0.89000	COM3	Combination	0.000	-9.746	0.000	0.0067	0.0000
3	0.89000	COM3	Combination	0.000	-7.128	0.000	-0.0057	0.0000
3	1.28350	COM3	Combination	0.000	-3.330	0.000	-0.0057	0.0000
3	1.67700	COM3	Combination	0.000	0.467	0.000	-0.0057	0.0000
3	1.67700	COM3	Combination	0.000	6.683	0.000	0.0093	0.0000
3	2.04550	COM3	Combination	0.000	10.240	0.000	0.0093	0.0000
3	2.41400	COM3	Combination	0.000	13.796	0.000	0.0093	0.0000
3	2.41400	COM3	Combination	0.000	16.467	0.000	-0.0208	0.0000
3	2.70750	COM3	Combination	0.000	19.300	0.000	-0.0208	0.0000
3	3.00100	COM3	Combination	0.000	22.132	0.000	-0.0208	0.0000
3	0.00000	LIFTLUG	Combination	0.000	-23.468	0.000	0.0430	0.0000
3	0.44500	LIFTLUG	Combination	0.000	-22.435	0.000	0.0430	0.0000
3	0.89000	LIFTLUG	Combination	0.000	-21.402	0.000	0.0430	0.0000
3	0.89000	LIFTLUG	Combination	0.000	-9.200	0.000	-0.0224	0.0000
3	1.28350	LIFTLUG	Combination	0.000	-8.287	0.000	-0.0224	0.0000
3	1.67700	LIFTLUG	Combination	0.000	-7.374	0.000	-0.0224	0.0000
3	1.67700	LIFTLUG	Combination	0.000	19.400	0.000	0.0323	0.0000
3	2.04550	LIFTLUG	Combination	0.000	20.255	0.000	0.0323	0.0000
3	2.41400	LIFTLUG	Combination	0.000	21.110	0.000	0.0323	0.0000
3	2.41400	LIFTLUG	Combination	0.000	32.226	0.000	-0.0786	0.0000
3	2.70750	LIFTLUG	Combination	0.000	32.907	0.000	-0.0786	0.0000
3	3.00100	LIFTLUG	Combination	0.000	33.588	0.000	-0.0786	0.0000
7	0.00000	COM1	Combination	0.000	-9.123	0.000	-0.0052	0.0000
7	0.44500	COM1	Combination	0.000	-7.677	0.000	-0.0052	0.0000
7	0.89000	COM1	Combination	0.000	-6.231	0.000	-0.0052	0.0000
7	0.89000	COM1	Combination	0.000	-4.579	0.000	-6.915E-04	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
7	1.28350	COM1	Combination	0.000	-3.300	0.000	-6.915E-04	0.0000
7	1.67700	COM1	Combination	0.000	-2.021	0.000	-6.915E-04	0.0000
7	1.67700	COM1	Combination	0.000	6.253	0.000	-0.0059	0.0000
7	2.04550	COM1	Combination	0.000	7.450	0.000	-0.0059	0.0000
7	2.41400	COM1	Combination	0.000	8.648	0.000	-0.0059	0.0000
7	2.41400	COM1	Combination	0.000	10.806	0.000	0.0181	0.0000
7	2.70750	COM1	Combination	0.000	11.760	0.000	0.0181	0.0000
7	3.00100	COM1	Combination	0.000	12.713	0.000	0.0181	0.0000
7	0.00000	COM2	Combination	0.000	-29.984	0.000	-0.0343	0.0000
7	0.44500	COM2	Combination	0.000	-28.693	0.000	-0.0343	0.0000
7	0.89000	COM2	Combination	0.000	-27.401	0.000	-0.0343	0.0000
7	0.89000	COM2	Combination	0.000	-17.334	0.000	-0.0021	0.0000
7	1.28350	COM2	Combination	0.000	-16.192	0.000	-0.0021	0.0000
7	1.67700	COM2	Combination	0.000	-15.050	0.000	-0.0021	0.0000
7	1.67700	COM2	Combination	0.000	30.482	0.000	-0.0208	0.0000
7	2.04550	COM2	Combination	0.000	31.551	0.000	-0.0208	0.0000
7	2.41400	COM2	Combination	0.000	32.620	0.000	-0.0208	0.0000
7	2.41400	COM2	Combination	0.000	43.624	0.000	0.0857	0.0000
7	2.70750	COM2	Combination	0.000	44.476	0.000	0.0857	0.0000
7	3.00100	COM2	Combination	0.000	45.327	0.000	0.0857	0.0000
7	0.00000	COM3	Combination	0.000	-17.996	0.000	-0.0030	0.0000
7	0.44500	COM3	Combination	0.000	-13.701	0.000	-0.0030	0.0000
7	0.89000	COM3	Combination	0.000	-9.406	0.000	-0.0030	0.0000
7	0.89000	COM3	Combination	0.000	-7.783	0.000	0.0012	0.0000
7	1.28350	COM3	Combination	0.000	-3.985	0.000	0.0012	0.0000
7	1.67700	COM3	Combination	0.000	-0.187	0.000	0.0012	0.0000
7	1.67700	COM3	Combination	0.000	7.090	0.000	-0.0056	0.0000
7	2.04550	COM3	Combination	0.000	10.646	0.000	-0.0056	0.0000
7	2.41400	COM3	Combination	0.000	14.203	0.000	-0.0056	0.0000
7	2.41400	COM3	Combination	0.000	16.147	0.000	0.0169	0.0000
7	2.70750	COM3	Combination	0.000	18.979	0.000	0.0169	0.0000
7	3.00100	COM3	Combination	0.000	21.812	0.000	0.0169	0.0000
7	0.00000	LIFTLUG	Combination	0.000	-21.075	0.000	-0.0235	0.0000
7	0.44500	LIFTLUG	Combination	0.000	-20.042	0.000	-0.0235	0.0000
7	0.89000	LIFTLUG	Combination	0.000	-19.009	0.000	-0.0235	0.0000
7	0.89000	LIFTLUG	Combination	0.000	-12.101	0.000	-0.0015	0.0000
7	1.28350	LIFTLUG	Combination	0.000	-11.187	0.000	-0.0015	0.0000
7	1.67700	LIFTLUG	Combination	0.000	-10.274	0.000	-0.0015	0.0000
7	1.67700	LIFTLUG	Combination	0.000	21.066	0.000	-0.0145	0.0000
7	2.04550	LIFTLUG	Combination	0.000	21.921	0.000	-0.0145	0.0000
7	2.41400	LIFTLUG	Combination	0.000	22.776	0.000	-0.0145	0.0000
7	2.41400	LIFTLUG	Combination	0.000	30.369	0.000	0.0593	0.0000
7	2.70750	LIFTLUG	Combination	0.000	31.051	0.000	0.0593	0.0000
7	3.00100	LIFTLUG	Combination	0.000	31.732	0.000	0.0593	0.0000
14	0.00000	COM1	Combination	0.000	-1.652	0.000	-0.0492	0.0000
14	0.44033	COM1	Combination	0.000	-0.446	0.000	-0.0161	0.0000
14	0.88067	COM1	Combination	0.000	0.760	0.000	0.0171	0.0000
14	1.32100	COM1	Combination	0.000	1.966	0.000	0.0503	0.0000
14	0.00000	COM2	Combination	0.000	-10.068	0.000	-0.3149	0.0000
14	0.44033	COM2	Combination	0.000	-2.345	0.000	-0.1025	0.0000
14	0.88067	COM2	Combination	0.000	5.378	0.000	0.1099	0.0000
14	1.32100	COM2	Combination	0.000	13.100	0.000	0.3224	0.0000
14	0.00000	COM3	Combination	0.000	-1.624	0.000	-0.0446	0.0000
14	0.44033	COM3	Combination	0.000	-0.547	0.000	-0.0150	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
14	0.88067	COM3	Combination	0.000	0.530	0.000	0.0146	0.0000
14	1.32100	COM3	Combination	0.000	1.607	0.000	0.0442	0.0000
14	0.00000	LIFTLUG	Combination	0.000	-6.909	0.000	-0.2158	0.0000
14	0.44033	LIFTLUG	Combination	0.000	-1.617	0.000	-0.0702	0.0000
14	0.88067	LIFTLUG	Combination	0.000	3.675	0.000	0.0753	0.0000
14	1.32100	LIFTLUG	Combination	0.000	8.968	0.000	0.2209	0.0000
15	0.00000	COM1	Combination	0.000	-3.016	0.000	-0.0807	0.0000
15	0.42680	COM1	Combination	0.000	-1.847	0.000	-0.0486	0.0000
15	0.85360	COM1	Combination	0.000	-0.678	0.000	-0.0164	0.0000
15	1.28040	COM1	Combination	0.000	0.491	0.000	0.0158	0.0000
15	1.70720	COM1	Combination	0.000	1.660	0.000	0.0479	0.0000
15	2.13400	COM1	Combination	0.000	2.829	0.000	0.0801	0.0000
15	0.00000	COM2	Combination	0.000	-19.629	0.000	-0.5171	0.0000
15	0.42680	COM2	Combination	0.000	-12.144	0.000	-0.3112	0.0000
15	0.85360	COM2	Combination	0.000	-4.658	0.000	-0.1052	0.0000
15	1.28040	COM2	Combination	0.000	2.827	0.000	0.1007	0.0000
15	1.70720	COM2	Combination	0.000	10.312	0.000	0.3066	0.0000
15	2.13400	COM2	Combination	0.000	17.798	0.000	0.5125	0.0000
15	0.00000	COM3	Combination	0.000	-2.601	0.000	-0.0717	0.0000
15	0.42680	COM3	Combination	0.000	-1.557	0.000	-0.0429	0.0000
15	0.85360	COM3	Combination	0.000	-0.513	0.000	-0.0142	0.0000
15	1.28040	COM3	Combination	0.000	0.530	0.000	0.0145	0.0000
15	1.70720	COM3	Combination	0.000	1.574	0.000	0.0432	0.0000
15	2.13400	COM3	Combination	0.000	2.618	0.000	0.0719	0.0000
15	0.00000	LIFTLUG	Combination	0.000	-13.445	0.000	-0.3543	0.0000
15	0.42680	LIFTLUG	Combination	0.000	-8.316	0.000	-0.2132	0.0000
15	0.85360	LIFTLUG	Combination	0.000	-3.186	0.000	-0.0721	0.0000
15	1.28040	LIFTLUG	Combination	0.000	1.943	0.000	0.0690	0.0000
15	1.70720	LIFTLUG	Combination	0.000	7.073	0.000	0.2101	0.0000
15	2.13400	LIFTLUG	Combination	0.000	12.202	0.000	0.3512	0.0000
18	0.00000	COM1	Combination	0.000	-2.158	0.000	-0.0441	0.0000
18	0.44033	COM1	Combination	0.000	-1.061	0.000	-0.0139	0.0000
18	0.88067	COM1	Combination	0.000	0.036	0.000	0.0162	0.0000
18	1.32100	COM1	Combination	0.000	1.133	0.000	0.0464	0.0000
18	0.00000	COM2	Combination	0.000	-11.004	0.000	-0.2539	0.0000
18	0.44033	COM2	Combination	0.000	-4.778	0.000	-0.0826	0.0000
18	0.88067	COM2	Combination	0.000	1.449	0.000	0.0886	0.0000
18	1.32100	COM2	Combination	0.000	7.676	0.000	0.2599	0.0000
18	0.00000	COM3	Combination	0.000	-1.944	0.000	-0.0392	0.0000
18	0.44033	COM3	Combination	0.000	-0.964	0.000	-0.0123	0.0000
18	0.88067	COM3	Combination	0.000	0.015	0.000	0.0147	0.0000
18	1.32100	COM3	Combination	0.000	0.995	0.000	0.0416	0.0000
18	0.00000	LIFTLUG	Combination	0.000	-7.593	0.000	-0.1745	0.0000
18	0.44033	LIFTLUG	Combination	0.000	-3.311	0.000	-0.0568	0.0000
18	0.88067	LIFTLUG	Combination	0.000	0.970	0.000	0.0610	0.0000
18	1.32100	LIFTLUG	Combination	0.000	5.252	0.000	0.1788	0.0000
19	0.00000	COM1	Combination	0.000	-2.337	0.000	-0.0738	0.0000
19	0.42680	COM1	Combination	0.000	-1.274	0.000	-0.0446	0.0000
19	0.85360	COM1	Combination	0.000	-0.211	0.000	-0.0153	0.0000
19	1.28040	COM1	Combination	0.000	0.853	0.000	0.0139	0.0000
19	1.70720	COM1	Combination	0.000	1.916	0.000	0.0432	0.0000
19	2.13400	COM1	Combination	0.000	2.980	0.000	0.0724	0.0000
19	0.00000	COM2	Combination	0.000	-14.035	0.000	-0.4169	0.0000
19	0.42680	COM2	Combination	0.000	-8.000	0.000	-0.2509	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
19	0.85360	COM2	Combination	0.000	-1.965	0.000	-0.0849	0.0000
19	1.28040	COM2	Combination	0.000	4.071	0.000	0.0811	0.0000
19	1.70720	COM2	Combination	0.000	10.106	0.000	0.2471	0.0000
19	2.13400	COM2	Combination	0.000	16.141	0.000	0.4132	0.0000
19	0.00000	COM3	Combination	0.000	-2.077	0.000	-0.0660	0.0000
19	0.42680	COM3	Combination	0.000	-1.127	0.000	-0.0399	0.0000
19	0.85360	COM3	Combination	0.000	-0.178	0.000	-0.0138	0.0000
19	1.28040	COM3	Combination	0.000	0.772	0.000	0.0123	0.0000
19	1.70720	COM3	Combination	0.000	1.721	0.000	0.0384	0.0000
19	2.13400	COM3	Combination	0.000	2.671	0.000	0.0646	0.0000
19	0.00000	LIFTLUG	Combination	0.000	-9.635	0.000	-0.2868	0.0000
19	0.42680	LIFTLUG	Combination	0.000	-5.485	0.000	-0.1726	0.0000
19	0.85360	LIFTLUG	Combination	0.000	-1.335	0.000	-0.0584	0.0000
19	1.28040	LIFTLUG	Combination	0.000	2.815	0.000	0.0557	0.0000
19	1.70720	LIFTLUG	Combination	0.000	6.965	0.000	0.1699	0.0000
19	2.13400	LIFTLUG	Combination	0.000	11.115	0.000	0.2841	0.0000
20	0.00000	COM1	Combination	0.000	-2.840	0.000	-0.0688	0.0000
20	0.44033	COM1	Combination	0.000	-1.175	0.000	-0.0230	0.0000
20	0.88067	COM1	Combination	0.000	0.490	0.000	0.0227	0.0000
20	1.32100	COM1	Combination	0.000	2.154	0.000	0.0685	0.0000
20	0.00000	COM2	Combination	0.000	-10.718	0.000	-0.2528	0.0000
20	0.44033	COM2	Combination	0.000	-4.615	0.000	-0.0849	0.0000
20	0.88067	COM2	Combination	0.000	1.488	0.000	0.0830	0.0000
20	1.32100	COM2	Combination	0.000	7.591	0.000	0.2509	0.0000
20	0.00000	COM3	Combination	0.000	-2.491	0.000	-0.0617	0.0000
20	0.44033	COM3	Combination	0.000	-1.005	0.000	-0.0208	0.0000
20	0.88067	COM3	Combination	0.000	0.482	0.000	0.0201	0.0000
20	1.32100	COM3	Combination	0.000	1.968	0.000	0.0610	0.0000
20	0.00000	LIFTLUG	Combination	0.000	-7.484	0.000	-0.1767	0.0000
20	0.44033	LIFTLUG	Combination	0.000	-3.217	0.000	-0.0593	0.0000
20	0.88067	LIFTLUG	Combination	0.000	1.050	0.000	0.0580	0.0000
20	1.32100	LIFTLUG	Combination	0.000	5.317	0.000	0.1754	0.0000
21	0.00000	COM1	Combination	0.000	-3.815	0.000	-0.1109	0.0000
21	0.42680	COM1	Combination	0.000	-2.202	0.000	-0.0665	0.0000
21	0.85360	COM1	Combination	0.000	-0.588	0.000	-0.0221	0.0000
21	1.28040	COM1	Combination	0.000	1.025	0.000	0.0223	0.0000
21	1.70720	COM1	Combination	0.000	2.639	0.000	0.0667	0.0000
21	2.13400	COM1	Combination	0.000	4.252	0.000	0.1111	0.0000
21	0.00000	COM2	Combination	0.000	-13.798	0.000	-0.4063	0.0000
21	0.42680	COM2	Combination	0.000	-7.882	0.000	-0.2435	0.0000
21	0.85360	COM2	Combination	0.000	-1.966	0.000	-0.0808	0.0000
21	1.28040	COM2	Combination	0.000	3.949	0.000	0.0819	0.0000
21	1.70720	COM2	Combination	0.000	9.865	0.000	0.2447	0.0000
21	2.13400	COM2	Combination	0.000	15.780	0.000	0.4074	0.0000
21	0.00000	COM3	Combination	0.000	-3.434	0.000	-0.0989	0.0000
21	0.42680	COM3	Combination	0.000	-1.993	0.000	-0.0592	0.0000
21	0.85360	COM3	Combination	0.000	-0.553	0.000	-0.0196	0.0000
21	1.28040	COM3	Combination	0.000	0.888	0.000	0.0200	0.0000
21	1.70720	COM3	Combination	0.000	2.328	0.000	0.0597	0.0000
21	2.13400	COM3	Combination	0.000	3.769	0.000	0.0993	0.0000
21	0.00000	LIFTLUG	Combination	0.000	-9.653	0.000	-0.2840	0.0000
21	0.42680	LIFTLUG	Combination	0.000	-5.517	0.000	-0.1703	0.0000
21	0.85360	LIFTLUG	Combination	0.000	-1.381	0.000	-0.0565	0.0000
21	1.28040	LIFTLUG	Combination	0.000	2.755	0.000	0.0573	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
21	1.70720	LIFTLUG	Combination	0.000	6.891	0.000	0.1710	0.0000
21	2.13400	LIFTLUG	Combination	0.000	11.026	0.000	0.2848	0.0000
22	0.00000	COM1	Combination	0.000	-4.980	0.000	2.348E-04	0.0000
22	0.44033	COM1	Combination	0.000	-3.287	0.000	2.348E-04	0.0000
22	0.88067	COM1	Combination	0.000	-1.594	0.000	2.348E-04	0.0000
22	1.32100	COM1	Combination	0.000	0.099	0.000	2.348E-04	0.0000
22	0.00000	COM2	Combination	0.000	-19.044	0.000	-0.0010	0.0000
22	0.44033	COM2	Combination	0.000	-13.355	0.000	-0.0010	0.0000
22	0.88067	COM2	Combination	0.000	-7.667	0.000	-0.0010	0.0000
22	1.32100	COM2	Combination	0.000	-1.978	0.000	-0.0010	0.0000
22	0.00000	COM3	Combination	0.000	-4.553	0.000	-3.066E-05	0.0000
22	0.44033	COM3	Combination	0.000	-3.042	0.000	-3.066E-05	0.0000
22	0.88067	COM3	Combination	0.000	-1.530	0.000	-3.066E-05	0.0000
22	1.32100	COM3	Combination	0.000	-0.018	0.000	-3.066E-05	0.0000
22	0.00000	LIFTLUG	Combination	0.000	-13.289	0.000	-6.596E-04	0.0000
22	0.44033	LIFTLUG	Combination	0.000	-9.295	0.000	-6.596E-04	0.0000
22	0.88067	LIFTLUG	Combination	0.000	-5.301	0.000	-6.596E-04	0.0000
22	1.32100	LIFTLUG	Combination	0.000	-1.307	0.000	-6.596E-04	0.0000
23	0.00000	COM1	Combination	0.000	-2.592	0.000	-1.390E-04	0.0000
23	0.42680	COM1	Combination	0.000	-0.951	0.000	-1.390E-04	0.0000
23	0.85360	COM1	Combination	0.000	0.690	0.000	-1.390E-04	0.0000
23	1.28040	COM1	Combination	0.000	2.331	0.000	-1.390E-04	0.0000
23	1.70720	COM1	Combination	0.000	3.972	0.000	-1.390E-04	0.0000
23	2.13400	COM1	Combination	0.000	5.613	0.000	-1.390E-04	0.0000
23	0.00000	COM2	Combination	0.000	-7.282	0.000	6.025E-04	0.0000
23	0.42680	COM2	Combination	0.000	-1.768	0.000	6.025E-04	0.0000
23	0.85360	COM2	Combination	0.000	3.745	0.000	6.025E-04	0.0000
23	1.28040	COM2	Combination	0.000	9.259	0.000	6.025E-04	0.0000
23	1.70720	COM2	Combination	0.000	14.773	0.000	6.025E-04	0.0000
23	2.13400	COM2	Combination	0.000	20.287	0.000	6.025E-04	0.0000
23	0.00000	COM3	Combination	0.000	-2.249	0.000	4.247E-05	0.0000
23	0.42680	COM3	Combination	0.000	-0.784	0.000	4.247E-05	0.0000
23	0.85360	COM3	Combination	0.000	0.681	0.000	4.247E-05	0.0000
23	1.28040	COM3	Combination	0.000	2.147	0.000	4.247E-05	0.0000
23	1.70720	COM3	Combination	0.000	3.612	0.000	4.247E-05	0.0000
23	2.13400	COM3	Combination	0.000	5.077	0.000	4.247E-05	0.0000
23	0.00000	LIFTLUG	Combination	0.000	-5.163	0.000	3.851E-04	0.0000
23	0.42680	LIFTLUG	Combination	0.000	-1.292	0.000	3.851E-04	0.0000
23	0.85360	LIFTLUG	Combination	0.000	2.579	0.000	3.851E-04	0.0000
23	1.28040	LIFTLUG	Combination	0.000	6.450	0.000	3.851E-04	0.0000
23	1.70720	LIFTLUG	Combination	0.000	10.321	0.000	3.851E-04	0.0000
23	2.13400	LIFTLUG	Combination	0.000	14.193	0.000	3.851E-04	0.0000
26	0.00000	COM1	Combination	0.000	-4.543	0.000	-5.183E-04	0.0000
26	0.33867	COM1	Combination	0.000	-3.111	0.000	-5.183E-04	0.0000
26	0.67733	COM1	Combination	0.000	-1.679	0.000	-5.183E-04	0.0000
26	1.01600	COM1	Combination	0.000	-0.247	0.000	-5.183E-04	0.0000
26	1.01600	COM1	Combination	0.000	-0.105	0.000	-0.0019	0.0000
26	1.38867	COM1	Combination	0.000	1.470	0.000	-0.0019	0.0000
26	1.76133	COM1	Combination	0.000	3.046	0.000	-0.0019	0.0000
26	2.13400	COM1	Combination	0.000	4.622	0.000	-0.0019	0.0000
26	0.00000	COM2	Combination	0.000	-19.319	0.000	-0.0012	0.0000
26	0.33867	COM2	Combination	0.000	-13.157	0.000	-0.0012	0.0000
26	0.67733	COM2	Combination	0.000	-6.996	0.000	-0.0012	0.0000
26	1.01600	COM2	Combination	0.000	-0.834	0.000	-0.0012	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
26	1.01600	COM2	Combination	0.000	-0.711	0.000	-0.0073	0.0000
26	1.38867	COM2	Combination	0.000	6.069	0.000	-0.0073	0.0000
26	1.76133	COM2	Combination	0.000	12.849	0.000	-0.0073	0.0000
26	2.13400	COM2	Combination	0.000	19.629	0.000	-0.0073	0.0000
26	0.00000	COM3	Combination	0.000	-4.059	0.000	-2.271E-04	0.0000
26	0.33867	COM3	Combination	0.000	-2.781	0.000	-2.271E-04	0.0000
26	0.67733	COM3	Combination	0.000	-1.502	0.000	-2.271E-04	0.0000
26	1.01600	COM3	Combination	0.000	-0.223	0.000	-2.271E-04	0.0000
26	1.01600	COM3	Combination	0.000	-0.096	0.000	-0.0022	0.0000
26	1.38867	COM3	Combination	0.000	1.311	0.000	-0.0022	0.0000
26	1.76133	COM3	Combination	0.000	2.718	0.000	-0.0022	0.0000
26	2.13400	COM3	Combination	0.000	4.125	0.000	-0.0022	0.0000
26	0.00000	LIFTLUG	Combination	0.000	-13.420	0.000	-8.636E-04	0.0000
26	0.33867	LIFTLUG	Combination	0.000	-9.142	0.000	-8.636E-04	0.0000
26	0.67733	LIFTLUG	Combination	0.000	-4.864	0.000	-8.636E-04	0.0000
26	1.01600	LIFTLUG	Combination	0.000	-0.586	0.000	-8.636E-04	0.0000
26	1.01600	LIFTLUG	Combination	0.000	-0.487	0.000	-0.0051	0.0000
26	1.38867	LIFTLUG	Combination	0.000	4.221	0.000	-0.0051	0.0000
26	1.76133	LIFTLUG	Combination	0.000	8.929	0.000	-0.0051	0.0000
26	2.13400	LIFTLUG	Combination	0.000	13.636	0.000	-0.0051	0.0000
27	0.00000	COM1	Combination	0.000	-2.774	0.000	-0.0726	0.0000
27	0.44033	COM1	Combination	0.000	-0.974	0.000	-0.0232	0.0000
27	0.88067	COM1	Combination	0.000	0.825	0.000	0.0263	0.0000
27	1.32100	COM1	Combination	0.000	2.624	0.000	0.0758	0.0000
27	0.00000	COM2	Combination	0.000	-12.208	0.000	-0.3225	0.0000
27	0.44033	COM2	Combination	0.000	-4.253	0.000	-0.1036	0.0000
27	0.88067	COM2	Combination	0.000	3.702	0.000	0.1152	0.0000
27	1.32100	COM2	Combination	0.000	11.657	0.000	0.3341	0.0000
27	0.00000	COM3	Combination	0.000	-2.472	0.000	-0.0647	0.0000
27	0.44033	COM3	Combination	0.000	-0.865	0.000	-0.0205	0.0000
27	0.88067	COM3	Combination	0.000	0.741	0.000	0.0237	0.0000
27	1.32100	COM3	Combination	0.000	2.348	0.000	0.0679	0.0000
27	0.00000	LIFTLUG	Combination	0.000	-8.469	0.000	-0.2236	0.0000
27	0.44033	LIFTLUG	Combination	0.000	-2.951	0.000	-0.0718	0.0000
27	0.88067	LIFTLUG	Combination	0.000	2.566	0.000	0.0799	0.0000
27	1.32100	LIFTLUG	Combination	0.000	8.084	0.000	0.2317	0.0000
29	0.00000	COM1	Combination	0.000	-0.139	0.000	0.0012	0.0000
29	0.45600	COM1	Combination	0.000	1.438E-03	0.000	0.0012	0.0000
29	0.91200	COM1	Combination	0.000	0.141	0.000	0.0012	0.0000
29	0.00000	COM2	Combination	0.000	-0.127	0.000	0.0044	0.0000
29	0.45600	COM2	Combination	0.000	-1.687E-03	0.000	0.0044	0.0000
29	0.91200	COM2	Combination	0.000	0.123	0.000	0.0044	0.0000
29	0.00000	COM3	Combination	0.000	-0.123	0.000	0.0011	0.0000
29	0.45600	COM3	Combination	0.000	2.045E-03	0.000	0.0011	0.0000
29	0.91200	COM3	Combination	0.000	0.127	0.000	0.0011	0.0000
29	0.00000	LIFTLUG	Combination	0.000	-0.101	0.000	0.0031	0.0000
29	0.45600	LIFTLUG	Combination	0.000	-9.533E-04	0.000	0.0031	0.0000
29	0.91200	LIFTLUG	Combination	0.000	0.099	0.000	0.0031	0.0000
30	0.00000	COM1	Combination	0.000	-4.237	0.000	-0.0047	0.0000
30	0.44033	COM1	Combination	0.000	-2.785	0.000	-0.0047	0.0000
30	0.88067	COM1	Combination	0.000	-1.324	0.000	-0.0047	0.0000
30	1.32100	COM1	Combination	0.000	0.147	0.000	-0.0047	0.0000
30	0.00000	COM2	Combination	0.000	-9.628	0.000	-0.0186	0.0000
30	0.44033	COM2	Combination	0.000	-7.040	0.000	-0.0186	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
30	0.88067	COM2	Combination	0.000	-4.314	0.000	-0.0186	0.0000
30	1.32100	COM2	Combination	0.000	-1.452	0.000	-0.0186	0.0000
30	0.00000	COM3	Combination	0.000	-5.004	0.000	-0.0022	0.0000
30	0.44033	COM3	Combination	0.000	-3.709	0.000	-0.0022	0.0000
30	0.88067	COM3	Combination	0.000	-2.404	0.000	-0.0022	0.0000
30	1.32100	COM3	Combination	0.000	-1.091	0.000	-0.0022	0.0000
30	0.00000	LIFTLUG	Combination	0.000	-6.923	0.000	-0.0130	0.0000
30	0.44033	LIFTLUG	Combination	0.000	-5.025	0.000	-0.0130	0.0000
30	0.88067	LIFTLUG	Combination	0.000	-3.034	0.000	-0.0130	0.0000
30	1.32100	LIFTLUG	Combination	0.000	-0.950	0.000	-0.0130	0.0000
31	0.00000	COM1	Combination	0.000	-3.492	0.000	0.0027	0.0000
31	0.42680	COM1	Combination	0.000	-2.057	0.000	0.0027	0.0000
31	0.85360	COM1	Combination	0.000	-0.612	0.000	0.0027	0.0000
31	1.28040	COM1	Combination	0.000	0.842	0.000	0.0027	0.0000
31	1.70720	COM1	Combination	0.000	2.305	0.000	0.0027	0.0000
31	2.13400	COM1	Combination	0.000	3.778	0.000	0.0027	0.0000
31	0.00000	COM2	Combination	0.000	-7.100	0.000	0.0107	0.0000
31	0.42680	COM2	Combination	0.000	-4.194	0.000	0.0107	0.0000
31	0.85360	COM2	Combination	0.000	-1.159	0.000	0.0107	0.0000
31	1.28040	COM2	Combination	0.000	2.004	0.000	0.0107	0.0000
31	1.70720	COM2	Combination	0.000	5.297	0.000	0.0107	0.0000
31	2.13400	COM2	Combination	0.000	8.718	0.000	0.0107	0.0000
31	0.00000	COM3	Combination	0.000	-2.778	0.000	0.0011	0.0000
31	0.42680	COM3	Combination	0.000	-1.496	0.000	0.0011	0.0000
31	0.85360	COM3	Combination	0.000	-0.206	0.000	0.0011	0.0000
31	1.28040	COM3	Combination	0.000	1.092	0.000	0.0011	0.0000
31	1.70720	COM3	Combination	0.000	2.399	0.000	0.0011	0.0000
31	2.13400	COM3	Combination	0.000	3.714	0.000	0.0011	0.0000
31	0.00000	LIFTLUG	Combination	0.000	-5.149	0.000	0.0074	0.0000
31	0.42680	LIFTLUG	Combination	0.000	-3.041	0.000	0.0074	0.0000
31	0.85360	LIFTLUG	Combination	0.000	-0.846	0.000	0.0074	0.0000
31	1.28040	LIFTLUG	Combination	0.000	1.436	0.000	0.0074	0.0000
31	1.70720	LIFTLUG	Combination	0.000	3.806	0.000	0.0074	0.0000
31	2.13400	LIFTLUG	Combination	0.000	6.262	0.000	0.0074	0.0000
42	0.00000	COM1	Combination	0.000	-3.972	0.000	-0.0696	0.0000
42	0.44033	COM1	Combination	0.000	-2.285	0.000	-0.0232	0.0000
42	0.88067	COM1	Combination	0.000	-0.598	0.000	0.0232	0.0000
42	1.32100	COM1	Combination	0.000	1.089	0.000	0.0696	0.0000
42	0.00000	COM2	Combination	0.000	-15.071	0.000	-0.2653	0.0000
42	0.44033	COM2	Combination	0.000	-8.658	0.000	-0.0889	0.0000
42	0.88067	COM2	Combination	0.000	-2.245	0.000	0.0875	0.0000
42	1.32100	COM2	Combination	0.000	4.167	0.000	0.2640	0.0000
42	0.00000	COM3	Combination	0.000	-3.576	0.000	-0.0620	0.0000
42	0.44033	COM3	Combination	0.000	-2.070	0.000	-0.0205	0.0000
42	0.88067	COM3	Combination	0.000	-0.563	0.000	0.0209	0.0000
42	1.32100	COM3	Combination	0.000	0.943	0.000	0.0624	0.0000
42	0.00000	LIFTLUG	Combination	0.000	-10.520	0.000	-0.1851	0.0000
42	0.44033	LIFTLUG	Combination	0.000	-6.044	0.000	-0.0620	0.0000
42	0.88067	LIFTLUG	Combination	0.000	-1.568	0.000	0.0611	0.0000
42	1.32100	LIFTLUG	Combination	0.000	2.908	0.000	0.1843	0.0000
43	0.00000	COM1	Combination	0.000	-3.137	0.000	-0.1110	0.0000
43	0.42680	COM1	Combination	0.000	-1.523	0.000	-0.0666	0.0000
43	0.85360	COM1	Combination	0.000	0.090	0.000	-0.0222	0.0000
43	1.28040	COM1	Combination	0.000	1.704	0.000	0.0222	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
43	1.70720	COM1	Combination	0.000	3.317	0.000	0.0666	0.0000
43	2.13400	COM1	Combination	0.000	4.930	0.000	0.1109	0.0000
43	0.00000	COM2	Combination	0.000	-11.399	0.000	-0.4065	0.0000
43	0.42680	COM2	Combination	0.000	-5.484	0.000	-0.2438	0.0000
43	0.85360	COM2	Combination	0.000	0.432	0.000	-0.0810	0.0000
43	1.28040	COM2	Combination	0.000	6.348	0.000	0.0817	0.0000
43	1.70720	COM2	Combination	0.000	12.263	0.000	0.2444	0.0000
43	2.13400	COM2	Combination	0.000	18.179	0.000	0.4072	0.0000
43	0.00000	COM3	Combination	0.000	-2.782	0.000	-0.0992	0.0000
43	0.42680	COM3	Combination	0.000	-1.342	0.000	-0.0596	0.0000
43	0.85360	COM3	Combination	0.000	0.099	0.000	-0.0200	0.0000
43	1.28040	COM3	Combination	0.000	1.540	0.000	0.0197	0.0000
43	1.70720	COM3	Combination	0.000	2.980	0.000	0.0593	0.0000
43	2.13400	COM3	Combination	0.000	4.421	0.000	0.0989	0.0000
43	0.00000	LIFTLUG	Combination	0.000	-7.973	0.000	-0.2842	0.0000
43	0.42680	LIFTLUG	Combination	0.000	-3.837	0.000	-0.1704	0.0000
43	0.85360	LIFTLUG	Combination	0.000	0.299	0.000	-0.0567	0.0000
43	1.28040	LIFTLUG	Combination	0.000	4.435	0.000	0.0571	0.0000
43	1.70720	LIFTLUG	Combination	0.000	8.570	0.000	0.1709	0.0000
43	2.13400	LIFTLUG	Combination	0.000	12.706	0.000	0.2846	0.0000
44	0.00000	COM1	Combination	0.000	-22.910	0.000	0.0331	0.0000
44	0.43200	COM1	Combination	0.000	-21.506	0.000	0.0331	0.0000
44	0.43200	COM1	Combination	0.000	-15.893	0.000	0.0053	0.0000
44	0.74300	COM1	Combination	0.000	-14.883	0.000	0.0053	0.0000
44	1.05400	COM1	Combination	0.000	-13.872	0.000	0.0053	0.0000
44	1.05400	COM1	Combination	0.000	-9.620	0.000	-0.0124	0.0000
44	1.32550	COM1	Combination	0.000	-8.738	0.000	-0.0124	0.0000
44	1.59700	COM1	Combination	0.000	-7.856	0.000	-0.0124	0.0000
44	1.59700	COM1	Combination	0.000	4.059	0.000	0.0039	0.0000
44	2.05300	COM1	Combination	0.000	5.540	0.000	0.0039	0.0000
44	2.50900	COM1	Combination	0.000	7.022	0.000	0.0039	0.0000
44	2.50900	COM1	Combination	0.000	11.644	0.000	0.0155	0.0000
44	2.85400	COM1	Combination	0.000	12.765	0.000	0.0155	0.0000
44	3.19900	COM1	Combination	0.000	13.886	0.000	0.0155	0.0000
44	3.19900	COM1	Combination	0.000	18.817	0.000	-0.0514	0.0000
44	3.67400	COM1	Combination	0.000	20.360	0.000	-0.0514	0.0000
44	0.00000	COM2	Combination	0.000	-70.050	0.000	0.1266	0.0000
44	0.43200	COM2	Combination	0.000	-68.797	0.000	0.1266	0.0000
44	0.43200	COM2	Combination	0.000	-48.510	0.000	0.0185	0.0000
44	0.74300	COM2	Combination	0.000	-47.607	0.000	0.0185	0.0000
44	1.05400	COM2	Combination	0.000	-46.705	0.000	0.0185	0.0000
44	1.05400	COM2	Combination	0.000	-30.925	0.000	-0.0452	0.0000
44	1.32550	COM2	Combination	0.000	-30.137	0.000	-0.0452	0.0000
44	1.59700	COM2	Combination	0.000	-29.349	0.000	-0.0452	0.0000
44	1.59700	COM2	Combination	0.000	16.924	0.000	0.0168	0.0000
44	2.05300	COM2	Combination	0.000	18.247	0.000	0.0168	0.0000
44	2.50900	COM2	Combination	0.000	19.569	0.000	0.0168	0.0000
44	2.50900	COM2	Combination	0.000	39.199	0.000	0.0520	0.0000
44	2.85400	COM2	Combination	0.000	40.200	0.000	0.0520	0.0000
44	3.19900	COM2	Combination	0.000	41.201	0.000	0.0520	0.0000
44	3.19900	COM2	Combination	0.000	59.380	0.000	-0.1902	0.0000
44	3.67400	COM2	Combination	0.000	60.758	0.000	-0.1902	0.0000
44	0.00000	COM3	Combination	0.000	-32.615	0.000	0.0309	0.0000
44	0.43200	COM3	Combination	0.000	-28.446	0.000	0.0309	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
44	0.43200	COM3	Combination	0.000	-23.369	0.000	0.0036	0.0000
44	0.74300	COM3	Combination	0.000	-20.367	0.000	0.0036	0.0000
44	1.05400	COM3	Combination	0.000	-17.366	0.000	0.0036	0.0000
44	1.05400	COM3	Combination	0.000	-13.597	0.000	-0.0116	0.0000
44	1.32550	COM3	Combination	0.000	-10.977	0.000	-0.0116	0.0000
44	1.59700	COM3	Combination	0.000	-8.356	0.000	-0.0116	0.0000
44	1.59700	COM3	Combination	0.000	1.812	0.000	0.0038	0.0000
44	2.05300	COM3	Combination	0.000	6.213	0.000	0.0038	0.0000
44	2.50900	COM3	Combination	0.000	10.614	0.000	0.0038	0.0000
44	2.50900	COM3	Combination	0.000	14.739	0.000	0.0146	0.0000
44	2.85400	COM3	Combination	0.000	18.068	0.000	0.0146	0.0000
44	3.19900	COM3	Combination	0.000	21.398	0.000	0.0146	0.0000
44	3.19900	COM3	Combination	0.000	25.819	0.000	-0.0470	0.0000
44	3.67400	COM3	Combination	0.000	30.403	0.000	-0.0470	0.0000
44	0.00000	LIFTLUG	Combination	0.000	-49.427	0.000	0.0884	0.0000
44	0.43200	LIFTLUG	Combination	0.000	-48.425	0.000	0.0884	0.0000
44	0.43200	LIFTLUG	Combination	0.000	-34.232	0.000	0.0130	0.0000
44	0.74300	LIFTLUG	Combination	0.000	-33.510	0.000	0.0130	0.0000
44	1.05400	LIFTLUG	Combination	0.000	-32.788	0.000	0.0130	0.0000
44	1.05400	LIFTLUG	Combination	0.000	-21.762	0.000	-0.0316	0.0000
44	1.32550	LIFTLUG	Combination	0.000	-21.132	0.000	-0.0316	0.0000
44	1.59700	LIFTLUG	Combination	0.000	-20.501	0.000	-0.0316	0.0000
44	1.59700	LIFTLUG	Combination	0.000	11.766	0.000	0.0117	0.0000
44	2.05300	LIFTLUG	Combination	0.000	12.824	0.000	0.0117	0.0000
44	2.50900	LIFTLUG	Combination	0.000	13.882	0.000	0.0117	0.0000
44	2.50900	LIFTLUG	Combination	0.000	27.519	0.000	0.0365	0.0000
44	2.85400	LIFTLUG	Combination	0.000	28.320	0.000	0.0365	0.0000
44	3.19900	LIFTLUG	Combination	0.000	29.120	0.000	0.0365	0.0000
44	3.19900	LIFTLUG	Combination	0.000	41.826	0.000	-0.1329	0.0000
44	3.67400	LIFTLUG	Combination	0.000	42.929	0.000	-0.1329	0.0000
45	0.00000	COM1	Combination	0.000	-18.347	0.000	0.0305	0.0000
45	0.33075	COM1	Combination	0.000	-17.273	0.000	0.0305	0.0000
45	0.66150	COM1	Combination	0.000	-16.198	0.000	0.0305	0.0000
45	0.66150	COM1	Combination	0.000	-11.564	0.000	-0.0156	0.0000
45	0.99225	COM1	Combination	0.000	-10.489	0.000	-0.0156	0.0000
45	1.32300	COM1	Combination	0.000	-9.415	0.000	-0.0156	0.0000
45	1.32300	COM1	Combination	0.000	2.075	0.000	0.0121	0.0000
45	1.57500	COM1	Combination	0.000	2.893	0.000	0.0121	0.0000
45	1.82700	COM1	Combination	0.000	3.712	0.000	0.0121	0.0000
45	1.82700	COM1	Combination	0.000	7.865	0.000	-0.0025	0.0000
45	2.13150	COM1	Combination	0.000	8.854	0.000	-0.0025	0.0000
45	2.43600	COM1	Combination	0.000	9.843	0.000	-0.0025	0.0000
45	2.43600	COM1	Combination	0.000	13.756	0.000	-0.0010	0.0000
45	2.74600	COM1	Combination	0.000	14.763	0.000	-0.0010	0.0000
45	2.74600	COM1	Combination	0.000	18.541	0.000	-0.0511	0.0000
45	3.00000	COM1	Combination	0.000	19.367	0.000	-0.0511	0.0000
45	0.00000	COM2	Combination	0.000	-52.424	0.000	0.1136	0.0000
45	0.33075	COM2	Combination	0.000	-51.465	0.000	0.1136	0.0000
45	0.66150	COM2	Combination	0.000	-50.505	0.000	0.1136	0.0000
45	0.66150	COM2	Combination	0.000	-32.555	0.000	-0.0631	0.0000
45	0.99225	COM2	Combination	0.000	-31.595	0.000	-0.0631	0.0000
45	1.32300	COM2	Combination	0.000	-30.636	0.000	-0.0631	0.0000
45	1.32300	COM2	Combination	0.000	9.453	0.000	0.0377	0.0000
45	1.57500	COM2	Combination	0.000	10.184	0.000	0.0377	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
45	1.82700	COM2	Combination	0.000	10.915	0.000	0.0377	0.0000
45	1.82700	COM2	Combination	0.000	25.427	0.000	-0.0191	0.0000
45	2.13150	COM2	Combination	0.000	26.311	0.000	-0.0191	0.0000
45	2.43600	COM2	Combination	0.000	27.194	0.000	-0.0191	0.0000
45	2.43600	COM2	Combination	0.000	39.355	0.000	-0.0320	0.0000
45	2.74600	COM2	Combination	0.000	40.255	0.000	-0.0320	0.0000
45	2.74600	COM2	Combination	0.000	48.973	0.000	-0.1296	0.0000
45	3.00000	COM2	Combination	0.000	49.710	0.000	-0.1296	0.0000
45	0.00000	COM3	Combination	0.000	-26.714	0.000	0.0276	0.0000
45	0.33075	COM3	Combination	0.000	-23.522	0.000	0.0276	0.0000
45	0.66150	COM3	Combination	0.000	-20.329	0.000	0.0276	0.0000
45	0.66150	COM3	Combination	0.000	-16.199	0.000	-0.0141	0.0000
45	0.99225	COM3	Combination	0.000	-13.007	0.000	-0.0141	0.0000
45	1.32300	COM3	Combination	0.000	-9.815	0.000	-0.0141	0.0000
45	1.32300	COM3	Combination	0.000	0.311	0.000	0.0123	0.0000
45	1.57500	COM3	Combination	0.000	2.743	0.000	0.0123	0.0000
45	1.82700	COM3	Combination	0.000	5.175	0.000	0.0123	0.0000
45	1.82700	COM3	Combination	0.000	8.928	0.000	8.102E-04	0.0000
45	2.13150	COM3	Combination	0.000	11.866	0.000	8.102E-04	0.0000
45	2.43600	COM3	Combination	0.000	14.805	0.000	8.102E-04	0.0000
45	2.43600	COM3	Combination	0.000	18.498	0.000	0.0040	0.0000
45	2.74600	COM3	Combination	0.000	21.490	0.000	0.0040	0.0000
45	2.74600	COM3	Combination	0.000	25.203	0.000	-0.0500	0.0000
45	3.00000	COM3	Combination	0.000	27.655	0.000	-0.0500	0.0000
45	0.00000	LIFTLUG	Combination	0.000	-37.134	0.000	0.0794	0.0000
45	0.33075	LIFTLUG	Combination	0.000	-36.366	0.000	0.0794	0.0000
45	0.66150	LIFTLUG	Combination	0.000	-35.598	0.000	0.0794	0.0000
45	0.66150	LIFTLUG	Combination	0.000	-23.080	0.000	-0.0439	0.0000
45	0.99225	LIFTLUG	Combination	0.000	-22.312	0.000	-0.0439	0.0000
45	1.32300	LIFTLUG	Combination	0.000	-21.545	0.000	-0.0439	0.0000
45	1.32300	LIFTLUG	Combination	0.000	6.549	0.000	0.0266	0.0000
45	1.57500	LIFTLUG	Combination	0.000	7.134	0.000	0.0266	0.0000
45	1.82700	LIFTLUG	Combination	0.000	7.719	0.000	0.0266	0.0000
45	1.82700	LIFTLUG	Combination	0.000	17.888	0.000	-0.0130	0.0000
45	2.13150	LIFTLUG	Combination	0.000	18.594	0.000	-0.0130	0.0000
45	2.43600	LIFTLUG	Combination	0.000	19.301	0.000	-0.0130	0.0000
45	2.43600	LIFTLUG	Combination	0.000	27.874	0.000	-0.0215	0.0000
45	2.74600	LIFTLUG	Combination	0.000	28.594	0.000	-0.0215	0.0000
45	2.74600	LIFTLUG	Combination	0.000	34.856	0.000	-0.0925	0.0000
45	3.00000	LIFTLUG	Combination	0.000	35.445	0.000	-0.0925	0.0000
46	0.00000	COM1	Combination	0.000	-22.238	0.000	-0.0311	0.0000
46	0.43200	COM1	Combination	0.000	-20.834	0.000	-0.0311	0.0000
46	0.43200	COM1	Combination	0.000	-15.854	0.000	5.711E-04	0.0000
46	0.74300	COM1	Combination	0.000	-14.843	0.000	5.711E-04	0.0000
46	1.05400	COM1	Combination	0.000	-13.833	0.000	5.711E-04	0.0000
46	1.05400	COM1	Combination	0.000	-10.993	0.000	0.0022	0.0000
46	1.32550	COM1	Combination	0.000	-10.111	0.000	0.0022	0.0000
46	1.59700	COM1	Combination	0.000	-9.229	0.000	0.0022	0.0000
46	1.59700	COM1	Combination	0.000	5.342	0.000	-0.0067	0.0000
46	2.01650	COM1	Combination	0.000	6.705	0.000	-0.0067	0.0000
46	2.43600	COM1	Combination	0.000	8.068	0.000	-0.0067	0.0000
46	2.43600	COM1	Combination	0.000	10.842	0.000	-0.0060	0.0000
46	2.81750	COM1	Combination	0.000	12.082	0.000	-0.0060	0.0000
46	3.19900	COM1	Combination	0.000	13.321	0.000	-0.0060	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
46	3.19900	COM1	Combination	0.000	17.294	0.000	0.0439	0.0000
46	3.67400	COM1	Combination	0.000	18.837	0.000	0.0439	0.0000
46	0.00000	COM2	Combination	0.000	-68.731	0.000	-0.1223	0.0000
46	0.43200	COM2	Combination	0.000	-67.478	0.000	-0.1223	0.0000
46	0.43200	COM2	Combination	0.000	-48.434	0.000	0.0050	0.0000
46	0.74300	COM2	Combination	0.000	-47.531	0.000	0.0050	0.0000
46	1.05400	COM2	Combination	0.000	-46.629	0.000	0.0050	0.0000
46	1.05400	COM2	Combination	0.000	-35.911	0.000	0.0083	0.0000
46	1.32550	COM2	Combination	0.000	-35.123	0.000	0.0083	0.0000
46	1.59700	COM2	Combination	0.000	-34.335	0.000	0.0083	0.0000
46	1.59700	COM2	Combination	0.000	21.887	0.000	-0.0274	0.0000
46	2.01650	COM2	Combination	0.000	23.104	0.000	-0.0274	0.0000
46	2.43600	COM2	Combination	0.000	24.321	0.000	-0.0274	0.0000
46	2.43600	COM2	Combination	0.000	36.529	0.000	-0.0184	0.0000
46	2.81750	COM2	Combination	0.000	37.636	0.000	-0.0184	0.0000
46	3.19900	COM2	Combination	0.000	38.743	0.000	-0.0184	0.0000
46	3.19900	COM2	Combination	0.000	53.814	0.000	0.1648	0.0000
46	3.67400	COM2	Combination	0.000	55.192	0.000	0.1648	0.0000
46	0.00000	COM3	Combination	0.000	-31.826	0.000	-0.0295	0.0000
46	0.43200	COM3	Combination	0.000	-27.656	0.000	-0.0295	0.0000
46	0.43200	COM3	Combination	0.000	-23.103	0.000	0.0017	0.0000
46	0.74300	COM3	Combination	0.000	-20.101	0.000	0.0017	0.0000
46	1.05400	COM3	Combination	0.000	-17.100	0.000	0.0017	0.0000
46	1.05400	COM3	Combination	0.000	-14.609	0.000	0.0025	0.0000
46	1.32550	COM3	Combination	0.000	-11.989	0.000	0.0025	0.0000
46	1.59700	COM3	Combination	0.000	-9.368	0.000	0.0025	0.0000
46	1.59700	COM3	Combination	0.000	2.884	0.000	-0.0062	0.0000
46	2.01650	COM3	Combination	0.000	6.933	0.000	-0.0062	0.0000
46	2.43600	COM3	Combination	0.000	10.982	0.000	-0.0062	0.0000
46	2.43600	COM3	Combination	0.000	13.454	0.000	-0.0064	0.0000
46	2.81750	COM3	Combination	0.000	17.136	0.000	-0.0064	0.0000
46	3.19900	COM3	Combination	0.000	20.818	0.000	-0.0064	0.0000
46	3.19900	COM3	Combination	0.000	24.394	0.000	0.0396	0.0000
46	3.67400	COM3	Combination	0.000	28.978	0.000	0.0396	0.0000
46	0.00000	LIFTLUG	Combination	0.000	-48.468	0.000	-0.0853	0.0000
46	0.43200	LIFTLUG	Combination	0.000	-47.465	0.000	-0.0853	0.0000
46	0.43200	LIFTLUG	Combination	0.000	-34.177	0.000	0.0034	0.0000
46	0.74300	LIFTLUG	Combination	0.000	-33.455	0.000	0.0034	0.0000
46	1.05400	LIFTLUG	Combination	0.000	-32.733	0.000	0.0034	0.0000
46	1.05400	LIFTLUG	Combination	0.000	-25.249	0.000	0.0058	0.0000
46	1.32550	LIFTLUG	Combination	0.000	-24.619	0.000	0.0058	0.0000
46	1.59700	LIFTLUG	Combination	0.000	-23.989	0.000	0.0058	0.0000
46	1.59700	LIFTLUG	Combination	0.000	15.227	0.000	-0.0191	0.0000
46	2.01650	LIFTLUG	Combination	0.000	16.201	0.000	-0.0191	0.0000
46	2.43600	LIFTLUG	Combination	0.000	17.175	0.000	-0.0191	0.0000
46	2.43600	LIFTLUG	Combination	0.000	25.644	0.000	-0.0130	0.0000
46	2.81750	LIFTLUG	Combination	0.000	26.529	0.000	-0.0130	0.0000
46	3.19900	LIFTLUG	Combination	0.000	27.415	0.000	-0.0130	0.0000
46	3.19900	LIFTLUG	Combination	0.000	37.935	0.000	0.1151	0.0000
46	3.67400	LIFTLUG	Combination	0.000	39.037	0.000	0.1151	0.0000
47	0.00000	COM1	Combination	0.000	-17.231	0.000	-0.0234	0.0000
47	0.33075	COM1	Combination	0.000	-16.157	0.000	-0.0234	0.0000
47	0.66150	COM1	Combination	0.000	-15.082	0.000	-0.0234	0.0000
47	0.66150	COM1	Combination	0.000	-11.744	0.000	0.0077	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
47	0.99225	COM1	Combination	0.000	-10.669	0.000	0.0077	0.0000
47	1.32300	COM1	Combination	0.000	-9.594	0.000	0.0077	0.0000
47	1.32300	COM1	Combination	0.000	4.655	0.000	-0.0011	0.0000
47	1.57500	COM1	Combination	0.000	5.474	0.000	-0.0011	0.0000
47	1.82700	COM1	Combination	0.000	6.293	0.000	-0.0011	0.0000
47	1.82700	COM1	Combination	0.000	9.014	0.000	0.0029	0.0000
47	2.13150	COM1	Combination	0.000	10.003	0.000	0.0029	0.0000
47	2.43600	COM1	Combination	0.000	10.993	0.000	0.0029	0.0000
47	2.43600	COM1	Combination	0.000	13.498	0.000	0.0330	0.0000
47	2.74600	COM1	Combination	0.000	14.505	0.000	0.0330	0.0000
47	2.74600	COM1	Combination	0.000	15.159	0.000	-0.0214	0.0000
47	3.00000	COM1	Combination	0.000	15.984	0.000	-0.0214	0.0000
47	0.00000	COM2	Combination	0.000	-48.202	0.000	-0.0855	0.0000
47	0.33075	COM2	Combination	0.000	-47.243	0.000	-0.0855	0.0000
47	0.66150	COM2	Combination	0.000	-46.283	0.000	-0.0855	0.0000
47	0.66150	COM2	Combination	0.000	-33.680	0.000	0.0312	0.0000
47	0.99225	COM2	Combination	0.000	-32.721	0.000	0.0312	0.0000
47	1.32300	COM2	Combination	0.000	-31.761	0.000	0.0312	0.0000
47	1.32300	COM2	Combination	0.000	18.031	0.000	0.0029	0.0000
47	1.57500	COM2	Combination	0.000	18.762	0.000	0.0029	0.0000
47	1.82700	COM2	Combination	0.000	19.493	0.000	0.0029	0.0000
47	1.82700	COM2	Combination	0.000	28.708	0.000	0.0171	0.0000
47	2.13150	COM2	Combination	0.000	29.591	0.000	0.0171	0.0000
47	2.43600	COM2	Combination	0.000	30.475	0.000	0.0171	0.0000
47	2.43600	COM2	Combination	0.000	37.950	0.000	0.0988	0.0000
47	2.74600	COM2	Combination	0.000	38.849	0.000	0.0988	0.0000
47	2.74600	COM2	Combination	0.000	37.720	0.000	-0.0446	0.0000
47	3.00000	COM2	Combination	0.000	38.457	0.000	-0.0446	0.0000
47	0.00000	COM3	Combination	0.000	-25.413	0.000	-0.0206	0.0000
47	0.33075	COM3	Combination	0.000	-22.221	0.000	-0.0206	0.0000
47	0.66150	COM3	Combination	0.000	-19.029	0.000	-0.0206	0.0000
47	0.66150	COM3	Combination	0.000	-16.060	0.000	0.0070	0.0000
47	0.99225	COM3	Combination	0.000	-12.868	0.000	0.0070	0.0000
47	1.32300	COM3	Combination	0.000	-9.676	0.000	0.0070	0.0000
47	1.32300	COM3	Combination	0.000	2.832	0.000	-0.0027	0.0000
47	1.57500	COM3	Combination	0.000	5.265	0.000	-0.0027	0.0000
47	1.82700	COM3	Combination	0.000	7.697	0.000	-0.0027	0.0000
47	1.82700	COM3	Combination	0.000	10.199	0.000	-9.174E-04	0.0000
47	2.13150	COM3	Combination	0.000	13.137	0.000	-9.174E-04	0.0000
47	2.43600	COM3	Combination	0.000	16.076	0.000	-9.174E-04	0.0000
47	2.43600	COM3	Combination	0.000	18.642	0.000	0.0347	0.0000
47	2.74600	COM3	Combination	0.000	21.634	0.000	0.0347	0.0000
47	2.74600	COM3	Combination	0.000	22.118	0.000	-0.0358	0.0000
47	3.00000	COM3	Combination	0.000	24.569	0.000	-0.0358	0.0000
47	0.00000	LIFTLUG	Combination	0.000	-34.186	0.000	-0.0598	0.0000
47	0.33075	LIFTLUG	Combination	0.000	-33.418	0.000	-0.0598	0.0000
47	0.66150	LIFTLUG	Combination	0.000	-32.651	0.000	-0.0598	0.0000
47	0.66150	LIFTLUG	Combination	0.000	-23.852	0.000	0.0217	0.0000
47	0.99225	LIFTLUG	Combination	0.000	-23.084	0.000	0.0217	0.0000
47	1.32300	LIFTLUG	Combination	0.000	-22.316	0.000	0.0217	0.0000
47	1.32300	LIFTLUG	Combination	0.000	12.575	0.000	0.0018	0.0000
47	1.57500	LIFTLUG	Combination	0.000	13.160	0.000	0.0018	0.0000
47	1.82700	LIFTLUG	Combination	0.000	13.745	0.000	0.0018	0.0000
47	1.82700	LIFTLUG	Combination	0.000	20.212	0.000	0.0118	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
47	2.13150	LIFTLUG	Combination	0.000	20.918	0.000	0.0118	0.0000
47	2.43600	LIFTLUG	Combination	0.000	21.625	0.000	0.0118	0.0000
47	2.43600	LIFTLUG	Combination	0.000	26.907	0.000	0.0698	0.0000
47	2.74600	LIFTLUG	Combination	0.000	27.626	0.000	0.0698	0.0000
47	2.74600	LIFTLUG	Combination	0.000	26.951	0.000	-0.0323	0.0000
47	3.00000	LIFTLUG	Combination	0.000	27.541	0.000	-0.0323	0.0000
52	0.00000	COM1	Combination	0.000	-2.721	0.000	-0.0684	0.0000
52	0.44033	COM1	Combination	0.000	-1.072	0.000	-0.0230	0.0000
52	0.88067	COM1	Combination	0.000	0.576	0.000	0.0223	0.0000
52	1.32100	COM1	Combination	0.000	2.225	0.000	0.0677	0.0000
52	0.00000	COM2	Combination	0.000	-9.214	0.000	-0.2456	0.0000
52	0.44033	COM2	Combination	0.000	-3.332	0.000	-0.0838	0.0000
52	0.88067	COM2	Combination	0.000	2.551	0.000	0.0780	0.0000
52	1.32100	COM2	Combination	0.000	8.434	0.000	0.2399	0.0000
52	0.00000	COM3	Combination	0.000	-2.502	0.000	-0.0605	0.0000
52	0.44033	COM3	Combination	0.000	-1.030	0.000	-0.0200	0.0000
52	0.88067	COM3	Combination	0.000	0.442	0.000	0.0205	0.0000
52	1.32100	COM3	Combination	0.000	1.914	0.000	0.0610	0.0000
52	0.00000	LIFTLUG	Combination	0.000	-6.467	0.000	-0.1719	0.0000
52	0.44033	LIFTLUG	Combination	0.000	-2.349	0.000	-0.0586	0.0000
52	0.88067	LIFTLUG	Combination	0.000	1.769	0.000	0.0547	0.0000
52	1.32100	LIFTLUG	Combination	0.000	5.887	0.000	0.1680	0.0000
53	0.00000	COM1	Combination	0.000	-3.837	0.000	-0.1097	0.0000
53	0.42680	COM1	Combination	0.000	-2.239	0.000	-0.0657	0.0000
53	0.85360	COM1	Combination	0.000	-0.642	0.000	-0.0217	0.0000
53	1.28040	COM1	Combination	0.000	0.956	0.000	0.0222	0.0000
53	1.70720	COM1	Combination	0.000	2.554	0.000	0.0662	0.0000
53	2.13400	COM1	Combination	0.000	4.152	0.000	0.1101	0.0000
53	0.00000	COM2	Combination	0.000	-13.998	0.000	-0.3903	0.0000
53	0.42680	COM2	Combination	0.000	-8.296	0.000	-0.2334	0.0000
53	0.85360	COM2	Combination	0.000	-2.594	0.000	-0.0766	0.0000
53	1.28040	COM2	Combination	0.000	3.108	0.000	0.0803	0.0000
53	1.70720	COM2	Combination	0.000	8.810	0.000	0.2371	0.0000
53	2.13400	COM2	Combination	0.000	14.512	0.000	0.3940	0.0000
53	0.00000	COM3	Combination	0.000	-3.381	0.000	-0.0983	0.0000
53	0.42680	COM3	Combination	0.000	-1.954	0.000	-0.0590	0.0000
53	0.85360	COM3	Combination	0.000	-0.528	0.000	-0.0198	0.0000
53	1.28040	COM3	Combination	0.000	0.899	0.000	0.0195	0.0000
53	1.70720	COM3	Combination	0.000	2.326	0.000	0.0587	0.0000
53	2.13400	COM3	Combination	0.000	3.752	0.000	0.0980	0.0000
53	0.00000	LIFTLUG	Combination	0.000	-9.789	0.000	-0.2733	0.0000
53	0.42680	LIFTLUG	Combination	0.000	-5.797	0.000	-0.1635	0.0000
53	0.85360	LIFTLUG	Combination	0.000	-1.806	0.000	-0.0537	0.0000
53	1.28040	LIFTLUG	Combination	0.000	2.186	0.000	0.0562	0.0000
53	1.70720	LIFTLUG	Combination	0.000	6.178	0.000	0.1660	0.0000
53	2.13400	LIFTLUG	Combination	0.000	10.169	0.000	0.2758	0.0000
54	0.00000	COM1	Combination	0.000	-2.506	0.000	-0.0670	0.0000
54	0.44033	COM1	Combination	0.000	-0.917	0.000	-0.0233	0.0000
54	0.88067	COM1	Combination	0.000	0.672	0.000	0.0204	0.0000
54	1.32100	COM1	Combination	0.000	2.261	0.000	0.0641	0.0000
54	0.00000	COM2	Combination	0.000	-7.475	0.000	-0.2153	0.0000
54	0.44033	COM2	Combination	0.000	-2.415	0.000	-0.0761	0.0000
54	0.88067	COM2	Combination	0.000	2.646	0.000	0.0631	0.0000
54	1.32100	COM2	Combination	0.000	7.706	0.000	0.2023	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
54	0.0000	COM3	Combination	0.000	-2.566	0.000	-0.0589	0.0000
54	0.44033	COM3	Combination	0.000	-1.147	0.000	-0.0199	0.0000
54	0.88067	COM3	Combination	0.000	0.271	0.000	0.0192	0.0000
54	1.32100	COM3	Combination	0.000	1.690	0.000	0.0582	0.0000
54	0.00000	LIFTLUG	Combination	0.000	-5.282	0.000	-0.1515	0.0000
54	0.44033	LIFTLUG	Combination	0.000	-1.719	0.000	-0.0535	0.0000
54	0.88067	LIFTLUG	Combination	0.000	1.844	0.000	0.0445	0.0000
54	1.32100	LIFTLUG	Combination	0.000	5.407	0.000	0.1425	0.0000
55	0.00000	COM1	Combination	0.000	-3.788	0.000	-0.1051	0.0000
55	0.42680	COM1	Combination	0.000	-2.248	0.000	-0.0627	0.0000
55	0.85360	COM1	Combination	0.000	-0.708	0.000	-0.0204	0.0000
55	1.28040	COM1	Combination	0.000	0.832	0.000	0.0220	0.0000
55	1.70720	COM1	Combination	0.000	2.372	0.000	0.0644	0.0000
55	2.13400	COM1	Combination	0.000	3.912	0.000	0.1067	0.0000
55	0.00000	COM2	Combination	0.000	-12.364	0.000	-0.3335	0.0000
55	0.42680	COM2	Combination	0.000	-7.459	0.000	-0.1986	0.0000
55	0.85360	COM2	Combination	0.000	-2.554	0.000	-0.0637	0.0000
55	1.28040	COM2	Combination	0.000	2.351	0.000	0.0712	0.0000
55	1.70720	COM2	Combination	0.000	7.256	0.000	0.2062	0.0000
55	2.13400	COM2	Combination	0.000	12.161	0.000	0.3411	0.0000
55	0.00000	COM3	Combination	0.000	-3.182	0.000	-0.0944	0.0000
55	0.42680	COM3	Combination	0.000	-1.807	0.000	-0.0566	0.0000
55	0.85360	COM3	Combination	0.000	-0.433	0.000	-0.0188	0.0000
55	1.28040	COM3	Combination	0.000	0.942	0.000	0.0191	0.0000
55	1.70720	COM3	Combination	0.000	2.317	0.000	0.0569	0.0000
55	2.13400	COM3	Combination	0.000	3.692	0.000	0.0947	0.0000
55	0.00000	LIFTLUG	Combination	0.000	-8.693	0.000	-0.2349	0.0000
55	0.42680	LIFTLUG	Combination	0.000	-5.240	0.000	-0.1399	0.0000
55	0.85360	LIFTLUG	Combination	0.000	-1.787	0.000	-0.0449	0.0000
55	1.28040	LIFTLUG	Combination	0.000	1.667	0.000	0.0501	0.0000
55	1.70720	LIFTLUG	Combination	0.000	5.120	0.000	0.1451	0.0000
55	2.13400	LIFTLUG	Combination	0.000	8.573	0.000	0.2401	0.0000
58	0.00000	COM1	Combination	0.000	-3.338	0.000	-0.0723	0.0000
58	0.44033	COM1	Combination	0.000	-1.625	0.000	-0.0252	0.0000
58	0.88067	COM1	Combination	0.000	0.088	0.000	0.0220	0.0000
58	1.32100	COM1	Combination	0.000	1.802	0.000	0.0691	0.0000
58	0.00000	COM2	Combination	0.000	-12.603	0.000	-0.2858	0.0000
58	0.44033	COM2	Combination	0.000	-5.830	0.000	-0.0995	0.0000
58	0.88067	COM2	Combination	0.000	0.943	0.000	0.0868	0.0000
58	1.32100	COM2	Combination	0.000	7.716	0.000	0.2731	0.0000
58	0.00000	COM3	Combination	0.000	-2.969	0.000	-0.0647	0.0000
58	0.44033	COM3	Combination	0.000	-1.439	0.000	-0.0226	0.0000
58	0.88067	COM3	Combination	0.000	0.091	0.000	0.0195	0.0000
58	1.32100	COM3	Combination	0.000	1.621	0.000	0.0615	0.0000
58	0.00000	LIFTLUG	Combination	0.000	-8.799	0.000	-0.1991	0.0000
58	0.44033	LIFTLUG	Combination	0.000	-4.080	0.000	-0.0693	0.0000
58	0.88067	LIFTLUG	Combination	0.000	0.639	0.000	0.0605	0.0000
58	1.32100	LIFTLUG	Combination	0.000	5.358	0.000	0.1903	0.0000
59	0.00000	COM1	Combination	0.000	-3.670	0.000	-0.1132	0.0000
59	0.42680	COM1	Combination	0.000	-2.009	0.000	-0.0675	0.0000
59	0.85360	COM1	Combination	0.000	-0.348	0.000	-0.0218	0.0000
59	1.28040	COM1	Combination	0.000	1.312	0.000	0.0238	0.0000
59	1.70720	COM1	Combination	0.000	2.973	0.000	0.0695	0.0000
59	2.13400	COM1	Combination	0.000	4.634	0.000	0.1152	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
59	0.0000	COM2	Combination	0.000	-14.873	0.000	-0.4475	0.0000
59	0.42680	COM2	Combination	0.000	-8.309	0.000	-0.2669	0.0000
59	0.85360	COM2	Combination	0.000	-1.744	0.000	-0.0863	0.0000
59	1.28040	COM2	Combination	0.000	4.821	0.000	0.0943	0.0000
59	1.70720	COM2	Combination	0.000	11.385	0.000	0.2749	0.0000
59	2.13400	COM2	Combination	0.000	17.950	0.000	0.4554	0.0000
59	0.00000	COM3	Combination	0.000	-3.283	0.000	-0.1010	0.0000
59	0.42680	COM3	Combination	0.000	-1.801	0.000	-0.0602	0.0000
59	0.85360	COM3	Combination	0.000	-0.318	0.000	-0.0194	0.0000
59	1.28040	COM3	Combination	0.000	1.165	0.000	0.0214	0.0000
59	1.70720	COM3	Combination	0.000	2.647	0.000	0.0622	0.0000
59	2.13400	COM3	Combination	0.000	4.130	0.000	0.1030	0.0000
59	0.00000	LIFTLUG	Combination	0.000	-10.352	0.000	-0.3118	0.0000
59	0.42680	LIFTLUG	Combination	0.000	-5.778	0.000	-0.1860	0.0000
59	0.85360	LIFTLUG	Combination	0.000	-1.204	0.000	-0.0601	0.0000
59	1.28040	LIFTLUG	Combination	0.000	3.370	0.000	0.0657	0.0000
59	1.70720	LIFTLUG	Combination	0.000	7.944	0.000	0.1915	0.0000
59	2.13400	LIFTLUG	Combination	0.000	12.518	0.000	0.3173	0.0000
60	0.00000	COM1	Combination	0.000	-8.274	0.000	0.0024	0.0000
60	0.44033	COM1	Combination	0.000	-6.990	0.000	0.0024	0.0000
60	0.88067	COM1	Combination	0.000	-5.706	0.000	0.0024	0.0000
60	1.32100	COM1	Combination	0.000	-4.422	0.000	0.0024	0.0000
60	1.32100	COM1	Combination	0.000	0.815	0.000	-0.0015	0.0000
60	1.74780	COM1	Combination	0.000	2.059	0.000	-0.0015	0.0000
60	2.17460	COM1	Combination	0.000	3.304	0.000	-0.0015	0.0000
60	2.60140	COM1	Combination	0.000	4.548	0.000	-0.0015	0.0000
60	3.02820	COM1	Combination	0.000	5.793	0.000	-0.0015	0.0000
60	3.45500	COM1	Combination	0.000	7.038	0.000	-0.0015	0.0000
60	0.00000	COM2	Combination	0.000	-45.532	0.000	0.0083	0.0000
60	0.44033	COM2	Combination	0.000	-38.346	0.000	0.0083	0.0000
60	0.88067	COM2	Combination	0.000	-31.160	0.000	0.0083	0.0000
60	1.32100	COM2	Combination	0.000	-23.974	0.000	0.0083	0.0000
60	1.32100	COM2	Combination	0.000	4.077	0.000	-0.0053	0.0000
60	1.74780	COM2	Combination	0.000	11.043	0.000	-0.0053	0.0000
60	2.17460	COM2	Combination	0.000	18.008	0.000	-0.0053	0.0000
60	2.60140	COM2	Combination	0.000	24.973	0.000	-0.0053	0.0000
60	3.02820	COM2	Combination	0.000	31.938	0.000	-0.0053	0.0000
60	3.45500	COM2	Combination	0.000	38.904	0.000	-0.0053	0.0000
60	0.00000	COM3	Combination	0.000	-7.277	0.000	0.0016	0.0000
60	0.44033	COM3	Combination	0.000	-6.131	0.000	0.0016	0.0000
60	0.88067	COM3	Combination	0.000	-4.984	0.000	0.0016	0.0000
60	1.32100	COM3	Combination	0.000	-3.838	0.000	0.0016	0.0000
60	1.32100	COM3	Combination	0.000	0.659	0.000	-9.913E-04	0.0000
60	1.74780	COM3	Combination	0.000	1.771	0.000	-9.913E-04	0.0000
60	2.17460	COM3	Combination	0.000	2.882	0.000	-9.913E-04	0.0000
60	2.60140	COM3	Combination	0.000	3.993	0.000	-9.913E-04	0.0000
60	3.02820	COM3	Combination	0.000	5.104	0.000	-9.913E-04	0.0000
60	3.45500	COM3	Combination	0.000	6.216	0.000	-9.913E-04	0.0000
60	0.00000	LIFTLUG	Combination	0.000	-31.340	0.000	0.0058	0.0000
60	0.44033	LIFTLUG	Combination	0.000	-26.396	0.000	0.0058	0.0000
60	0.88067	LIFTLUG	Combination	0.000	-21.453	0.000	0.0058	0.0000
60	1.32100	LIFTLUG	Combination	0.000	-16.509	0.000	0.0058	0.0000
60	1.32100	LIFTLUG	Combination	0.000	2.815	0.000	-0.0037	0.0000
60	1.74780	LIFTLUG	Combination	0.000	7.607	0.000	-0.0037	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
60	2.17460	LIFTLUG	Combination	0.000	12.399	0.000	-0.0037	0.0000
60	2.60140	LIFTLUG	Combination	0.000	17.190	0.000	-0.0037	0.0000
60	3.02820	LIFTLUG	Combination	0.000	21.982	0.000	-0.0037	0.0000
60	3.45500	LIFTLUG	Combination	0.000	26.774	0.000	-0.0037	0.0000
61	0.00000	COM1	Combination	0.000	-14.249	0.000	-0.0026	0.0000
61	0.44033	COM1	Combination	0.000	-12.459	0.000	-0.0026	0.0000
61	0.88067	COM1	Combination	0.000	-10.669	0.000	-0.0026	0.0000
61	1.32100	COM1	Combination	0.000	-8.879	0.000	-0.0026	0.0000
61	1.32100	COM1	Combination	0.000	2.814	0.000	0.0017	0.0000
61	1.74780	COM1	Combination	0.000	4.549	0.000	0.0017	0.0000
61	2.17460	COM1	Combination	0.000	6.284	0.000	0.0017	0.0000
61	2.60140	COM1	Combination	0.000	8.019	0.000	0.0017	0.0000
61	3.02820	COM1	Combination	0.000	9.754	0.000	0.0017	0.0000
61	3.45500	COM1	Combination	0.000	11.489	0.000	0.0017	0.0000
61	0.00000	COM2	Combination	0.000	-49.792	0.000	-0.0135	0.0000
61	0.44033	COM2	Combination	0.000	-43.575	0.000	-0.0135	0.0000
61	0.88067	COM2	Combination	0.000	-37.358	0.000	-0.0135	0.0000
61	1.32100	COM2	Combination	0.000	-31.141	0.000	-0.0135	0.0000
61	1.32100	COM2	Combination	0.000	9.958	0.000	0.0087	0.0000
61	1.74780	COM2	Combination	0.000	15.984	0.000	0.0087	0.0000
61	2.17460	COM2	Combination	0.000	22.010	0.000	0.0087	0.0000
61	2.60140	COM2	Combination	0.000	28.037	0.000	0.0087	0.0000
61	3.02820	COM2	Combination	0.000	34.063	0.000	0.0087	0.0000
61	3.45500	COM2	Combination	0.000	40.089	0.000	0.0087	0.0000
61	0.00000	COM3	Combination	0.000	-12.508	0.000	-0.0017	0.0000
61	0.44033	COM3	Combination	0.000	-10.910	0.000	-0.0017	0.0000
61	0.88067	COM3	Combination	0.000	-9.312	0.000	-0.0017	0.0000
61	1.32100	COM3	Combination	0.000	-7.714	0.000	-0.0017	0.0000
61	1.32100	COM3	Combination	0.000	2.380	0.000	0.0011	0.0000
61	1.74780	COM3	Combination	0.000	3.929	0.000	0.0011	0.0000
61	2.17460	COM3	Combination	0.000	5.479	0.000	0.0011	0.0000
61	2.60140	COM3	Combination	0.000	7.028	0.000	0.0011	0.0000
61	3.02820	COM3	Combination	0.000	8.577	0.000	0.0011	0.0000
61	3.45500	COM3	Combination	0.000	10.126	0.000	0.0011	0.0000
61	0.00000	LIFTLUG	Combination	0.000	-34.891	0.000	-0.0093	0.0000
61	0.44033	LIFTLUG	Combination	0.000	-30.533	0.000	-0.0093	0.0000
61	0.88067	LIFTLUG	Combination	0.000	-26.175	0.000	-0.0093	0.0000
61	1.32100	LIFTLUG	Combination	0.000	-21.818	0.000	-0.0093	0.0000
61	1.32100	LIFTLUG	Combination	0.000	6.974	0.000	0.0060	0.0000
61	1.74780	LIFTLUG	Combination	0.000	11.198	0.000	0.0060	0.0000
61	2.17460	LIFTLUG	Combination	0.000	15.422	0.000	0.0060	0.0000
61	2.60140	LIFTLUG	Combination	0.000	19.646	0.000	0.0060	0.0000
61	3.02820	LIFTLUG	Combination	0.000	23.870	0.000	0.0060	0.0000
61	3.45500	LIFTLUG	Combination	0.000	28.094	0.000	0.0060	0.0000
62	0.00000	COM1	Combination	0.000	-2.041	0.000	-0.0013	0.0000
62	0.44500	COM1	Combination	0.000	-1.904	0.000	-0.0013	0.0000
62	0.89000	COM1	Combination	0.000	-1.767	0.000	-0.0013	0.0000
62	0.89000	COM1	Combination	0.000	3.214	0.000	8.000E-04	0.0000
62	1.28350	COM1	Combination	0.000	3.335	0.000	8.000E-04	0.0000
62	1.67700	COM1	Combination	0.000	3.456	0.000	8.000E-04	0.0000
62	0.00000	COM2	Combination	0.000	-14.282	0.000	-0.0090	0.0000
62	0.44500	COM2	Combination	0.000	-14.160	0.000	-0.0090	0.0000
62	0.89000	COM2	Combination	0.000	-14.038	0.000	-0.0090	0.0000
62	0.89000	COM2	Combination	0.000	18.691	0.000	0.0055	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
62	1.28350	COM2	Combination	0.000	18.799	0.000	0.0055	0.0000
62	1.67700	COM2	Combination	0.000	18.907	0.000	0.0055	0.0000
62	0.00000	COM3	Combination	0.000	-1.560	0.000	-5.181E-04	0.0000
62	0.44500	COM3	Combination	0.000	-1.438	0.000	-5.181E-04	0.0000
62	0.89000	COM3	Combination	0.000	-1.315	0.000	-5.181E-04	0.0000
62	0.89000	COM3	Combination	0.000	2.892	0.000	9.355E-04	0.0000
62	1.28350	COM3	Combination	0.000	3.000	0.000	9.355E-04	0.0000
62	1.67700	COM3	Combination	0.000	3.108	0.000	9.355E-04	0.0000
62	0.00000	LIFTLUG	Combination	0.000	-9.765	0.000	-0.0061	0.0000
62	0.44500	LIFTLUG	Combination	0.000	-9.667	0.000	-0.0061	0.0000
62	0.89000	LIFTLUG	Combination	0.000	-9.569	0.000	-0.0061	0.0000
62	0.89000	LIFTLUG	Combination	0.000	12.843	0.000	0.0038	0.0000
62	1.28350	LIFTLUG	Combination	0.000	12.930	0.000	0.0038	0.0000
62	1.67700	LIFTLUG	Combination	0.000	13.016	0.000	0.0038	0.0000
63	0.00000	COM1	Combination	0.000	-8.162	0.000	-0.0020	0.0000
63	0.25200	COM1	Combination	0.000	-8.085	0.000	-0.0020	0.0000
63	0.50400	COM1	Combination	0.000	-8.007	0.000	-0.0020	0.0000
63	0.50400	COM1	Combination	0.000	-1.945	0.000	3.760E-04	0.0000
63	0.80850	COM1	Combination	0.000	-1.852	0.000	3.760E-04	0.0000
63	1.11300	COM1	Combination	0.000	-1.758	0.000	3.760E-04	0.0000
63	1.11300	COM1	Combination	0.000	4.290	0.000	-0.0027	0.0000
63	1.42300	COM1	Combination	0.000	4.386	0.000	-0.0027	0.0000
63	1.42300	COM1	Combination	0.000	8.025	0.000	0.0106	0.0000
63	1.67700	COM1	Combination	0.000	8.244	0.000	0.0106	0.0000
63	0.00000	COM2	Combination	0.000	-27.259	0.000	-0.0064	0.0000
63	0.25200	COM2	Combination	0.000	-27.190	0.000	-0.0064	0.0000
63	0.50400	COM2	Combination	0.000	-27.121	0.000	-0.0064	0.0000
63	0.50400	COM2	Combination	0.000	-4.689	0.000	0.0029	0.0000
63	0.80850	COM2	Combination	0.000	-4.605	0.000	0.0029	0.0000
63	1.11300	COM2	Combination	0.000	-4.522	0.000	0.0029	0.0000
63	1.11300	COM2	Combination	0.000	15.548	0.000	-0.0024	0.0000
63	1.42300	COM2	Combination	0.000	15.633	0.000	-0.0024	0.0000
63	1.42300	COM2	Combination	0.000	21.281	0.000	0.0279	0.0000
63	1.67700	COM2	Combination	0.000	23.297	0.000	0.0279	0.0000
63	0.00000	COM3	Combination	0.000	-7.012	0.000	-0.0020	0.0000
63	0.25200	COM3	Combination	0.000	-6.943	0.000	-0.0020	0.0000
63	0.50400	COM3	Combination	0.000	-6.873	0.000	-0.0020	0.0000
63	0.50400	COM3	Combination	0.000	-1.578	0.000	-1.047E-04	0.0000
63	0.80850	COM3	Combination	0.000	-1.495	0.000	-1.047E-04	0.0000
63	1.11300	COM3	Combination	0.000	-1.411	0.000	-1.047E-04	0.0000
63	1.11300	COM3	Combination	0.000	3.461	0.000	-0.0041	0.0000
63	1.42300	COM3	Combination	0.000	3.546	0.000	-0.0041	0.0000
63	1.42300	COM3	Combination	0.000	5.233	0.000	0.0105	0.0000
63	1.67700	COM3	Combination	0.000	5.429	0.000	0.0105	0.0000
63	0.00000	LIFTLUG	Combination	0.000	-19.144	0.000	-0.0045	0.0000
63	0.25200	LIFTLUG	Combination	0.000	-19.089	0.000	-0.0045	0.0000
63	0.50400	LIFTLUG	Combination	0.000	-19.034	0.000	-0.0045	0.0000
63	0.50400	LIFTLUG	Combination	0.000	-3.358	0.000	0.0020	0.0000
63	0.80850	LIFTLUG	Combination	0.000	-3.291	0.000	0.0020	0.0000
63	1.11300	LIFTLUG	Combination	0.000	-3.224	0.000	0.0020	0.0000
63	1.11300	LIFTLUG	Combination	0.000	10.876	0.000	-0.0019	0.0000
63	1.42300	LIFTLUG	Combination	0.000	10.944	0.000	-0.0019	0.0000
63	1.42300	LIFTLUG	Combination	0.000	15.143	0.000	0.0199	0.0000
63	1.67700	LIFTLUG	Combination	0.000	16.513	0.000	0.0199	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
64	0.0000	COM1	Combination	0.000	-14.571	0.000	0.0025	0.0000
64	0.44033	COM1	Combination	0.000	-12.714	0.000	0.0025	0.0000
64	0.88067	COM1	Combination	0.000	-10.857	0.000	0.0025	0.0000
64	1.32100	COM1	Combination	0.000	-9.001	0.000	0.0025	0.0000
64	1.32100	COM1	Combination	0.000	2.668	0.000	-0.0029	0.0000
64	1.65967	COM1	Combination	0.000	4.114	0.000	-0.0029	0.0000
64	1.99833	COM1	Combination	0.000	5.559	0.000	-0.0029	0.0000
64	2.33700	COM1	Combination	0.000	7.004	0.000	-0.0029	0.0000
64	2.33700	COM1	Combination	0.000	7.143	0.000	-2.622E-04	0.0000
64	2.70967	COM1	Combination	0.000	8.733	0.000	-2.622E-04	0.0000
64	3.08233	COM1	Combination	0.000	10.324	0.000	-2.622E-04	0.0000
64	3.45500	COM1	Combination	0.000	11.914	0.000	-2.622E-04	0.0000
64	0.00000	COM2	Combination	0.000	-56.222	0.000	0.0098	0.0000
64	0.44033	COM2	Combination	0.000	-49.088	0.000	0.0098	0.0000
64	0.88067	COM2	Combination	0.000	-41.953	0.000	0.0098	0.0000
64	1.32100	COM2	Combination	0.000	-34.818	0.000	0.0098	0.0000
64	1.32100	COM2	Combination	0.000	10.070	0.000	-0.0083	0.0000
64	1.65967	COM2	Combination	0.000	15.795	0.000	-0.0083	0.0000
64	1.99833	COM2	Combination	0.000	21.520	0.000	-0.0083	0.0000
64	2.33700	COM2	Combination	0.000	27.246	0.000	-0.0083	0.0000
64	2.33700	COM2	Combination	0.000	27.372	0.000	-0.0038	0.0000
64	2.70967	COM2	Combination	0.000	33.673	0.000	-0.0038	0.0000
64	3.08233	COM2	Combination	0.000	39.973	0.000	-0.0038	0.0000
64	3.45500	COM2	Combination	0.000	46.273	0.000	-0.0038	0.0000
64	0.00000	COM3	Combination	0.000	-12.253	0.000	0.0019	0.0000
64	0.44033	COM3	Combination	0.000	-10.595	0.000	0.0019	0.0000
64	0.88067	COM3	Combination	0.000	-8.937	0.000	0.0019	0.0000
64	1.32100	COM3	Combination	0.000	-7.279	0.000	0.0019	0.0000
64	1.32100	COM3	Combination	0.000	1.914	0.000	-0.0032	0.0000
64	1.65967	COM3	Combination	0.000	3.204	0.000	-0.0032	0.0000
64	1.99833	COM3	Combination	0.000	4.495	0.000	-0.0032	0.0000
64	2.33700	COM3	Combination	0.000	5.785	0.000	-0.0032	0.0000
64	2.33700	COM3	Combination	0.000	5.908	0.000	6.790E-04	0.0000
64	2.70967	COM3	Combination	0.000	7.328	0.000	6.790E-04	0.0000
64	3.08233	COM3	Combination	0.000	8.749	0.000	6.790E-04	0.0000
64	3.45500	COM3	Combination	0.000	10.169	0.000	6.790E-04	0.0000
64	0.00000	LIFTLUG	Combination	0.000	-39.216	0.000	0.0069	0.0000
64	0.44033	LIFTLUG	Combination	0.000	-34.239	0.000	0.0069	0.0000
64	0.88067	LIFTLUG	Combination	0.000	-29.261	0.000	0.0069	0.0000
64	1.32100	LIFTLUG	Combination	0.000	-24.284	0.000	0.0069	0.0000
64	1.32100	LIFTLUG	Combination	0.000	7.031	0.000	-0.0059	0.0000
64	1.65967	LIFTLUG	Combination	0.000	11.020	0.000	-0.0059	0.0000
64	1.99833	LIFTLUG	Combination	0.000	15.009	0.000	-0.0059	0.0000
64	2.33700	LIFTLUG	Combination	0.000	18.998	0.000	-0.0059	0.0000
64	2.33700	LIFTLUG	Combination	0.000	19.099	0.000	-0.0026	0.0000
64	2.70967	LIFTLUG	Combination	0.000	23.488	0.000	-0.0026	0.0000
64	3.08233	LIFTLUG	Combination	0.000	27.878	0.000	-0.0026	0.0000
64	3.45500	LIFTLUG	Combination	0.000	32.267	0.000	-0.0026	0.0000
65	0.00000	COM1	Combination	0.000	-1.781	0.000	-0.0016	0.0000
65	0.36850	COM1	Combination	0.000	-1.667	0.000	-0.0016	0.0000
65	0.73700	COM1	Combination	0.000	-1.554	0.000	-0.0016	0.0000
65	0.73700	COM1	Combination	0.000	1.916	0.000	-0.0010	0.0000
65	1.03050	COM1	Combination	0.000	2.006	0.000	-0.0010	0.0000
65	1.32400	COM1	Combination	0.000	2.096	0.000	-0.0010	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
65	1.32400	COM1	Combination	0.000	-3.657	0.000	0.0011	0.0000
65	1.75600	COM1	Combination	0.000	-3.524	0.000	0.0011	0.0000
65	1.75600	COM1	Combination	0.000	-0.833	0.000	-8.654E-04	0.0000
65	2.06700	COM1	Combination	0.000	-0.738	0.000	-8.654E-04	0.0000
65	2.37800	COM1	Combination	0.000	-0.642	0.000	-8.654E-04	0.0000
65	2.37800	COM1	Combination	0.000	5.327	0.000	0.0020	0.0000
65	2.64950	COM1	Combination	0.000	5.411	0.000	0.0020	0.0000
65	2.92100	COM1	Combination	0.000	5.494	0.000	0.0020	0.0000
65	0.00000	COM2	Combination	0.000	-9.144	0.000	-0.0074	0.0000
65	0.36850	COM2	Combination	0.000	-9.043	0.000	-0.0074	0.0000
65	0.73700	COM2	Combination	0.000	-8.942	0.000	-0.0074	0.0000
65	0.73700	COM2	Combination	0.000	12.769	0.000	-0.0015	0.0000
65	1.03050	COM2	Combination	0.000	12.849	0.000	-0.0015	0.0000
65	1.32400	COM2	Combination	0.000	12.929	0.000	-0.0015	0.0000
65	1.32400	COM2	Combination	0.000	-8.010	0.000	0.0070	0.0000
65	1.75600	COM2	Combination	0.000	-7.892	0.000	0.0070	0.0000
65	1.75600	COM2	Combination	0.000	-2.587	0.000	-0.0030	0.0000
65	2.06700	COM2	Combination	0.000	-2.502	0.000	-0.0030	0.0000
65	2.37800	COM2	Combination	0.000	-2.417	0.000	-0.0030	0.0000
65	2.37800	COM2	Combination	0.000	18.972	0.000	0.0073	0.0000
65	2.64950	COM2	Combination	0.000	19.046	0.000	0.0073	0.0000
65	2.92100	COM2	Combination	0.000	19.121	0.000	0.0073	0.0000
65	0.00000	COM3	Combination	0.000	-1.389	0.000	-0.0015	0.0000
65	0.36850	COM3	Combination	0.000	-1.288	0.000	-0.0015	0.0000
65	0.73700	COM3	Combination	0.000	-1.187	0.000	-0.0015	0.0000
65	0.73700	COM3	Combination	0.000	1.885	0.000	-0.0012	0.0000
65	1.03050	COM3	Combination	0.000	1.965	0.000	-0.0012	0.0000
65	1.32400	COM3	Combination	0.000	2.046	0.000	-0.0012	0.0000
65	1.32400	COM3	Combination	0.000	-3.879	0.000	0.0012	0.0000
65	1.75600	COM3	Combination	0.000	-3.760	0.000	0.0012	0.0000
65	1.75600	COM3	Combination	0.000	-1.530	0.000	-6.312E-04	0.0000
65	2.06700	COM3	Combination	0.000	-1.445	0.000	-6.312E-04	0.0000
65	2.37800	COM3	Combination	0.000	-1.359	0.000	-6.312E-04	0.0000
65	2.37800	COM3	Combination	0.000	4.042	0.000	0.0019	0.0000
65	2.64950	COM3	Combination	0.000	4.117	0.000	0.0019	0.0000
65	2.92100	COM3	Combination	0.000	4.191	0.000	0.0019	0.0000
65	0.00000	LIFTLUG	Combination	0.000	-6.308	0.000	-0.0051	0.0000
65	0.36850	LIFTLUG	Combination	0.000	-6.227	0.000	-0.0051	0.0000
65	0.73700	LIFTLUG	Combination	0.000	-6.147	0.000	-0.0051	0.0000
65	0.73700	LIFTLUG	Combination	0.000	8.740	0.000	-0.0011	0.0000
65	1.03050	LIFTLUG	Combination	0.000	8.805	0.000	-0.0011	0.0000
65	1.32400	LIFTLUG	Combination	0.000	8.869	0.000	-0.0011	0.0000
65	1.32400	LIFTLUG	Combination	0.000	-5.775	0.000	0.0048	0.0000
65	1.75600	LIFTLUG	Combination	0.000	-5.681	0.000	0.0048	0.0000
65	1.75600	LIFTLUG	Combination	0.000	-1.824	0.000	-0.0021	0.0000
65	2.06700	LIFTLUG	Combination	0.000	-1.756	0.000	-0.0021	0.0000
65	2.37800	LIFTLUG	Combination	0.000	-1.688	0.000	-0.0021	0.0000
65	2.37800	LIFTLUG	Combination	0.000	13.282	0.000	0.0051	0.0000
65	2.64950	LIFTLUG	Combination	0.000	13.342	0.000	0.0051	0.0000
65	2.92100	LIFTLUG	Combination	0.000	13.401	0.000	0.0051	0.0000
66	0.00000	COM1	Combination	0.000	-6.175	0.000	-0.0042	0.0000
66	0.41950	COM1	Combination	0.000	-6.046	0.000	-0.0042	0.0000
66	0.83900	COM1	Combination	0.000	-5.917	0.000	-0.0042	0.0000
66	0.83900	COM1	Combination	0.000	-3.293	0.000	0.0938	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
66	0.91200	COM1	Combination	0.000	-3.270	0.000	0.0938	0.0000
66	0.91200	COM1	Combination	0.000	1.273	0.000	-0.0080	0.0000
66	1.25700	COM1	Combination	0.000	1.379	0.000	-0.0080	0.0000
66	1.60200	COM1	Combination	0.000	1.485	0.000	-0.0080	0.0000
66	1.60200	COM1	Combination	0.000	5.711	0.000	-5.782E-04	0.0000
66	2.07700	COM1	Combination	0.000	5.856	0.000	-5.782E-04	0.0000
66	2.07700	COM1	Combination	0.000	-2.346	0.000	0.0014	0.0000
66	2.40775	COM1	Combination	0.000	-2.245	0.000	0.0014	0.0000
66	2.73850	COM1	Combination	0.000	-2.143	0.000	0.0014	0.0000
66	2.73850	COM1	Combination	0.000	3.328	0.000	0.0024	0.0000
66	3.06925	COM1	Combination	0.000	3.430	0.000	0.0024	0.0000
66	3.40000	COM1	Combination	0.000	3.531	0.000	0.0024	0.0000
66	0.00000	COM2	Combination	0.000	-25.767	0.000	-0.0153	0.0000
66	0.41950	COM2	Combination	0.000	-25.652	0.000	-0.0153	0.0000
66	0.83900	COM2	Combination	0.000	-25.537	0.000	-0.0153	0.0000
66	0.83900	COM2	Combination	0.000	-13.880	0.000	0.3396	0.0000
66	0.91200	COM2	Combination	0.000	-13.860	0.000	0.3396	0.0000
66	0.91200	COM2	Combination	0.000	5.459	0.000	-0.0288	0.0000
66	1.25700	COM2	Combination	0.000	5.554	0.000	-0.0288	0.0000
66	1.60200	COM2	Combination	0.000	5.648	0.000	-0.0288	0.0000
66	1.60200	COM2	Combination	0.000	21.215	0.000	-0.0020	0.0000
66	2.07700	COM2	Combination	0.000	21.345	0.000	-0.0020	0.0000
66	2.07700	COM2	Combination	0.000	-9.111	0.000	0.0046	0.0000
66	2.40775	COM2	Combination	0.000	-9.021	0.000	0.0046	0.0000
66	2.73850	COM2	Combination	0.000	-8.930	0.000	0.0046	0.0000
66	2.73850	COM2	Combination	0.000	13.659	0.000	0.0098	0.0000
66	3.06925	COM2	Combination	0.000	13.750	0.000	0.0098	0.0000
66	3.40000	COM2	Combination	0.000	13.840	0.000	0.0098	0.0000
66	0.00000	COM3	Combination	0.000	-5.002	0.000	-0.0036	0.0000
66	0.41950	COM3	Combination	0.000	-4.886	0.000	-0.0036	0.0000
66	0.83900	COM3	Combination	0.000	-4.771	0.000	-0.0036	0.0000
66	0.83900	COM3	Combination	0.000	-2.424	0.000	0.0788	0.0000
66	0.91200	COM3	Combination	0.000	-2.404	0.000	0.0788	0.0000
66	0.91200	COM3	Combination	0.000	1.656	0.000	-0.0070	0.0000
66	1.25700	COM3	Combination	0.000	1.750	0.000	-0.0070	0.0000
66	1.60200	COM3	Combination	0.000	1.845	0.000	-0.0070	0.0000
66	1.60200	COM3	Combination	0.000	5.570	0.000	-6.162E-04	0.0000
66	2.07700	COM3	Combination	0.000	5.700	0.000	-6.162E-04	0.0000
66	2.07700	COM3	Combination	0.000	-2.185	0.000	0.0014	0.0000
66	2.40775	COM3	Combination	0.000	-2.094	0.000	0.0014	0.0000
66	2.73850	COM3	Combination	0.000	-2.003	0.000	0.0014	0.0000
66	2.73850	COM3	Combination	0.000	2.901	0.000	0.0022	0.0000
66	3.06925	COM3	Combination	0.000	2.991	0.000	0.0022	0.0000
66	3.40000	COM3	Combination	0.000	3.082	0.000	0.0022	0.0000
66	0.00000	LIFTLUG	Combination	0.000	-17.913	0.000	-0.0107	0.0000
66	0.41950	LIFTLUG	Combination	0.000	-17.821	0.000	-0.0107	0.0000
66	0.83900	LIFTLUG	Combination	0.000	-17.729	0.000	-0.0107	0.0000
66	0.83900	LIFTLUG	Combination	0.000	-9.645	0.000	0.2376	0.0000
66	0.91200	LIFTLUG	Combination	0.000	-9.629	0.000	0.2376	0.0000
66	0.91200	LIFTLUG	Combination	0.000	3.791	0.000	-0.0202	0.0000
66	1.25700	LIFTLUG	Combination	0.000	3.867	0.000	-0.0202	0.0000
66	1.60200	LIFTLUG	Combination	0.000	3.942	0.000	-0.0202	0.0000
66	1.60200	LIFTLUG	Combination	0.000	14.823	0.000	-0.0014	0.0000
66	2.07700	LIFTLUG	Combination	0.000	14.927	0.000	-0.0014	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
66	2.07700	LIFTLUG	Combination	0.000	-6.354	0.000	0.0032	0.0000
66	2.40775	LIFTLUG	Combination	0.000	-6.281	0.000	0.0032	0.0000
66	2.73850	LIFTLUG	Combination	0.000	-6.208	0.000	0.0032	0.0000
66	2.73850	LIFTLUG	Combination	0.000	9.502	0.000	0.0068	0.0000
66	3.06925	LIFTLUG	Combination	0.000	9.575	0.000	0.0068	0.0000
66	3.40000	LIFTLUG	Combination	0.000	9.647	0.000	0.0068	0.0000
67	0.00000	COM1	Combination	0.000	-7.807	0.000	-0.0406	0.0000
67	0.44033	COM1	Combination	0.000	-6.804	0.000	-0.0130	0.0000
67	0.88067	COM1	Combination	0.000	-5.801	0.000	0.0146	0.0000
67	1.32100	COM1	Combination	0.000	-4.798	0.000	0.0422	0.0000
67	0.00000	COM2	Combination	0.000	-33.441	0.000	-0.2027	0.0000
67	0.44033	COM2	Combination	0.000	-28.507	0.000	-0.0669	0.0000
67	0.88067	COM2	Combination	0.000	-23.573	0.000	0.0688	0.0000
67	1.32100	COM2	Combination	0.000	-18.639	0.000	0.2045	0.0000
67	0.00000	COM3	Combination	0.000	-7.507	0.000	-0.0362	0.0000
67	0.44033	COM3	Combination	0.000	-6.611	0.000	-0.0115	0.0000
67	0.88067	COM3	Combination	0.000	-5.715	0.000	0.0131	0.0000
67	1.32100	COM3	Combination	0.000	-4.820	0.000	0.0378	0.0000
67	0.00000	LIFTLUG	Combination	0.000	-23.223	0.000	-0.1399	0.0000
67	0.44033	LIFTLUG	Combination	0.000	-19.815	0.000	-0.0462	0.0000
67	0.88067	LIFTLUG	Combination	0.000	-16.406	0.000	0.0476	0.0000
67	1.32100	LIFTLUG	Combination	0.000	-12.997	0.000	0.1414	0.0000
68	0.00000	COM1	Combination	0.000	0.956	0.000	-0.0674	0.0000
68	0.42680	COM1	Combination	0.000	1.928	0.000	-0.0406	0.0000
68	0.85360	COM1	Combination	0.000	2.900	0.000	-0.0139	0.0000
68	1.28040	COM1	Combination	0.000	3.873	0.000	0.0129	0.0000
68	1.70720	COM1	Combination	0.000	4.845	0.000	0.0396	0.0000
68	2.13400	COM1	Combination	0.000	5.817	0.000	0.0664	0.0000
68	0.00000	COM2	Combination	0.000	2.300	0.000	-0.3295	0.0000
68	0.42680	COM2	Combination	0.000	7.083	0.000	-0.1979	0.0000
68	0.85360	COM2	Combination	0.000	11.865	0.000	-0.0664	0.0000
68	1.28040	COM2	Combination	0.000	16.647	0.000	0.0652	0.0000
68	1.70720	COM2	Combination	0.000	21.430	0.000	0.1967	0.0000
68	2.13400	COM2	Combination	0.000	26.212	0.000	0.3283	0.0000
68	0.00000	COM3	Combination	0.000	1.105	0.000	-0.0602	0.0000
68	0.42680	COM3	Combination	0.000	1.973	0.000	-0.0363	0.0000
68	0.85360	COM3	Combination	0.000	2.841	0.000	-0.0124	0.0000
68	1.28040	COM3	Combination	0.000	3.709	0.000	0.0115	0.0000
68	1.70720	COM3	Combination	0.000	4.578	0.000	0.0353	0.0000
68	2.13400	COM3	Combination	0.000	5.446	0.000	0.0592	0.0000
68	0.00000	LIFTLUG	Combination	0.000	1.647	0.000	-0.2277	0.0000
68	0.42680	LIFTLUG	Combination	0.000	4.951	0.000	-0.1368	0.0000
68	0.85360	LIFTLUG	Combination	0.000	8.255	0.000	-0.0459	0.0000
68	1.28040	LIFTLUG	Combination	0.000	11.559	0.000	0.0450	0.0000
68	1.70720	LIFTLUG	Combination	0.000	14.863	0.000	0.1359	0.0000
68	2.13400	LIFTLUG	Combination	0.000	18.167	0.000	0.2268	0.0000
69	0.00000	COM1	Combination	0.000	-11.974	0.000	-0.0694	0.0000
69	0.44033	COM1	Combination	0.000	-10.318	0.000	-0.0239	0.0000
69	0.88067	COM1	Combination	0.000	-8.662	0.000	0.0217	0.0000
69	1.32100	COM1	Combination	0.000	-7.007	0.000	0.0672	0.0000
69	0.00000	COM2	Combination	0.000	-43.850	0.000	-0.2513	0.0000
69	0.44033	COM2	Combination	0.000	-37.868	0.000	-0.0867	0.0000
69	0.88067	COM2	Combination	0.000	-31.886	0.000	0.0778	0.0000
69	1.32100	COM2	Combination	0.000	-25.903	0.000	0.2424	0.0000

Table 21: Element Forces - Frames, Part 1 of 2

Frame	Station m	OutputCase	CaseType	P KN	V2 KN	V3 KN	T KN-m	M2 KN-m
69	0.00000	COM3	Combination	0.000	-11.043	0.000	-0.0621	0.0000
69	0.44033	COM3	Combination	0.000	-9.564	0.000	-0.0214	0.0000
69	0.88067	COM3	Combination	0.000	-8.086	0.000	0.0193	0.0000
69	1.32100	COM3	Combination	0.000	-6.607	0.000	0.0599	0.0000
69	0.00000	LIFTLUG	Combination	0.000	-30.659	0.000	-0.1758	0.0000
69	0.44033	LIFTLUG	Combination	0.000	-26.474	0.000	-0.0607	0.0000
69	0.88067	LIFTLUG	Combination	0.000	-22.288	0.000	0.0545	0.0000
69	1.32100	LIFTLUG	Combination	0.000	-18.103	0.000	0.1696	0.0000
70	0.00000	COM1	Combination	0.000	1.196	0.000	-0.1097	0.0000
70	0.42680	COM1	Combination	0.000	2.801	0.000	-0.0656	0.0000
70	0.85360	COM1	Combination	0.000	4.406	0.000	-0.0214	0.0000
70	1.28040	COM1	Combination	0.000	6.011	0.000	0.0227	0.0000
70	1.70720	COM1	Combination	0.000	7.616	0.000	0.0669	0.0000
70	2.13400	COM1	Combination	0.000	9.221	0.000	0.1110	0.0000
70	0.00000	COM2	Combination	0.000	4.553	0.000	-0.3961	0.0000
70	0.42680	COM2	Combination	0.000	10.351	0.000	-0.2366	0.0000
70	0.85360	COM2	Combination	0.000	16.150	0.000	-0.0771	0.0000
70	1.28040	COM2	Combination	0.000	21.948	0.000	0.0825	0.0000
70	1.70720	COM2	Combination	0.000	27.747	0.000	0.2420	0.0000
70	2.13400	COM2	Combination	0.000	33.545	0.000	0.4015	0.0000
70	0.00000	COM3	Combination	0.000	1.278	0.000	-0.0979	0.0000
70	0.42680	COM3	Combination	0.000	2.711	0.000	-0.0585	0.0000
70	0.85360	COM3	Combination	0.000	4.144	0.000	-0.0191	0.0000
70	1.28040	COM3	Combination	0.000	5.577	0.000	0.0203	0.0000
70	1.70720	COM3	Combination	0.000	7.010	0.000	0.0598	0.0000
70	2.13400	COM3	Combination	0.000	8.443	0.000	0.0992	0.0000
70	0.00000	LIFTLUG	Combination	0.000	3.178	0.000	-0.2771	0.0000
70	0.42680	LIFTLUG	Combination	0.000	7.234	0.000	-0.1655	0.0000
70	0.85360	LIFTLUG	Combination	0.000	11.291	0.000	-0.0539	0.0000
70	1.28040	LIFTLUG	Combination	0.000	15.348	0.000	0.0577	0.0000
70	1.70720	LIFTLUG	Combination	0.000	19.405	0.000	0.1693	0.0000
70	2.13400	LIFTLUG	Combination	0.000	23.461	0.000	0.2809	0.0000

Table 21: Element Forces - Frames, Part 2 of 2

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
1	0.00000	COM1	-3.4934	1-1	0.00000
1	0.44033	COM1	-0.3433	1-1	0.44033
1	0.88067	COM1	2.0561	1-1	0.88067
1	1.32100	COM1	3.7046	1-1	1.32100
1	1.32100	COM1	3.7058	1-2	0.00000
1	1.74780	COM1	3.7162	1-2	0.42680
1	2.17460	COM1	3.0211	1-2	0.85360
1	2.60140	COM1	1.6207	1-2	1.28040
1	3.02820	COM1	-0.4851	1-2	1.70720
1	3.45500	COM1	-3.2963	1-2	2.13400
1	0.00000	COM2	-13.4948	1-1	0.00000
1	0.44033	COM2	-1.8093	1-1	0.44033
1	0.88067	COM2	7.6527	1-1	0.88067
1	1.32100	COM2	14.8912	1-1	1.32100
1	1.32100	COM2	14.9002	1-2	0.00000

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
1	1.74780	COM2	13.6985	1-2	0.42680
1	2.17460	COM2	10.4079	1-2	0.85360
1	2.60140	COM2	5.0284	1-2	1.28040
1	3.02820	COM2	-2.4400	1-2	1.70720
1	3.45500	COM2	-11.9973	1-2	2.13400
1	0.00000	COM3	-7.5835	1-1	0.00000
1	0.44033	COM3	-0.3730	1-1	0.44033
1	0.88067	COM3	4.8584	1-1	0.88067
1	1.32100	COM3	8.1105	1-1	1.32100
1	1.32100	COM3	8.1111	1-2	0.00000
1	1.74780	COM3	8.7088	1-2	0.42680
1	2.17460	COM3	7.4472	1-2	0.85360
1	2.60140	COM3	4.3263	1-2	1.28040
1	3.02820	COM3	-0.6541	1-2	1.70720
1	3.45500	COM3	-7.4938	1-2	2.13400
1	0.00000	LIFTLUG	-9.4124	1-1	0.00000
1	0.44033	LIFTLUG	-1.2471	1-1	0.44033
1	0.88067	LIFTLUG	5.3466	1-1	0.88067
1	1.32100	LIFTLUG	10.3685	1-1	1.32100
1	1.32100	LIFTLUG	10.3746	1-2	0.00000
1	1.74780	LIFTLUG	9.5747	1-2	0.42680
1	2.17460	LIFTLUG	7.2982	1-2	0.85360
1	2.60140	LIFTLUG	3.5452	1-2	1.28040
1	3.02820	LIFTLUG	-1.6844	1-2	1.70720
1	3.45500	LIFTLUG	-8.3906	1-2	2.13400
2	0.00000	COM1	-0.0214	2-1	0.00000
2	0.44033	COM1	3.5558	2-1	0.44033
2	0.88067	COM1	6.5031	2-1	0.88067
2	1.32100	COM1	8.8203	2-1	1.32100
2	1.32100	COM1	8.8309	2-2	0.00000
2	1.74780	COM1	6.9569	2-2	0.42680
2	2.17460	COM1	4.4910	2-2	0.85360
2	2.60140	COM1	1.4332	2-2	1.28040
2	3.02820	COM1	-2.2166	2-2	1.70720
2	3.45500	COM1	-6.4582	2-2	2.13400
2	0.00000	COM2	-0.0446	2-1	0.00000
2	0.44033	COM2	6.5835	2-1	0.44033
2	0.88067	COM2	12.6491	2-1	0.88067
2	1.32100	COM2	18.1522	2-1	1.32100
2	1.32100	COM2	18.1801	2-2	0.00000
2	1.74780	COM2	13.0342	2-2	0.42680
2	2.17460	COM2	7.3598	2-2	0.85360
2	2.60140	COM2	1.1569	2-2	1.28040
2	3.02820	COM2	-5.5745	2-2	1.70720
2	3.45500	COM2	-12.8344	2-2	2.13400
2	0.00000	COM3	-0.0358	2-1	0.00000
2	0.44033	COM3	6.3875	2-1	0.44033
2	0.88067	COM3	10.9396	2-1	0.88067
2	1.32100	COM3	13.6203	2-1	1.32100
2	1.32100	COM3	13.6308	2-2	0.00000
2	1.74780	COM3	12.1260	2-2	0.42680
2	2.17460	COM3	8.8631	2-2	0.85360
2	2.60140	COM3	3.8422	2-2	1.28040
2	3.02820	COM3	-2.9368	2-2	1.70720

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
2	3.45500	COM3	-11.4738	2-2	2.13400
2	0.00000	LIFTLUG	-0.0323	2-1	0.00000
2	0.44033	LIFTLUG	4.8123	2-1	0.44033
2	0.88067	LIFTLUG	9.2069	2-1	0.88067
2	1.32100	LIFTLUG	13.1515	2-1	1.32100
2	1.32100	LIFTLUG	13.1714	2-2	0.00000
2	1.74780	LIFTLUG	9.5177	2-2	0.42680
2	2.17460	LIFTLUG	5.4412	2-2	0.85360
2	2.60140	LIFTLUG	0.9419	2-2	1.28040
2	3.02820	LIFTLUG	-3.9802	2-2	1.70720
2	3.45500	LIFTLUG	-9.3251	2-2	2.13400
3	0.00000	COM1	-5.1586	3-1	0.00000
3	0.44500	COM1	-1.2270	3-1	0.44500
3	0.89000	COM1	2.0612	3-1	0.89000
3	0.89000	COM1	2.0589	3-2	0.00000
3	1.28350	COM1	3.3173	3-2	0.39350
3	1.67700	COM1	4.0726	3-2	0.78700
3	1.67700	COM1	4.0741	3-3	0.00000
3	2.04550	COM1	1.7317	3-3	0.36850
3	2.41400	COM1	-1.0518	3-3	0.73700
3	2.41400	COM1	-1.0423	3-4	0.00000
3	2.70750	COM1	-4.4496	3-4	0.29350
3	3.00100	COM1	-8.1368	3-4	0.58700
3	0.00000	COM2	-19.6919	3-1	0.00000
3	0.44500	COM2	-5.0737	3-1	0.44500
3	0.89000	COM2	8.9699	3-1	0.89000
3	0.89000	COM2	8.9470	3-2	0.00000
3	1.28350	COM2	13.8834	3-2	0.39350
3	1.67700	COM2	18.3705	3-2	0.78700
3	1.67700	COM2	18.3757	3-3	0.00000
3	2.04550	COM2	7.8344	3-3	0.36850
3	2.41400	COM2	-3.1008	3-3	0.73700
3	2.41400	COM2	-3.0700	3-4	0.00000
3	2.70750	COM2	-16.7988	3-4	0.29350
3	3.00100	COM2	-30.7776	3-4	0.58700
3	0.00000	COM3	-9.0121	3-1	0.00000
3	0.44500	COM3	-1.8086	3-1	0.44500
3	0.89000	COM3	3.4838	3-1	0.89000
3	0.89000	COM3	3.4839	3-2	0.00000
3	1.28350	COM3	5.5416	3-2	0.39350
3	1.67700	COM3	6.1048	3-2	0.78700
3	1.67700	COM3	6.1058	3-3	0.00000
3	2.04550	COM3	2.9878	3-3	0.36850
3	2.41400	COM3	-1.4408	3-3	0.73700
3	2.41400	COM3	-1.4319	3-4	0.00000
3	2.70750	COM3	-6.6806	3-4	0.29350
3	3.00100	COM3	-12.7607	3-4	0.58700
3	0.00000	LIFTLUG	-13.7420	3-1	0.00000
3	0.44500	LIFTLUG	-3.5285	3-1	0.44500
3	0.89000	LIFTLUG	6.2253	3-1	0.89000
3	0.89000	LIFTLUG	6.2098	3-2	0.00000
3	1.28350	LIFTLUG	9.6505	3-2	0.39350
3	1.67700	LIFTLUG	12.7318	3-2	0.78700
3	1.67700	LIFTLUG	12.7355	3-3	0.00000

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
3	2.04550	LIFTLUG	5.4291	3-3	0.36850
3	2.41400	LIFTLUG	-2.1924	3-3	0.73700
3	2.41400	LIFTLUG	-2.1707	3-4	0.00000
3	2.70750	LIFTLUG	-11.7289	3-4	0.29350
3	3.00100	LIFTLUG	-21.4871	3-4	0.58700
7	0.00000	COM1	-5.0827	7-1	0.00000
7	0.44500	COM1	-1.3448	7-1	0.44500
7	0.89000	COM1	1.7497	7-1	0.89000
7	0.89000	COM1	1.7459	7-2	0.00000
7	1.28350	COM1	3.2960	7-2	0.39350
7	1.67700	COM1	4.3430	7-2	0.78700
7	1.67700	COM1	4.3454	7-3	0.00000
7	2.04550	COM1	1.8207	7-3	0.36850
7	2.41400	COM1	-1.1453	7-3	0.73700
7	2.41400	COM1	-1.1300	7-4	0.00000
7	2.70750	COM1	-4.4415	7-4	0.29350
7	3.00100	COM1	-8.0330	7-4	0.58700
7	0.00000	COM2	-18.9125	7-1	0.00000
7	0.44500	COM2	-5.8571	7-1	0.44500
7	0.89000	COM2	6.6239	7-1	0.89000
7	0.89000	COM2	6.5859	7-2	0.00000
7	1.28350	COM2	13.1820	7-2	0.39350
7	1.67700	COM2	19.3289	7-2	0.78700
7	1.67700	COM2	19.3372	7-3	0.00000
7	2.04550	COM2	7.9077	7-3	0.36850
7	2.41400	COM2	-3.9158	7-3	0.73700
7	2.41400	COM2	-3.8670	7-4	0.00000
7	2.70750	COM2	-16.7957	7-4	0.29350
7	3.00100	COM2	-29.9743	7-4	0.58700
7	0.00000	COM3	-8.9594	7-1	0.00000
7	0.44500	COM3	-1.9068	7-1	0.44500
7	0.89000	COM3	3.2347	7-1	0.89000
7	0.89000	COM3	3.2347	7-2	0.00000
7	1.28350	COM3	5.5501	7-2	0.39350
7	1.67700	COM3	6.3710	7-2	0.78700
7	1.67700	COM3	6.3726	7-3	0.00000
7	2.04550	COM3	3.1047	7-3	0.36850
7	2.41400	COM3	-1.4738	7-3	0.73700
7	2.41400	COM3	-1.4595	7-4	0.00000
7	2.70750	COM3	-6.6142	7-4	0.29350
7	3.00100	COM3	-12.6003	7-4	0.58700
7	0.00000	LIFTLUG	-13.2134	7-1	0.00000
7	0.44500	LIFTLUG	-4.0648	7-1	0.44500
7	0.89000	LIFTLUG	4.6242	7-1	0.89000
7	0.89000	LIFTLUG	4.5984	7-2	0.00000
7	1.28350	LIFTLUG	9.1804	7-2	0.39350
7	1.67700	LIFTLUG	13.4030	7-2	0.78700
7	1.67700	LIFTLUG	13.4088	7-3	0.00000
7	2.04550	LIFTLUG	5.4885	7-3	0.36850
7	2.41400	LIFTLUG	-2.7469	7-3	0.73700
7	2.41400	LIFTLUG	-2.7125	7-4	0.00000
7	2.70750	LIFTLUG	-11.7259	7-4	0.29350
7	3.00100	LIFTLUG	-20.9392	7-4	0.58700
14	0.00000	COM1	-0.0045	14-1	0.00000

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
14	0.44033	COM1	0.4575	14-1	0.44033
14	0.88067	COM1	0.3884	14-1	0.88067
14	1.32100	COM1	-0.2116	14-1	1.32100
14	0.00000	COM2	-0.0322	14-1	0.00000
14	0.44033	COM2	2.7008	14-1	0.44033
14	0.88067	COM2	2.0331	14-1	0.88067
14	1.32100	COM2	-2.0350	14-1	1.32100
14	0.00000	COM3	-0.0041	14-1	0.00000
14	0.44033	COM3	0.4737	14-1	0.44033
14	0.88067	COM3	0.4774	14-1	0.88067
14	1.32100	COM3	0.0070	14-1	1.32100
14	0.00000	LIFTLUG	-0.0220	14-1	0.00000
14	0.44033	LIFTLUG	1.8550	14-1	0.44033
14	0.88067	LIFTLUG	1.4017	14-1	0.88067
14	1.32100	LIFTLUG	-1.3819	14-1	1.32100
15	0.00000	COM1	-0.2137	15-1	0.00000
15	0.42680	COM1	0.8240	15-1	0.42680
15	0.85360	COM1	1.3627	15-1	0.85360
15	1.28040	COM1	1.4026	15-1	1.28040
15	1.70720	COM1	0.9436	15-1	1.70720
15	2.13400	COM1	-0.0143	15-1	2.13400
15	0.00000	COM2	-2.0495	15-1	0.00000
15	0.42680	COM2	4.7308	15-1	0.42680
15	0.85360	COM2	8.3163	15-1	0.85360
15	1.28040	COM2	8.7071	15-1	1.28040
15	1.70720	COM2	5.9032	15-1	1.70720
15	2.13400	COM2	-0.0955	15-1	2.13400
15	0.00000	COM3	0.0055	15-1	0.00000
15	0.42680	COM3	0.8928	15-1	0.42680
15	0.85360	COM3	1.3347	15-1	0.85360
15	1.28040	COM3	1.3311	15-1	1.28040
15	1.70720	COM3	0.8821	15-1	1.70720
15	2.13400	COM3	-0.0124	15-1	2.13400
15	0.00000	LIFTLUG	-1.3918	15-1	0.00000
15	0.42680	LIFTLUG	3.2519	15-1	0.42680
15	0.85360	LIFTLUG	5.7065	15-1	0.85360
15	1.28040	LIFTLUG	5.9717	15-1	1.28040
15	1.70720	LIFTLUG	4.0478	15-1	1.70720
15	2.13400	LIFTLUG	-0.0654	15-1	2.13400
18	0.00000	COM1	-0.0239	18-1	0.00000
18	0.44033	COM1	0.6850	18-1	0.44033
18	0.88067	COM1	0.9107	18-1	0.88067
18	1.32100	COM1	0.6534	18-1	1.32100
18	0.00000	COM2	-0.1065	18-1	0.00000
18	0.44033	COM2	3.3682	18-1	0.44033
18	0.88067	COM2	4.1011	18-1	0.88067
18	1.32100	COM2	2.0922	18-1	1.32100
18	0.00000	COM3	-0.0225	18-1	0.00000
18	0.44033	COM3	0.6177	18-1	0.44033
18	0.88067	COM3	0.8266	18-1	0.88067
18	1.32100	COM3	0.6041	18-1	1.32100
18	0.00000	LIFTLUG	-0.0738	18-1	0.00000
18	0.44033	LIFTLUG	2.3270	18-1	0.44033
18	0.88067	LIFTLUG	2.8425	18-1	0.88067

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
18	1.32100	LIFTLUG	1.4726	18-1	1.32100
19	0.00000	COM1	0.6528	19-1	0.00000
19	0.42680	COM1	1.4235	19-1	0.42680
19	0.85360	COM1	1.7403	19-1	0.85360
19	1.28040	COM1	1.6032	19-1	1.28040
19	1.70720	COM1	1.0122	19-1	1.70720
19	2.13400	COM1	-0.0326	19-1	2.13400
19	0.00000	COM2	2.0863	19-1	0.00000
19	0.42680	COM2	6.7886	19-1	0.42680
19	0.85360	COM2	8.9151	19-1	0.85360
19	1.28040	COM2	8.4657	19-1	1.28040
19	1.70720	COM2	5.4405	19-1	1.70720
19	2.13400	COM2	-0.1605	19-1	2.13400
19	0.00000	COM3	0.6038	19-1	0.00000
19	0.42680	COM3	1.2875	19-1	0.42680
19	0.85360	COM3	1.5660	19-1	0.85360
19	1.28040	COM3	1.4393	19-1	1.28040
19	1.70720	COM3	0.9072	19-1	1.70720
19	2.13400	COM3	-0.0300	19-1	2.13400
19	0.00000	LIFTLUG	1.4686	19-1	0.00000
19	0.42680	LIFTLUG	4.6952	19-1	0.42680
19	0.85360	LIFTLUG	6.1506	19-1	0.85360
19	1.28040	LIFTLUG	5.8347	19-1	1.28040
19	1.70720	LIFTLUG	3.7475	19-1	1.70720
19	2.13400	LIFTLUG	-0.1109	19-1	2.13400
20	0.00000	COM1	-0.0016	20-1	0.00000
20	0.44033	COM1	0.8823	20-1	0.44033
20	0.88067	COM1	1.0333	20-1	0.88067
20	1.32100	COM1	0.4512	20-1	1.32100
20	0.00000	COM2	-0.0033	20-1	0.00000
20	0.44033	COM2	3.3727	20-1	0.44033
20	0.88067	COM2	4.0612	20-1	0.88067
20	1.32100	COM2	2.0623	20-1	1.32100
20	0.00000	COM3	-8.101E-04	20-1	0.00000
20	0.44033	COM3	0.7688	20-1	0.44033
20	0.88067	COM3	0.8840	20-1	0.88067
20	1.32100	COM3	0.3447	20-1	1.32100
20	0.00000	LIFTLUG	-0.0024	20-1	0.00000
20	0.44033	LIFTLUG	2.3535	20-1	0.44033
20	0.88067	LIFTLUG	2.8305	20-1	0.88067
20	1.32100	LIFTLUG	1.4286	20-1	1.32100
21	0.00000	COM1	0.4484	21-1	0.00000
21	0.42680	COM1	1.7324	21-1	0.42680
21	0.85360	COM1	2.3278	21-1	0.85360
21	1.28040	COM1	2.2346	21-1	1.28040
21	1.70720	COM1	1.4528	21-1	1.70720
21	2.13400	COM1	-0.0177	21-1	2.13400
21	0.00000	COM2	2.0520	21-1	0.00000
21	0.42680	COM2	6.6784	21-1	0.42680
21	0.85360	COM2	8.7800	21-1	0.85360
21	1.28040	COM2	8.3569	21-1	1.28040
21	1.70720	COM2	5.4089	21-1	1.70720
21	2.13400	COM2	-0.0638	21-1	2.13400
21	0.00000	COM3	0.3422	21-1	0.00000

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
21	0.42680	COM3	1.5004	21-1	0.42680
21	0.85360	COM3	2.0438	21-1	0.85360
21	1.28040	COM3	1.9723	21-1	1.28040
21	1.70720	COM3	1.2859	21-1	1.70720
21	2.13400	COM3	-0.0152	21-1	2.13400
21	0.00000	LIFTLUG	1.4214	21-1	0.00000
21	0.42680	LIFTLUG	4.6585	21-1	0.42680
21	0.85360	LIFTLUG	6.1305	21-1	0.85360
21	1.28040	LIFTLUG	5.8373	21-1	1.28040
21	1.70720	LIFTLUG	3.7789	21-1	1.70720
21	2.13400	LIFTLUG	-0.0446	21-1	2.13400
22	0.00000	COM1	-0.0317	22-1	0.00000
22	0.44033	COM1	1.7886	22-1	0.44033
22	0.88067	COM1	2.8634	22-1	0.88067
22	1.32100	COM1	3.1927	22-1	1.32100
22	0.00000	COM2	-0.1274	22-1	0.00000
22	0.44033	COM2	7.0059	22-1	0.44033
22	0.88067	COM2	11.6343	22-1	0.88067
22	1.32100	COM2	13.7577	22-1	1.32100
22	0.00000	COM3	-0.0312	22-1	0.00000
22	0.44033	COM3	1.6410	22-1	0.44033
22	0.88067	COM3	2.6475	22-1	0.88067
22	1.32100	COM3	2.9885	22-1	1.32100
22	0.00000	LIFTLUG	-0.0887	22-1	0.00000
22	0.44033	LIFTLUG	4.8835	22-1	0.44033
22	0.88067	LIFTLUG	8.0971	22-1	0.88067
22	1.32100	LIFTLUG	9.5519	22-1	1.32100
23	0.00000	COM1	3.1947	23-1	0.00000
23	0.42680	COM1	3.9509	23-1	0.42680
23	0.85360	COM1	4.0068	23-1	0.85360
23	1.28040	COM1	3.3623	23-1	1.28040
23	1.70720	COM1	2.0174	23-1	1.70720
23	2.13400	COM1	-0.0278	23-1	2.13400
23	0.00000	COM2	13.7677	23-1	0.00000
23	0.42680	COM2	15.6992	23-1	0.42680
23	0.85360	COM2	15.2773	23-1	0.85360
23	1.28040	COM2	12.5021	23-1	1.28040
23	1.70720	COM2	7.3737	23-1	1.70720
23	2.13400	COM2	-0.1081	23-1	2.13400
23	0.00000	COM3	2.9903	23-1	0.00000
23	0.42680	COM3	3.6375	23-1	0.42680
23	0.85360	COM3	3.6593	23-1	0.85360
23	1.28040	COM3	3.0558	23-1	1.28040
23	1.70720	COM3	1.8269	23-1	1.70720
23	2.13400	COM3	-0.0273	23-1	2.13400
23	0.00000	LIFTLUG	9.5588	23-1	0.00000
23	0.42680	LIFTLUG	10.9365	23-1	0.42680
23	0.85360	LIFTLUG	10.6619	23-1	0.85360
23	1.28040	LIFTLUG	8.7350	23-1	1.28040
23	1.70720	LIFTLUG	5.1560	23-1	1.70720
23	2.13400	LIFTLUG	-0.0754	23-1	2.13400
26	0.00000	COM1	0.1019	26-1	0.00000
26	0.33867	COM1	1.3980	26-1	0.33867
26	0.67733	COM1	2.2091	26-1	0.67733

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
26	1.01600	COM1	2.5352	26-1	1.01600
26	1.01600	COM1	2.5364	26-2	0.00000
26	1.38867	COM1	2.2821	26-2	0.37267
26	1.76133	COM1	1.4405	26-2	0.74533
26	2.13400	COM1	0.0116	26-2	1.11800
26	0.00000	COM2	0.3684	26-1	0.00000
26	0.33867	COM2	5.8677	26-1	0.33867
26	0.67733	COM2	9.2803	26-1	0.67733
26	1.01600	COM2	10.6062	26-1	1.01600
26	1.01600	COM2	10.6106	26-2	0.00000
26	1.38867	COM2	9.6122	26-2	0.37267
26	1.76133	COM2	6.0871	26-2	0.74533
26	2.13400	COM2	0.0352	26-2	1.11800
26	0.00000	COM3	0.0858	26-1	0.00000
26	0.33867	COM3	1.2441	26-1	0.33867
26	0.67733	COM3	1.9693	26-1	0.67733
26	1.01600	COM3	2.2615	26-1	1.01600
26	1.01600	COM3	2.2626	26-2	0.00000
26	1.38867	COM3	2.0364	26-2	0.37267
26	1.76133	COM3	1.2858	26-2	0.74533
26	2.13400	COM3	0.0108	26-2	1.11800
26	0.00000	LIFTLUG	0.2578	26-1	0.00000
26	0.33867	LIFTLUG	4.0782	26-1	0.33867
26	0.67733	LIFTLUG	6.4499	26-1	0.67733
26	1.01600	LIFTLUG	7.3726	26-1	1.01600
26	1.01600	LIFTLUG	7.3757	26-2	0.00000
26	1.38867	LIFTLUG	6.6798	26-2	0.37267
26	1.76133	LIFTLUG	4.2295	26-2	0.74533
26	2.13400	LIFTLUG	0.0249	26-2	1.11800
27	0.00000	COM1	-7.354E-04	27-1	0.00000
27	0.44033	COM1	0.8245	27-1	0.44033
27	0.88067	COM1	0.8574	27-1	0.88067
27	1.32100	COM1	0.0980	27-1	1.32100
27	0.00000	COM2	-0.0090	27-1	0.00000
27	0.44033	COM2	3.6153	27-1	0.44033
27	0.88067	COM2	3.7366	27-1	0.88067
27	1.32100	COM2	0.3549	27-1	1.32100
27	0.00000	COM3	1.778E-04	27-1	0.00000
27	0.44033	COM3	0.7350	27-1	0.44033
27	0.88067	COM3	0.7624	27-1	0.88067
27	1.32100	COM3	0.0824	27-1	1.32100
27	0.00000	LIFTLUG	-0.0061	27-1	0.00000
27	0.44033	LIFTLUG	2.5083	27-1	0.44033
27	0.88067	LIFTLUG	2.5931	27-1	0.88067
27	1.32100	LIFTLUG	0.2483	27-1	1.32100
29	0.00000	COM1	0.0027	29-1	0.00000
29	0.45600	COM1	0.0340	29-1	0.45600
29	0.91200	COM1	0.0014	29-1	0.91200
29	0.00000	COM2	0.0045	29-1	0.00000
29	0.45600	COM2	0.0338	29-1	0.45600
29	0.91200	COM2	0.0061	29-1	0.91200
29	0.00000	COM3	0.0038	29-1	0.00000
29	0.45600	COM3	0.0314	29-1	0.45600
29	0.91200	COM3	0.0020	29-1	0.91200

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
29	0.0000	LIFTLUG	0.0033	29-1	0.0000
29	0.4560	LIFTLUG	0.0266	29-1	0.4560
29	0.9120	LIFTLUG	0.0042	29-1	0.9120
30	0.0000	COM1	-2.4845	30-1	0.0000
30	0.44033	COM1	-0.9381	30-1	0.44033
30	0.88067	COM1	-0.0329	30-1	0.88067
30	1.32100	COM1	0.2267	30-1	1.32100
30	0.0000	COM2	-6.3678	30-1	0.0000
30	0.44033	COM2	-2.6929	30-1	0.44033
30	0.88067	COM2	-0.1880	30-1	0.88067
30	1.32100	COM2	1.0865	30-1	1.32100
30	0.0000	COM3	-3.1127	30-1	0.0000
30	0.44033	COM3	-1.1941	30-1	0.44033
30	0.88067	COM3	0.1520	30-1	0.88067
30	1.32100	COM3	0.9217	30-1	1.32100
30	0.0000	LIFTLUG	-4.5410	30-1	0.0000
30	0.44033	LIFTLUG	-1.9070	30-1	0.44033
30	0.88067	LIFTLUG	-0.1293	30-1	0.88067
30	1.32100	LIFTLUG	0.7513	30-1	1.32100
31	0.0000	COM1	0.2134	31-1	0.0000
31	0.42680	COM1	1.3980	31-1	0.42680
31	0.85360	COM1	1.9679	31-1	0.85360
31	1.28040	COM1	1.9192	31-1	1.28040
31	1.70720	COM1	1.2479	31-1	1.70720
31	2.13400	COM1	-0.0501	31-1	2.13400
31	0.0000	COM2	1.0562	31-1	0.0000
31	0.42680	COM2	3.4707	31-1	0.42680
31	0.85360	COM2	4.6177	31-1	0.85360
31	1.28040	COM2	4.4419	31-1	1.28040
31	1.70720	COM2	2.8885	31-1	1.70720
31	2.13400	COM2	-0.0976	31-1	2.13400
31	0.0000	COM3	0.9071	31-1	0.0000
31	0.42680	COM3	1.8196	31-1	0.42680
31	0.85360	COM3	2.1833	31-1	0.85360
31	1.28040	COM3	1.9947	31-1	1.28040
31	1.70720	COM3	1.2501	31-1	1.70720
31	2.13400	COM3	-0.0540	31-1	2.13400
31	0.0000	LIFTLUG	0.7295	31-1	0.0000
31	0.42680	LIFTLUG	2.4803	31-1	0.42680
31	0.85360	LIFTLUG	3.3127	31-1	0.85360
31	1.28040	LIFTLUG	3.1898	31-1	1.28040
31	1.70720	LIFTLUG	2.0742	31-1	1.70720
31	2.13400	LIFTLUG	-0.0710	31-1	2.13400
42	0.0000	COM1	-0.0499	42-1	0.0000
42	0.44033	COM1	1.3278	42-1	0.44033
42	0.88067	COM1	1.9625	42-1	0.88067
42	1.32100	COM1	1.8543	42-1	1.32100
42	0.0000	COM2	-0.1832	42-1	0.0000
42	0.44033	COM2	5.0411	42-1	0.44033
42	0.88067	COM2	7.4417	42-1	0.88067
42	1.32100	COM2	7.0186	42-1	1.32100
42	0.0000	COM3	-0.0460	42-1	0.0000
42	0.44033	COM3	1.1970	42-1	0.44033
42	0.88067	COM3	1.7767	42-1	0.88067

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
42	1.32100	COM3	1.6931	42-1	1.32100
42	0.00000	LIFTLUG	-0.1281	42-1	0.00000
42	0.44033	LIFTLUG	3.5188	42-1	0.44033
42	0.88067	LIFTLUG	5.1947	42-1	0.88067
42	1.32100	LIFTLUG	4.8998	42-1	1.32100
43	0.00000	COM1	1.8469	43-1	0.00000
43	0.42680	COM1	2.8413	43-1	0.42680
43	0.85360	COM1	3.1472	43-1	0.85360
43	1.28040	COM1	2.7644	43-1	1.28040
43	1.70720	COM1	1.6931	43-1	1.70720
43	2.13400	COM1	-0.0670	43-1	2.13400
43	0.00000	COM2	6.9918	43-1	0.00000
43	0.42680	COM2	10.5945	43-1	0.42680
43	0.85360	COM2	11.6725	43-1	0.85360
43	1.28040	COM2	10.2257	43-1	1.28040
43	1.70720	COM2	6.2542	43-1	1.70720
43	2.13400	COM2	-0.2422	43-1	2.13400
43	0.00000	COM3	1.6867	43-1	0.00000
43	0.42680	COM3	2.5667	43-1	0.42680
43	0.85360	COM3	2.8319	43-1	0.85360
43	1.28040	COM3	2.4822	43-1	1.28040
43	1.70720	COM3	1.5177	43-1	1.70720
43	2.13400	COM3	-0.0616	43-1	2.13400
43	0.00000	LIFTLUG	4.8811	43-1	0.00000
43	0.42680	LIFTLUG	7.4013	43-1	0.42680
43	0.85360	LIFTLUG	8.1563	43-1	0.85360
43	1.28040	LIFTLUG	7.1462	43-1	1.28040
43	1.70720	LIFTLUG	4.3710	43-1	1.70720
43	2.13400	LIFTLUG	-0.1694	43-1	2.13400
44	0.00000	COM1	-14.5954	44-1	0.00000
44	0.43200	COM1	-5.0017	44-1	0.43200
44	0.43200	COM1	-5.0016	44-2	0.00000
44	0.74300	COM1	-0.2159	44-2	0.31100
44	1.05400	COM1	4.2554	44-2	0.62200
44	1.05400	COM1	4.2613	44-3	0.00000
44	1.32550	COM1	6.7534	44-3	0.27150
44	1.59700	COM1	9.0060	44-3	0.54300
44	1.59700	COM1	9.0063	44-4	0.00000
44	2.05300	COM1	6.8176	44-4	0.45600
44	2.50900	COM1	3.9534	44-4	0.91200
44	2.50900	COM1	3.9553	44-5	0.00000
44	2.85400	COM1	-0.2554	44-5	0.34500
44	3.19900	COM1	-4.8528	44-5	0.69000
44	3.19900	COM1	-4.8281	44-6	0.00000
44	3.67400	COM1	-14.1326	44-6	0.47500
44	0.00000	COM2	-46.7483	44-1	0.00000
44	0.43200	COM2	-16.7575	44-1	0.43200
44	0.43200	COM2	-16.7581	44-2	0.00000
44	0.74300	COM2	-1.8119	44-2	0.31100
44	1.05400	COM2	12.8537	44-2	0.62200
44	1.05400	COM2	12.8804	44-3	0.00000
44	1.32550	COM2	21.1696	44-3	0.27150
44	1.59700	COM2	29.2449	44-3	0.54300
44	1.59700	COM2	29.2486	44-4	0.00000

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
44	2.05300	COM2	21.2299	44-4	0.45600
44	2.50900	COM2	12.6078	44-4	0.91200
44	2.50900	COM2	12.6151	44-5	0.00000
44	2.85400	COM2	-1.0812	44-5	0.34500
44	3.19900	COM2	-15.1228	44-5	0.69000
44	3.19900	COM2	-15.0298	44-6	0.00000
44	3.67400	COM2	-43.5624	44-6	0.47500
44	0.00000	COM3	-20.3231	44-1	0.00000
44	0.43200	COM3	-7.1338	44-1	0.43200
44	0.43200	COM3	-7.1338	44-2	0.00000
44	0.74300	COM3	-0.3328	44-2	0.31100
44	1.05400	COM3	5.5348	44-2	0.62200
44	1.05400	COM3	5.5392	44-3	0.00000
44	1.32550	COM3	8.8750	44-3	0.27150
44	1.59700	COM3	11.4995	44-3	0.54300
44	1.59700	COM3	11.4988	44-4	0.00000
44	2.05300	COM3	9.6690	44-4	0.45600
44	2.50900	COM3	5.8324	44-4	0.91200
44	2.50900	COM3	5.8346	44-5	0.00000
44	2.85400	COM3	0.1754	44-5	0.34500
44	3.19900	COM3	-6.6326	44-5	0.69000
44	3.19900	COM3	-6.6099	44-6	0.00000
44	3.67400	COM3	-19.9626	44-6	0.47500
44	0.00000	LIFTLUG	-32.9031	44-1	0.00000
44	0.43200	LIFTLUG	-11.7671	44-1	0.43200
44	0.43200	LIFTLUG	-11.7675	44-2	0.00000
44	0.74300	LIFTLUG	-1.2336	44-2	0.31100
44	1.05400	LIFTLUG	9.0758	44-2	0.62200
44	1.05400	LIFTLUG	9.0943	44-3	0.00000
44	1.32550	LIFTLUG	14.9170	44-3	0.27150
44	1.59700	LIFTLUG	20.5687	44-3	0.54300
44	1.59700	LIFTLUG	20.5713	44-4	0.00000
44	2.05300	LIFTLUG	14.9649	44-4	0.45600
44	2.50900	LIFTLUG	8.8758	44-4	0.91200
44	2.50900	LIFTLUG	8.8809	44-5	0.00000
44	2.85400	LIFTLUG	-0.7512	44-5	0.34500
44	3.19900	LIFTLUG	-10.6596	44-5	0.69000
44	3.19900	LIFTLUG	-10.5947	44-6	0.00000
44	3.67400	LIFTLUG	-30.7241	44-6	0.47500
45	0.00000	COM1	-11.4118	45-1	0.00000
45	0.33075	COM1	-5.5211	45-1	0.33075
45	0.66150	COM1	0.0141	45-1	0.66150
45	0.66150	COM1	0.0263	45-2	0.00000
45	0.99225	COM1	3.6734	45-2	0.33075
45	1.32300	COM1	6.9650	45-2	0.66150
45	1.32300	COM1	6.9633	45-3	0.00000
45	1.57500	COM1	6.3373	45-3	0.25200
45	1.82700	COM1	5.5050	45-3	0.50400
45	1.82700	COM1	5.5091	45-4	0.00000
45	2.13150	COM1	2.9637	45-4	0.30450
45	2.43600	COM1	0.1170	45-4	0.60900
45	2.43600	COM1	0.1179	45-5	0.00000
45	2.74600	COM1	-4.3025	45-5	0.31000
45	2.74600	COM1	-4.3052	45-6	0.00000

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
45	3.00000	COM1	-9.1195	45-6	0.25400
45	0.00000	COM2	-33.6984	45-1	0.00000
45	0.33075	COM2	-16.5178	45-1	0.33075
45	0.66150	COM2	0.3454	45-1	0.66150
45	0.66150	COM2	0.3838	45-2	0.00000
45	0.99225	COM2	10.9926	45-2	0.33075
45	1.32300	COM2	21.2841	45-2	0.66150
45	1.32300	COM2	21.2754	45-3	0.00000
45	1.57500	COM2	18.8012	45-3	0.25200
45	1.82700	COM2	16.1427	45-3	0.50400
45	1.82700	COM2	16.1480	45-4	0.00000
45	2.13150	COM2	8.2709	45-4	0.30450
45	2.43600	COM2	0.1249	45-4	0.60900
45	2.43600	COM2	0.1183	45-5	0.00000
45	2.74600	COM2	-12.2213	45-5	0.31000
45	2.74600	COM2	-12.2319	45-6	0.00000
45	3.00000	COM2	-24.7646	45-6	0.25400
45	0.00000	COM3	-15.5519	45-1	0.00000
45	0.33075	COM3	-7.2442	45-1	0.33075
45	0.66150	COM3	0.0077	45-1	0.66150
45	0.66150	COM3	0.0183	45-2	0.00000
45	0.99225	COM3	4.8483	45-2	0.33075
45	1.32300	COM3	8.6225	45-2	0.66150
45	1.32300	COM3	8.6214	45-3	0.00000
45	1.57500	COM3	8.2365	45-3	0.25200
45	1.82700	COM3	7.2388	45-3	0.50400
45	1.82700	COM3	7.2441	45-4	0.00000
45	2.13150	COM3	4.0782	45-4	0.30450
45	2.43600	COM3	0.0174	45-4	0.60900
45	2.43600	COM3	0.0243	45-5	0.00000
45	2.74600	COM3	-6.1737	45-5	0.31000
45	2.74600	COM3	-6.1748	45-6	0.00000
45	3.00000	COM3	-12.8877	45-6	0.25400
45	0.00000	LIFTLUG	-23.8241	45-1	0.00000
45	0.33075	LIFTLUG	-11.6691	45-1	0.33075
45	0.66150	LIFTLUG	0.2320	45-1	0.66150
45	0.66150	LIFTLUG	0.2590	45-2	0.00000
45	0.99225	LIFTLUG	7.7657	45-2	0.33075
45	1.32300	LIFTLUG	15.0186	45-2	0.66150
45	1.32300	LIFTLUG	15.0126	45-3	0.00000
45	1.57500	LIFTLUG	13.2886	45-3	0.25200
45	1.82700	LIFTLUG	11.4172	45-3	0.50400
45	1.82700	LIFTLUG	11.4212	45-4	0.00000
45	2.13150	LIFTLUG	5.8668	45-4	0.30450
45	2.43600	LIFTLUG	0.0972	45-4	0.60900
45	2.43600	LIFTLUG	0.0929	45-5	0.00000
45	2.74600	LIFTLUG	-8.6597	45-5	0.31000
45	2.74600	LIFTLUG	-8.6671	45-6	0.00000
45	3.00000	LIFTLUG	-17.5954	45-6	0.25400
46	0.00000	COM1	-14.4121	46-1	0.00000
46	0.43200	COM1	-5.1084	46-1	0.43200
46	0.43200	COM1	-5.1081	46-2	0.00000
46	0.74300	COM1	-0.3347	46-2	0.31100
46	1.05400	COM1	4.1245	46-2	0.62200

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
46	1.05400	COM1	4.1338	46-3	0.00000
46	1.32550	COM1	6.9987	46-3	0.27150
46	1.59700	COM1	9.6240	46-3	0.54300
46	1.59700	COM1	9.6266	46-4	0.00000
46	2.01650	COM1	7.0996	46-4	0.41950
46	2.43600	COM1	4.0008	46-4	0.83900
46	2.43600	COM1	4.0045	46-5	0.00000
46	2.81750	COM1	-0.3682	46-5	0.38150
46	3.19900	COM1	-5.2139	46-5	0.76300
46	3.19900	COM1	-5.1743	46-6	0.00000
46	3.67400	COM1	-13.7553	46-6	0.47500
46	0.00000	COM2	-46.2512	46-1	0.00000
46	0.43200	COM2	-16.8301	46-1	0.43200
46	0.43200	COM2	-16.8311	46-2	0.00000
46	0.74300	COM2	-1.9085	46-2	0.31100
46	1.05400	COM2	12.7334	46-2	0.62200
46	1.05400	COM2	12.7755	46-3	0.00000
46	1.32550	COM2	22.4183	46-3	0.27150
46	1.59700	COM2	31.8473	46-3	0.54300
46	1.59700	COM2	31.8571	46-4	0.00000
46	2.01650	COM2	22.4203	46-4	0.41950
46	2.43600	COM2	12.4729	46-4	0.83900
46	2.43600	COM2	12.4862	46-5	0.00000
46	2.81750	COM2	-1.6609	46-5	0.38150
46	3.19900	COM2	-16.2302	46-5	0.76300
46	3.19900	COM2	-16.0809	46-6	0.00000
46	3.67400	COM2	-41.9697	46-6	0.47500
46	0.00000	COM3	-20.0002	46-1	0.00000
46	0.43200	COM3	-7.1521	46-1	0.43200
46	0.43200	COM3	-7.1521	46-2	0.00000
46	0.74300	COM3	-0.4339	46-2	0.31100
46	1.05400	COM3	5.3509	46-2	0.62200
46	1.05400	COM3	5.3578	46-3	0.00000
46	1.32550	COM3	8.9684	46-3	0.27150
46	1.59700	COM3	11.8676	46-3	0.54300
46	1.59700	COM3	11.8695	46-4	0.00000
46	2.01650	COM3	9.8104	46-4	0.41950
46	2.43600	COM3	6.0528	46-4	0.83900
46	2.43600	COM3	6.0561	46-5	0.00000
46	2.81750	COM3	0.2212	46-5	0.38150
46	3.19900	COM3	-7.0184	46-5	0.76300
46	3.19900	COM3	-6.9820	46-6	0.00000
46	3.67400	COM3	-19.6577	46-6	0.47500
46	0.00000	LIFTLUG	-32.5498	46-1	0.00000
46	0.43200	LIFTLUG	-11.8282	46-1	0.43200
46	0.43200	LIFTLUG	-11.8289	46-2	0.00000
46	0.74300	LIFTLUG	-1.3122	46-2	0.31100
46	1.05400	LIFTLUG	8.9800	46-2	0.62200
46	1.05400	LIFTLUG	9.0091	46-3	0.00000
46	1.32550	LIFTLUG	15.7787	46-3	0.27150
46	1.59700	LIFTLUG	22.3772	46-3	0.54300
46	1.59700	LIFTLUG	22.3841	46-4	0.00000
46	2.01650	LIFTLUG	15.7920	46-4	0.41950
46	2.43600	LIFTLUG	8.7915	46-4	0.83900

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
46	2.43600	LIFTLUG	8.8009	46-5	0.00000
46	2.81750	LIFTLUG	-1.1511	46-5	0.38150
46	3.19900	LIFTLUG	-11.4408	46-5	0.76300
46	3.19900	LIFTLUG	-11.3366	46-6	0.00000
46	3.67400	LIFTLUG	-29.6173	46-6	0.47500
47	0.00000	COM1	-10.4621	47-1	0.00000
47	0.33075	COM1	-4.9406	47-1	0.33075
47	0.66150	COM1	0.2254	47-1	0.66150
47	0.66150	COM1	0.2449	47-2	0.00000
47	0.99225	COM1	3.9514	47-2	0.33075
47	1.32300	COM1	7.3024	47-2	0.66150
47	1.32300	COM1	7.2998	47-3	0.00000
47	1.57500	COM1	6.0235	47-3	0.25200
47	1.82700	COM1	4.5409	47-3	0.50400
47	1.82700	COM1	4.5474	47-4	0.00000
47	2.13150	COM1	1.6520	47-4	0.30450
47	2.43600	COM1	-1.5446	47-4	0.60900
47	2.43600	COM1	-1.5427	47-5	0.00000
47	2.74600	COM1	-5.8832	47-5	0.31000
47	2.74600	COM1	3.9629	47-6	0.00000
47	3.00000	COM1	0.0077	47-6	0.25400
47	0.00000	COM2	-30.5957	47-1	0.00000
47	0.33075	COM2	-14.8115	47-1	0.33075
47	0.66150	COM2	0.6553	47-1	0.66150
47	0.66150	COM2	0.7162	47-2	0.00000
47	0.99225	COM2	11.6972	47-2	0.33075
47	1.32300	COM2	22.3609	47-2	0.66150
47	1.32300	COM2	22.3474	47-3	0.00000
47	1.57500	COM2	17.7114	47-3	0.25200
47	1.82700	COM2	12.8912	47-3	0.50400
47	1.82700	COM2	12.8991	47-4	0.00000
47	2.13150	COM2	4.0230	47-4	0.30450
47	2.43600	COM2	-5.1220	47-4	0.60900
47	2.43600	COM2	-5.1317	47-5	0.00000
47	2.74600	COM2	-17.0356	47-5	0.31000
47	2.74600	COM2	9.7042	47-6	0.00000
47	3.00000	COM2	0.0298	47-6	0.25400
47	0.00000	COM3	-14.3510	47-1	0.00000
47	0.33075	COM3	-6.4735	47-1	0.33075
47	0.66150	COM3	0.3481	47-1	0.66150
47	0.66150	COM3	0.3651	47-2	0.00000
47	0.99225	COM3	5.1491	47-2	0.33075
47	1.32300	COM3	8.8773	47-2	0.66150
47	1.32300	COM3	8.8756	47-3	0.00000
47	1.57500	COM3	7.8554	47-3	0.25200
47	1.82700	COM3	6.2223	47-3	0.50400
47	1.82700	COM3	6.2307	47-4	0.00000
47	2.13150	COM3	2.6778	47-4	0.30450
47	2.43600	COM3	-1.7700	47-4	0.60900
47	2.43600	COM3	-1.7583	47-5	0.00000
47	2.74600	COM3	-8.0012	47-5	0.31000
47	2.74600	COM3	5.9327	47-6	0.00000
47	3.00000	COM3	0.0034	47-6	0.25400
47	0.00000	LIFTLUG	-21.6426	47-1	0.00000

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
47	0.33075	LIFTLUG	-10.4625	47-1	0.33075
47	0.66150	LIFTLUG	0.4637	47-1	0.66150
47	0.66150	LIFTLUG	0.5066	47-2	0.00000
47	0.99225	LIFTLUG	8.2685	47-2	0.33075
47	1.32300	LIFTLUG	15.7766	47-2	0.66150
47	1.32300	LIFTLUG	15.7673	47-3	0.00000
47	1.57500	LIFTLUG	12.5247	47-3	0.25200
47	1.82700	LIFTLUG	9.1347	47-3	0.50400
47	1.82700	LIFTLUG	9.1407	47-4	0.00000
47	2.13150	LIFTLUG	2.8787	47-4	0.30450
47	2.43600	LIFTLUG	-3.5986	47-4	0.60900
47	2.43600	LIFTLUG	-3.6048	47-5	0.00000
47	2.74600	LIFTLUG	-12.0575	47-5	0.31000
47	2.74600	LIFTLUG	6.9413	47-6	0.00000
47	3.00000	LIFTLUG	0.0208	47-6	0.25400
52	0.00000	COM1	-0.0040	52-1	0.00000
52	0.44033	COM1	0.8312	52-1	0.44033
52	0.88067	COM1	0.9404	52-1	0.88067
52	1.32100	COM1	0.3237	52-1	1.32100
52	0.00000	COM2	-0.0142	52-1	0.00000
52	0.44033	COM2	2.7480	52-1	0.44033
52	0.88067	COM2	2.9199	52-1	0.88067
52	1.32100	COM2	0.5014	52-1	1.32100
52	0.00000	COM3	-0.0018	52-1	0.00000
52	0.44033	COM3	0.7758	52-1	0.44033
52	0.88067	COM3	0.9053	52-1	0.88067
52	1.32100	COM3	0.3866	52-1	1.32100
52	0.00000	LIFTLUG	-0.0100	52-1	0.00000
52	0.44033	LIFTLUG	1.9310	52-1	0.44033
52	0.88067	LIFTLUG	2.0585	52-1	0.88067
52	1.32100	LIFTLUG	0.3728	52-1	1.32100
53	0.00000	COM1	0.3213	53-1	0.00000
53	0.42680	COM1	1.6181	53-1	0.42680
53	0.85360	COM1	2.2329	53-1	0.85360
53	1.28040	COM1	2.1657	53-1	1.28040
53	1.70720	COM1	1.4165	53-1	1.70720
53	2.13400	COM1	-0.0147	53-1	2.13400
53	0.00000	COM2	0.4920	53-1	0.00000
53	0.42680	COM2	5.2495	53-1	0.42680
53	0.85360	COM2	7.5733	53-1	0.85360
53	1.28040	COM2	7.4636	53-1	1.28040
53	1.70720	COM2	4.9202	53-1	1.70720
53	2.13400	COM2	-0.0568	53-1	2.13400
53	0.00000	COM3	0.3846	53-1	0.00000
53	0.42680	COM3	1.5233	53-1	0.42680
53	0.85360	COM3	2.0530	53-1	0.85360
53	1.28040	COM3	1.9737	53-1	1.28040
53	1.70720	COM3	1.2856	53-1	1.70720
53	2.13400	COM3	-0.0115	53-1	2.13400
53	0.00000	LIFTLUG	0.3663	53-1	0.00000
53	0.42680	LIFTLUG	3.6923	53-1	0.42680
53	0.85360	LIFTLUG	5.3147	53-1	0.85360
53	1.28040	LIFTLUG	5.2335	53-1	1.28040
53	1.70720	LIFTLUG	3.4488	53-1	1.70720

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
53	2.13400	LIFTLUG	-0.0396	53-1	2.13400
54	0.00000	COM1	-0.0301	54-1	0.00000
54	0.44033	COM1	0.7234	54-1	0.44033
54	0.88067	COM1	0.7772	54-1	0.88067
54	1.32100	COM1	0.1315	54-1	1.32100
54	0.00000	COM2	-0.0817	54-1	0.00000
54	0.44033	COM2	2.0958	54-1	0.44033
54	0.88067	COM2	2.0450	54-1	0.88067
54	1.32100	COM2	-0.2342	54-1	1.32100
54	0.00000	COM3	-0.0356	54-1	0.00000
54	0.44033	COM3	0.7820	54-1	0.44033
54	0.88067	COM3	0.9750	54-1	0.88067
54	1.32100	COM3	0.5433	54-1	1.32100
54	0.00000	LIFTLUG	-0.0580	54-1	0.00000
54	0.44033	LIFTLUG	1.4833	54-1	0.44033
54	0.88067	LIFTLUG	1.4559	54-1	0.88067
54	1.32100	LIFTLUG	-0.1405	54-1	1.32100
55	0.00000	COM1	0.1345	55-1	0.00000
55	0.42680	COM1	1.4224	55-1	0.42680
55	0.85360	COM1	2.0531	55-1	0.85360
55	1.28040	COM1	2.0265	55-1	1.28040
55	1.70720	COM1	1.3426	55-1	1.70720
55	2.13400	COM1	0.0015	55-1	2.13400
55	0.00000	COM2	-0.2289	55-1	0.00000
55	0.42680	COM2	4.0013	55-1	0.42680
55	0.85360	COM2	6.1379	55-1	0.85360
55	1.28040	COM2	6.1811	55-1	1.28040
55	1.70720	COM2	4.1308	55-1	1.70720
55	2.13400	COM2	-0.0129	55-1	2.13400
55	0.00000	COM3	0.5473	55-1	0.00000
55	0.42680	COM3	1.6121	55-1	0.42680
55	0.85360	COM3	2.0901	55-1	0.85360
55	1.28040	COM3	1.9813	55-1	1.28040
55	1.70720	COM3	1.2857	55-1	1.70720
55	2.13400	COM3	0.0032	55-1	2.13400
55	0.00000	LIFTLUG	-0.1366	55-1	0.00000
55	0.42680	LIFTLUG	2.8368	55-1	0.42680
55	0.85360	LIFTLUG	4.3364	55-1	0.85360
55	1.28040	LIFTLUG	4.3620	55-1	1.28040
55	1.70720	LIFTLUG	2.9137	55-1	1.70720
55	2.13400	LIFTLUG	-0.0084	55-1	2.13400
58	0.00000	COM1	-0.0311	58-1	0.00000
58	0.44033	COM1	1.0617	58-1	0.44033
58	0.88067	COM1	1.3999	58-1	0.88067
58	1.32100	COM1	0.9838	58-1	1.32100
58	0.00000	COM2	-0.1167	58-1	0.00000
58	0.44033	COM2	3.9416	58-1	0.44033
58	0.88067	COM2	5.0176	58-1	0.88067
58	1.32100	COM2	3.1113	58-1	1.32100
58	0.00000	COM3	-0.0276	58-1	0.00000
58	0.44033	COM3	0.9427	58-1	0.44033
58	0.88067	COM3	1.2394	58-1	0.88067
58	1.32100	COM3	0.8626	58-1	1.32100
58	0.00000	LIFTLUG	-0.0815	58-1	0.00000

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
58	0.44033	LIFTLUG	2.7541	58-1	0.44033
58	0.88067	LIFTLUG	3.5117	58-1	0.88067
58	1.32100	LIFTLUG	2.1913	58-1	1.32100
59	0.00000	COM1	0.9827	59-1	0.00000
59	0.42680	COM1	2.1945	59-1	0.42680
59	0.85360	COM1	2.6975	59-1	0.85360
59	1.28040	COM1	2.4917	59-1	1.28040
59	1.70720	COM1	1.5772	59-1	1.70720
59	2.13400	COM1	-0.0462	59-1	2.13400
59	0.00000	COM2	3.1061	59-1	0.00000
59	0.42680	COM2	8.0531	59-1	0.42680
59	0.85360	COM2	10.1984	59-1	0.85360
59	1.28040	COM2	9.5418	59-1	1.28040
59	1.70720	COM2	6.0835	59-1	1.70720
59	2.13400	COM2	-0.1766	59-1	2.13400
59	0.00000	COM3	0.8618	59-1	0.00000
59	0.42680	COM3	1.9467	59-1	0.42680
59	0.85360	COM3	2.3989	59-1	0.85360
59	1.28040	COM3	2.2182	59-1	1.28040
59	1.70720	COM3	1.4047	59-1	1.70720
59	2.13400	COM3	-0.0417	59-1	2.13400
59	0.00000	LIFTLUG	2.1877	59-1	0.00000
59	0.42680	LIFTLUG	5.6300	59-1	0.42680
59	0.85360	LIFTLUG	7.1201	59-1	0.85360
59	1.28040	LIFTLUG	6.6579	59-1	1.28040
59	1.70720	LIFTLUG	4.2434	59-1	1.70720
59	2.13400	LIFTLUG	-0.1233	59-1	2.13400
60	0.00000	COM1	0.0052	60-1	0.00000
60	0.44033	COM1	3.3658	60-1	0.44033
60	0.88067	COM1	6.1611	60-1	0.88067
60	1.32100	COM1	8.3909	60-1	1.32100
60	1.32100	COM1	8.3933	60-2	0.00000
60	1.74780	COM1	7.7800	60-2	0.42680
60	2.17460	COM1	6.6355	60-2	0.85360
60	2.60140	COM1	4.9598	60-2	1.28040
60	3.02820	COM1	2.7529	60-2	1.70720
60	3.45500	COM1	0.0148	60-2	2.13400
60	0.00000	COM2	0.0187	60-1	0.00000
60	0.44033	COM2	18.4858	60-1	0.44033
60	0.88067	COM2	33.7887	60-1	0.88067
60	1.32100	COM2	45.9273	60-1	1.32100
60	1.32100	COM2	45.9402	60-2	0.00000
60	1.74780	COM2	42.7136	60-2	0.42680
60	2.17460	COM2	36.5142	60-2	0.85360
60	2.60140	COM2	27.3421	60-2	1.28040
60	3.02820	COM2	15.1972	60-2	1.70720
60	3.45500	COM2	0.0795	60-2	2.13400
60	0.00000	COM3	0.0067	60-1	0.00000
60	0.44033	COM3	2.9587	60-1	0.44033
60	0.88067	COM3	5.4058	60-1	0.88067
60	1.32100	COM3	7.3481	60-1	1.32100
60	1.32100	COM3	7.3505	60-2	0.00000
60	1.74780	COM3	6.8320	60-2	0.42680
60	2.17460	COM3	5.8392	60-2	0.85360

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
60	2.60140	COM3	4.3721	60-2	1.28040
60	3.02820	COM3	2.4307	60-2	1.70720
60	3.45500	COM3	0.0150	60-2	2.13400
60	0.00000	LIFTLUG	0.0131	60-1	0.00000
60	0.44033	LIFTLUG	12.7246	60-1	0.44033
60	0.88067	LIFTLUG	23.2593	60-1	0.88067
60	1.32100	LIFTLUG	31.6171	60-1	1.32100
60	1.32100	LIFTLUG	31.6260	60-2	0.00000
60	1.74780	LIFTLUG	29.4019	60-2	0.42680
60	2.17460	LIFTLUG	25.1327	60-2	0.85360
60	2.60140	LIFTLUG	18.8185	60-2	1.28040
60	3.02820	LIFTLUG	10.4592	60-2	1.70720
60	3.45500	LIFTLUG	0.0547	60-2	2.13400
61	0.00000	COM1	0.0088	61-1	0.00000
61	0.44033	COM1	5.8891	61-1	0.44033
61	0.88067	COM1	10.9812	61-1	0.88067
61	1.32100	COM1	15.2851	61-1	1.32100
61	1.32100	COM1	15.2895	61-2	0.00000
61	1.74780	COM1	13.7182	61-2	0.42680
61	2.17460	COM1	11.4064	61-2	0.85360
61	2.60140	COM1	8.3540	61-2	1.28040
61	3.02820	COM1	4.5612	61-2	1.70720
61	3.45500	COM1	0.0278	61-2	2.13400
61	0.00000	COM2	0.0283	61-1	0.00000
61	0.44033	COM2	20.5847	61-1	0.44033
61	0.88067	COM2	38.4034	61-1	0.88067
61	1.32100	COM2	53.4846	61-1	1.32100
61	1.32100	COM2	53.5008	61-2	0.00000
61	1.74780	COM2	47.9647	61-2	0.42680
61	2.17460	COM2	39.8565	61-2	0.85360
61	2.60140	COM2	29.1765	61-2	1.28040
61	3.02820	COM2	15.9246	61-2	1.70720
61	3.45500	COM2	0.1007	61-2	2.13400
61	0.00000	COM3	0.0097	61-1	0.00000
61	0.44033	COM3	5.1656	61-1	0.44033
61	0.88067	COM3	9.6178	61-1	0.88067
61	1.32100	COM3	13.3663	61-1	1.32100
61	1.32100	COM3	13.3705	61-2	0.00000
61	1.74780	COM3	12.0240	61-2	0.42680
61	2.17460	COM3	10.0164	61-2	0.85360
61	2.60140	COM3	7.3475	61-2	1.28040
61	3.02820	COM3	4.0176	61-2	1.70720
61	3.45500	COM3	0.0264	61-2	2.13400
61	0.00000	LIFTLUG	0.0199	61-1	0.00000
61	0.44033	LIFTLUG	14.4242	61-1	0.44033
61	0.88067	LIFTLUG	26.9096	61-1	0.88067
61	1.32100	LIFTLUG	37.4760	61-1	1.32100
61	1.32100	LIFTLUG	37.4874	61-2	0.00000
61	1.74780	LIFTLUG	33.6096	61-2	0.42680
61	2.17460	LIFTLUG	27.9289	61-2	0.85360
61	2.60140	LIFTLUG	20.4455	61-2	1.28040
61	3.02820	LIFTLUG	11.1594	61-2	1.70720
61	3.45500	LIFTLUG	0.0704	61-2	2.13400
62	0.00000	COM1	-0.0069	62-1	0.00000

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
62	0.44500	COM1	0.8708	62-1	0.44500
62	0.89000	COM1	1.6876	62-1	0.89000
62	0.89000	COM1	1.6937	62-2	0.00000
62	1.28350	COM1	0.4051	62-2	0.39350
62	1.67700	COM1	-0.9310	62-2	0.78700
62	0.00000	COM2	-0.0455	62-1	0.00000
62	0.44500	COM2	6.2830	62-1	0.44500
62	0.89000	COM2	12.5572	62-1	0.89000
62	0.89000	COM2	12.6181	62-2	0.00000
62	1.28350	COM2	5.2420	62-2	0.39350
62	1.67700	COM2	-2.1766	62-2	0.78700
62	0.00000	COM3	-0.0030	62-1	0.00000
62	0.44500	COM3	0.6638	62-1	0.44500
62	0.89000	COM3	1.2764	62-1	0.89000
62	0.89000	COM3	1.2762	62-2	0.00000
62	1.28350	COM3	0.1170	62-2	0.39350
62	1.67700	COM3	-1.0847	62-2	0.78700
62	0.00000	LIFTLUG	-0.0312	62-1	0.00000
62	0.44500	LIFTLUG	4.2923	62-1	0.44500
62	0.89000	LIFTLUG	8.5724	62-1	0.89000
62	0.89000	LIFTLUG	8.6137	62-2	0.00000
62	1.28350	LIFTLUG	3.5429	62-2	0.39350
62	1.67700	LIFTLUG	-1.5619	62-2	0.78700
63	0.00000	COM1	-1.7938	63-1	0.00000
63	0.25200	COM1	0.2533	63-1	0.25200
63	0.50400	COM1	2.2809	63-1	0.50400
63	0.50400	COM1	2.2703	63-2	0.00000
63	0.80850	COM1	2.8483	63-2	0.30450
63	1.11300	COM1	3.3979	63-2	0.60900
63	1.11300	COM1	3.3951	63-3	0.00000
63	1.42300	COM1	2.0503	63-3	0.31000
63	1.42300	COM1	2.0577	63-4	0.00000
63	1.67700	COM1	-0.0128	63-4	0.25400
63	0.00000	COM2	-6.0373	63-1	0.00000
63	0.25200	COM2	0.8233	63-1	0.25200
63	0.50400	COM2	7.6664	63-1	0.50400
63	0.50400	COM2	7.6532	63-2	0.00000
63	0.80850	COM2	9.0683	63-2	0.30450
63	1.11300	COM2	10.4580	63-2	0.60900
63	1.11300	COM2	10.4742	63-3	0.00000
63	1.42300	COM2	5.6411	63-3	0.31000
63	1.42300	COM2	5.6704	63-4	0.00000
63	1.67700	COM2	-0.0491	63-4	0.25400
63	0.00000	COM3	-1.9427	63-1	0.00000
63	0.25200	COM3	-0.1845	63-1	0.25200
63	0.50400	COM3	1.5564	63-1	0.50400
63	0.50400	COM3	1.5428	63-2	0.00000
63	0.80850	COM3	2.0107	63-2	0.30450
63	1.11300	COM3	2.4531	63-2	0.60900
63	1.11300	COM3	2.4345	63-3	0.00000
63	1.42300	COM3	1.3485	63-3	0.31000
63	1.42300	COM3	1.3518	63-4	0.00000
63	1.67700	COM3	-0.0061	63-4	0.25400
63	0.00000	LIFTLUG	-4.2384	63-1	0.00000

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
63	0.25200	LIFTLUG	0.5790	63-1	0.25200
63	0.50400	LIFTLUG	5.3824	63-1	0.50400
63	0.50400	LIFTLUG	5.3724	63-2	0.00000
63	0.80850	LIFTLUG	6.3846	63-2	0.30450
63	1.11300	LIFTLUG	7.3765	63-2	0.60900
63	1.11300	LIFTLUG	7.3870	63-3	0.00000
63	1.42300	LIFTLUG	4.0048	63-3	0.31000
63	1.42300	LIFTLUG	4.0252	63-4	0.00000
63	1.67700	LIFTLUG	-0.0343	63-4	0.25400
64	0.00000	COM1	0.0089	64-1	0.00000
64	0.44033	COM1	6.0162	64-1	0.44033
64	0.88067	COM1	11.2058	64-1	0.88067
64	1.32100	COM1	15.5779	64-1	1.32100
64	1.32100	COM1	15.5841	64-2	0.00000
64	1.65967	COM1	14.4357	64-2	0.33867
64	1.99833	COM1	12.7979	64-2	0.67733
64	2.33700	COM1	10.6705	64-2	1.01600
64	2.33700	COM1	10.6693	64-3	0.00000
64	2.70967	COM1	7.7110	64-3	0.37267
64	3.08233	COM1	4.1600	64-3	0.74533
64	3.45500	COM1	0.0162	64-3	1.11800
64	0.00000	COM2	0.0357	64-1	0.00000
64	0.44033	COM2	23.2214	64-1	0.44033
64	0.88067	COM2	43.2655	64-1	0.88067
64	1.32100	COM2	60.1679	64-1	1.32100
64	1.32100	COM2	60.1905	64-2	0.00000
64	1.65967	COM2	55.8107	64-2	0.33867
64	1.99833	COM2	49.4920	64-2	0.67733
64	2.33700	COM2	41.2342	64-2	1.01600
64	2.33700	COM2	41.2298	64-3	0.00000
64	2.70967	COM2	29.8551	64-3	0.37267
64	3.08233	COM2	16.1325	64-3	0.74533
64	3.45500	COM2	0.0620	64-3	1.11800
64	0.00000	COM3	0.0087	64-1	0.00000
64	0.44033	COM3	5.0389	64-1	0.44033
64	0.88067	COM3	9.3391	64-1	0.88067
64	1.32100	COM3	12.9093	64-1	1.32100
64	1.32100	COM3	12.9147	64-2	0.00000
64	1.65967	COM3	12.0480	64-2	0.33867
64	1.99833	COM3	10.7443	64-2	0.67733
64	2.33700	COM3	9.0035	64-2	1.01600
64	2.33700	COM3	9.0024	64-3	0.00000
64	2.70967	COM3	6.5360	64-3	0.37267
64	3.08233	COM3	3.5403	64-3	0.74533
64	3.45500	COM3	0.0154	64-3	1.11800
64	0.00000	LIFTLUG	0.0249	64-1	0.00000
64	0.44033	LIFTLUG	16.1972	64-1	0.44033
64	0.88067	LIFTLUG	30.1777	64-1	0.88067
64	1.32100	LIFTLUG	41.9664	64-1	1.32100
64	1.32100	LIFTLUG	41.9822	64-2	0.00000
64	1.65967	LIFTLUG	38.9257	64-2	0.33867
64	1.99833	LIFTLUG	34.5182	64-2	0.67733
64	2.33700	LIFTLUG	28.7598	64-2	1.01600
64	2.33700	LIFTLUG	28.7567	64-3	0.00000

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
64	2.70967	LIFTLUG	20.8214	64-3	0.37267
64	3.08233	LIFTLUG	11.2502	64-3	0.74533
64	3.45500	LIFTLUG	0.0433	64-3	1.11800
65	0.00000	COM1	-0.9349	65-1	0.00000
65	0.36850	COM1	-0.2996	65-1	0.36850
65	0.73700	COM1	0.2940	65-1	0.73700
65	0.73700	COM1	0.2692	65-2	0.00000
65	1.03050	COM1	-0.3064	65-2	0.29350
65	1.32400	COM1	-0.9085	65-2	0.58700
65	1.32400	COM1	-1.1763	65-3	0.00000
65	1.75600	COM1	0.3749	65-3	0.43200
65	1.75600	COM1	0.3745	65-4	0.00000
65	2.06700	COM1	0.6188	65-4	0.31100
65	2.37800	COM1	0.8333	65-4	0.62200
65	2.37800	COM1	0.8181	65-5	0.00000
65	2.64950	COM1	-0.6395	65-5	0.27150
65	2.92100	COM1	-2.1198	65-5	0.54300
65	0.00000	COM2	-2.1901	65-1	0.00000
65	0.36850	COM2	1.1610	65-1	0.36850
65	0.73700	COM2	4.4748	65-1	0.73700
65	0.73700	COM2	4.3952	65-2	0.00000
65	1.03050	COM2	0.6358	65-2	0.29350
65	1.32400	COM2	-3.1472	65-2	0.58700
65	1.32400	COM2	-4.2572	65-3	0.00000
65	1.75600	COM2	-0.8224	65-3	0.43200
65	1.75600	COM2	-0.8208	65-4	0.00000
65	2.06700	COM2	-0.0294	65-4	0.31100
65	2.37800	COM2	0.7355	65-4	0.62200
65	2.37800	COM2	0.6667	65-5	0.00000
65	2.64950	COM2	-4.4942	65-5	0.27150
65	2.92100	COM2	-9.6753	65-5	0.54300
65	0.00000	COM3	-1.0873	65-1	0.00000
65	0.36850	COM3	-0.5940	65-1	0.36850
65	0.73700	COM3	-0.1380	65-1	0.73700
65	0.73700	COM3	-0.1612	65-2	0.00000
65	1.03050	COM3	-0.7261	65-2	0.29350
65	1.32400	COM3	-1.3148	65-2	0.58700
65	1.32400	COM3	-1.5757	65-3	0.00000
65	1.75600	COM3	0.0744	65-3	0.43200
65	1.75600	COM3	0.0745	65-4	0.00000
65	2.06700	COM3	0.5371	65-4	0.31100
65	2.37800	COM3	0.9731	65-4	0.62200
65	2.37800	COM3	0.9619	65-5	0.00000
65	2.64950	COM3	-0.1457	65-5	0.27150
65	2.92100	COM3	-1.2735	65-5	0.54300
65	0.00000	LIFTLUG	-1.5714	65-1	0.00000
65	0.36850	LIFTLUG	0.7383	65-1	0.36850
65	0.73700	LIFTLUG	3.0182	65-1	0.73700
65	0.73700	LIFTLUG	2.9622	65-2	0.00000
65	1.03050	LIFTLUG	0.3874	65-2	0.29350
65	1.32400	LIFTLUG	-2.2063	65-2	0.58700
65	1.32400	LIFTLUG	-2.9782	65-3	0.00000
65	1.75600	LIFTLUG	-0.5037	65-3	0.43200
65	1.75600	LIFTLUG	-0.5026	65-4	0.00000

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
65	2.06700	LIFTLUG	0.0541	65-4	0.31100
65	2.37800	LIFTLUG	0.5896	65-4	0.62200
65	2.37800	LIFTLUG	0.5419	65-5	0.00000
65	2.64950	LIFTLUG	-3.0723	65-5	0.27150
65	2.92100	LIFTLUG	-6.7026	65-5	0.54300
66	0.00000	COM1	-2.1253	66-1	0.00000
66	0.41950	COM1	0.4380	66-1	0.41950
66	0.83900	COM1	2.9473	66-1	0.83900
66	0.83900	COM1	2.9436	66-2	0.00000
66	0.91200	COM1	3.1832	66-2	0.07300
66	0.91200	COM1	3.1826	66-3	0.00000
66	1.25700	COM1	2.7253	66-3	0.34500
66	1.60200	COM1	2.2314	66-3	0.69000
66	1.60200	COM1	2.1671	66-4	0.00000
66	2.07700	COM1	-0.5801	66-4	0.47500
66	2.07700	COM1	-0.9827	66-5	0.00000
66	2.40775	COM1	-0.2234	66-5	0.33075
66	2.73850	COM1	0.5023	66-5	0.66150
66	2.73850	COM1	0.4705	66-6	0.00000
66	3.06925	COM1	-0.6470	66-6	0.33075
66	3.40000	COM1	-1.7982	66-6	0.66150
66	0.00000	COM2	-9.6935	66-1	0.00000
66	0.41950	COM2	1.0917	66-1	0.41950
66	0.83900	COM2	11.8286	66-1	0.83900
66	0.83900	COM2	11.8152	66-2	0.00000
66	0.91200	COM2	12.8277	66-2	0.07300
66	0.91200	COM2	12.8265	66-3	0.00000
66	1.25700	COM2	10.9268	66-3	0.34500
66	1.60200	COM2	8.9944	66-3	0.69000
66	1.60200	COM2	8.7522	66-4	0.00000
66	2.07700	COM2	-1.3557	66-4	0.47500
66	2.07700	COM2	-2.8320	66-5	0.00000
66	2.40775	COM2	0.1666	66-5	0.33075
66	2.73850	COM2	3.1352	66-5	0.66150
66	2.73850	COM2	3.0359	66-6	0.00000
66	3.06925	COM2	-1.4968	66-6	0.33075
66	3.40000	COM2	-6.0595	66-6	0.66150
66	0.00000	COM3	-1.2786	66-1	0.00000
66	0.41950	COM3	0.7954	66-1	0.41950
66	0.83900	COM3	2.8211	66-1	0.83900
66	0.83900	COM3	2.8178	66-2	0.00000
66	0.91200	COM3	2.9940	66-2	0.07300
66	0.91200	COM3	2.9938	66-3	0.00000
66	1.25700	COM3	2.4063	66-3	0.34500
66	1.60200	COM3	1.7862	66-3	0.69000
66	1.60200	COM3	1.7271	66-4	0.00000
66	2.07700	COM3	-0.9496	66-4	0.47500
66	2.07700	COM3	-1.3243	66-5	0.00000
66	2.40775	COM3	-0.6167	66-5	0.33075
66	2.73850	COM3	0.0610	66-5	0.66150
66	2.73850	COM3	0.0333	66-6	0.00000
66	3.06925	COM3	-0.9411	66-6	0.33075
66	3.40000	COM3	-1.9455	66-6	0.66150
66	0.00000	LIFTLUG	-6.7153	66-1	0.00000

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
66	0.41950	LIFTLUG	0.7799	66-1	0.41950
66	0.83900	LIFTLUG	8.2366	66-1	0.83900
66	0.83900	LIFTLUG	8.2273	66-2	0.00000
66	0.91200	LIFTLUG	8.9308	66-2	0.07300
66	0.91200	LIFTLUG	8.9299	66-3	0.00000
66	1.25700	LIFTLUG	7.6090	66-3	0.34500
66	1.60200	LIFTLUG	6.2619	66-3	0.69000
66	1.60200	LIFTLUG	6.0928	66-4	0.00000
66	2.07700	LIFTLUG	-0.9729	66-4	0.47500
66	2.07700	LIFTLUG	-2.0050	66-5	0.00000
66	2.40775	LIFTLUG	0.0845	66-5	0.33075
66	2.73850	LIFTLUG	2.1499	66-5	0.66150
66	2.73850	LIFTLUG	2.0800	66-6	0.00000
66	3.06925	LIFTLUG	-1.0749	66-6	0.33075
66	3.40000	LIFTLUG	-4.2537	66-6	0.66150
67	0.00000	COM1	-5.1031	67-1	0.00000
67	0.44033	COM1	-1.8861	67-1	0.44033
67	0.88067	COM1	0.8892	67-1	0.88067
67	1.32100	COM1	3.2228	67-1	1.32100
67	0.00000	COM2	-21.3932	67-1	0.00000
67	0.44033	COM2	-7.7543	67-1	0.44033
67	0.88067	COM2	3.7120	67-1	0.88067
67	1.32100	COM2	13.0057	67-1	1.32100
67	0.00000	COM3	-4.9879	67-1	0.00000
67	0.44033	COM3	-1.8797	67-1	0.44033
67	0.88067	COM3	0.8342	67-1	0.88067
67	1.32100	COM3	3.1536	67-1	1.32100
67	0.00000	LIFTLUG	-14.8696	67-1	0.00000
67	0.44033	LIFTLUG	-5.3941	67-1	0.44033
67	0.88067	LIFTLUG	2.5805	67-1	0.88067
67	1.32100	LIFTLUG	9.0541	67-1	1.32100
68	0.00000	COM1	3.2207	68-1	0.00000
68	0.42680	COM1	2.6054	68-1	0.42680
68	0.85360	COM1	1.5751	68-1	0.85360
68	1.28040	COM1	0.1297	68-1	1.28040
68	1.70720	COM1	-1.7305	68-1	1.70720
68	2.13400	COM1	-4.0058	68-1	2.13400
68	0.00000	COM2	12.9972	68-1	0.00000
68	0.42680	COM2	10.9948	68-1	0.42680
68	0.85360	COM2	6.9513	68-1	0.85360
68	1.28040	COM2	0.8667	68-1	1.28040
68	1.70720	COM2	-7.2589	68-1	1.70720
68	2.13400	COM2	-17.4257	68-1	2.13400
68	0.00000	COM3	3.1512	68-1	0.00000
68	0.42680	COM3	2.4944	68-1	0.42680
68	0.85360	COM3	1.4669	68-1	0.85360
68	1.28040	COM3	0.0690	68-1	1.28040
68	1.70720	COM3	-1.6995	68-1	1.70720
68	2.13400	COM3	-3.8385	68-1	2.13400
68	0.00000	LIFTLUG	9.0482	68-1	0.00000
68	0.42680	LIFTLUG	7.6401	68-1	0.42680
68	0.85360	LIFTLUG	4.8217	68-1	0.85360
68	1.28040	LIFTLUG	0.5933	68-1	1.28040
68	1.70720	LIFTLUG	-5.0453	68-1	1.70720

Table 21: Element Forces - Frames, Part 2 of 2

Frame	Station m	OutputCase	M3 KN-m	FrameElem	ElemStation m
68	2.13400	LIFTLUG	-12.0940	68-1	2.13400
69	0.00000	COM1	-7.6569	69-1	0.00000
69	0.44033	COM1	-2.7489	69-1	0.44033
69	0.88067	COM1	1.4300	69-1	0.88067
69	1.32100	COM1	4.8798	69-1	1.32100
69	0.00000	COM2	-28.1012	69-1	0.00000
69	0.44033	COM2	-10.1095	69-1	0.44033
69	0.88067	COM2	5.2480	69-1	0.88067
69	1.32100	COM2	17.9712	69-1	1.32100
69	0.00000	COM3	-7.0856	69-1	0.00000
69	0.44033	COM3	-2.5486	69-1	0.44033
69	0.88067	COM3	1.3374	69-1	0.88067
69	1.32100	COM3	4.5724	69-1	1.32100
69	0.00000	LIFTLUG	-19.6457	69-1	0.00000
69	0.44033	LIFTLUG	-7.0669	69-1	0.44033
69	0.88067	LIFTLUG	3.6689	69-1	0.88067
69	1.32100	LIFTLUG	12.5617	69-1	1.32100
70	0.00000	COM1	4.8778	70-1	0.00000
70	0.42680	COM1	4.0247	70-1	0.42680
70	0.85360	COM1	2.4866	70-1	0.85360
70	1.28040	COM1	0.2634	70-1	1.28040
70	1.70720	COM1	-2.6447	70-1	1.70720
70	2.13400	COM1	-6.2378	70-1	2.13400
70	0.00000	COM2	17.9645	70-1	0.00000
70	0.42680	COM2	14.7840	70-1	0.42680
70	0.85360	COM2	9.1286	70-1	0.85360
70	1.28040	COM2	0.9985	70-1	1.28040
70	1.70720	COM2	-9.6065	70-1	1.70720
70	2.13400	COM2	-22.6863	70-1	2.13400
70	0.00000	COM3	4.5704	70-1	0.00000
70	0.42680	COM3	3.7193	70-1	0.42680
70	0.85360	COM3	2.2566	70-1	0.85360
70	1.28040	COM3	0.1823	70-1	1.28040
70	1.70720	COM3	-2.5036	70-1	1.70720
70	2.13400	COM3	-5.8011	70-1	2.13400
70	0.00000	LIFTLUG	12.5571	70-1	0.00000
70	0.42680	LIFTLUG	10.3351	70-1	0.42680
70	0.85360	LIFTLUG	6.3818	70-1	0.85360
70	1.28040	LIFTLUG	0.6970	70-1	1.28040
70	1.70720	LIFTLUG	-6.7192	70-1	1.70720
70	2.13400	LIFTLUG	-15.8668	70-1	2.13400

10. Area results

This section provides area results, including items such as forces and stresses.

Table 22: Element Forces - Area Shells, Part 1 of 4

Table 22: Element Forces - Area Shells, Part 1 of 4

Area	AreaElem	ShellType	Joint	OutputCase	CaseType	F11 KN/m	F22 KN/m	F12 KN/m
1	1	Shell-Thin	2	COM1	Combination	0.00	0.00	0.00
1	1	Shell-Thin	5	COM1	Combination	0.00	0.00	0.00
1	1	Shell-Thin	7	COM1	Combination	0.00	0.00	0.00
1	1	Shell-Thin	1	COM1	Combination	0.00	0.00	0.00
1	1	Shell-Thin	2	COM2	Combination	0.00	0.00	0.00
1	1	Shell-Thin	5	COM2	Combination	0.00	0.00	0.00
1	1	Shell-Thin	7	COM2	Combination	0.00	0.00	0.00
1	1	Shell-Thin	1	COM2	Combination	0.00	0.00	0.00
1	1	Shell-Thin	2	COM3	Combination	0.00	0.00	0.00
1	1	Shell-Thin	5	COM3	Combination	0.00	0.00	0.00
1	1	Shell-Thin	7	COM3	Combination	0.00	0.00	0.00
1	1	Shell-Thin	1	COM3	Combination	0.00	0.00	0.00
1	1	Shell-Thin	2	LIFTLUG	Combination	0.00	0.00	0.00
1	1	Shell-Thin	5	LIFTLUG	Combination	0.00	0.00	0.00
1	1	Shell-Thin	7	LIFTLUG	Combination	0.00	0.00	0.00
1	1	Shell-Thin	1	LIFTLUG	Combination	0.00	0.00	0.00
2	2	Shell-Thin	7	COM1	Combination	0.00	0.00	0.00
2	2	Shell-Thin	5	COM1	Combination	0.00	0.00	0.00
2	2	Shell-Thin	12	COM1	Combination	0.00	0.00	0.00
2	2	Shell-Thin	11	COM1	Combination	0.00	0.00	0.00
2	2	Shell-Thin	7	COM2	Combination	0.00	0.00	0.00
2	2	Shell-Thin	5	COM2	Combination	0.00	0.00	0.00
2	2	Shell-Thin	12	COM2	Combination	0.00	0.00	0.00
2	2	Shell-Thin	11	COM2	Combination	0.00	0.00	0.00
2	2	Shell-Thin	7	COM3	Combination	0.00	0.00	0.00
2	2	Shell-Thin	5	COM3	Combination	0.00	0.00	0.00
2	2	Shell-Thin	12	COM3	Combination	0.00	0.00	0.00
2	2	Shell-Thin	11	COM3	Combination	0.00	0.00	0.00
2	2	Shell-Thin	7	LIFTLUG	Combination	0.00	0.00	0.00
2	2	Shell-Thin	5	LIFTLUG	Combination	0.00	0.00	0.00
2	2	Shell-Thin	12	LIFTLUG	Combination	0.00	0.00	0.00
2	2	Shell-Thin	11	LIFTLUG	Combination	0.00	0.00	0.00
3	3	Shell-Thin	11	COM1	Combination	0.00	0.00	0.00
3	3	Shell-Thin	12	COM1	Combination	0.00	0.00	0.00
3	3	Shell-Thin	4	COM1	Combination	0.00	0.00	0.00
3	3	Shell-Thin	39	COM1	Combination	0.00	0.00	0.00
3	3	Shell-Thin	11	COM2	Combination	0.00	0.00	0.00
3	3	Shell-Thin	12	COM2	Combination	0.00	0.00	0.00
3	3	Shell-Thin	4	COM2	Combination	0.00	0.00	0.00
3	3	Shell-Thin	39	COM2	Combination	0.00	0.00	0.00
3	3	Shell-Thin	11	COM3	Combination	0.00	0.00	0.00
3	3	Shell-Thin	12	COM3	Combination	0.00	0.00	0.00
3	3	Shell-Thin	4	COM3	Combination	0.00	0.00	0.00
3	3	Shell-Thin	39	COM3	Combination	0.00	0.00	0.00
3	3	Shell-Thin	11	LIFTLUG	Combination	0.00	0.00	0.00
3	3	Shell-Thin	12	LIFTLUG	Combination	0.00	0.00	0.00
3	3	Shell-Thin	4	LIFTLUG	Combination	0.00	0.00	0.00
3	3	Shell-Thin	39	LIFTLUG	Combination	0.00	0.00	0.00

Table 22: Element Forces - Area Shells, Part 2 of 4

Table 22: Element Forces - Area Shells, Part 2 of 4

Area	AreaElem	Joint	OutputCase	FMax KN/m	FMin KN/m	FAngle Degrees	FVM KN/m	M11 KN-m/m
1	1	2	COM1	0.00	0.00	0.000	0.00	-3.0264
1	1	5	COM1	0.00	0.00	0.000	0.00	2.0960
1	1	7	COM1	0.00	0.00	0.000	0.00	1.9985
1	1	1	COM1	0.00	0.00	0.000	0.00	-2.9060
1	1	2	COM2	0.00	0.00	0.000	0.00	-11.7555
1	1	5	COM2	0.00	0.00	0.000	0.00	5.4499
1	1	7	COM2	0.00	0.00	0.000	0.00	5.2568
1	1	1	COM2	0.00	0.00	0.000	0.00	-10.6179
1	1	2	COM3	0.00	0.00	0.000	0.00	-5.2513
1	1	5	COM3	0.00	0.00	0.000	0.00	2.8749
1	1	7	COM3	0.00	0.00	0.000	0.00	2.7700
1	1	1	COM3	0.00	0.00	0.000	0.00	-5.1537
1	1	2	LIFTLUG	0.00	0.00	0.000	0.00	-8.1973
1	1	5	LIFTLUG	0.00	0.00	0.000	0.00	3.8828
1	1	7	LIFTLUG	0.00	0.00	0.000	0.00	3.7425
1	1	1	LIFTLUG	0.00	0.00	0.000	0.00	-7.4245
2	2	7	COM1	0.00	0.00	0.000	0.00	-1.8191
2	2	5	COM1	0.00	0.00	0.000	0.00	-1.6728
2	2	12	COM1	0.00	0.00	0.000	0.00	0.2594
2	2	11	COM1	0.00	0.00	0.000	0.00	0.0783
2	2	7	COM2	0.00	0.00	0.000	0.00	-4.8703
2	2	5	COM2	0.00	0.00	0.000	0.00	-3.7327
2	2	12	COM2	0.00	0.00	0.000	0.00	-0.9100
2	2	11	COM2	0.00	0.00	0.000	0.00	-1.1765
2	2	7	COM3	0.00	0.00	0.000	0.00	-1.6164
2	2	5	COM3	0.00	0.00	0.000	0.00	-1.5509
2	2	12	COM3	0.00	0.00	0.000	0.00	0.4004
2	2	11	COM3	0.00	0.00	0.000	0.00	0.0625
2	2	7	LIFTLUG	0.00	0.00	0.000	0.00	-3.4634
2	2	5	LIFTLUG	0.00	0.00	0.000	0.00	-2.6876
2	2	12	LIFTLUG	0.00	0.00	0.000	0.00	-0.5758
2	2	11	LIFTLUG	0.00	0.00	0.000	0.00	-0.7750
3	3	11	COM1	0.00	0.00	0.000	0.00	2.2336
3	3	12	COM1	0.00	0.00	0.000	0.00	1.3456
3	3	4	COM1	0.00	0.00	0.000	0.00	-4.8919
3	3	39	COM1	0.00	0.00	0.000	0.00	-5.9121
3	3	11	COM2	0.00	0.00	0.000	0.00	5.7619
3	3	12	COM2	0.00	0.00	0.000	0.00	3.5750
3	3	4	COM2	0.00	0.00	0.000	0.00	-13.2454
3	3	39	COM2	0.00	0.00	0.000	0.00	-16.2950
3	3	11	COM3	0.00	0.00	0.000	0.00	3.6738
3	3	12	COM3	0.00	0.00	0.000	0.00	2.1864
3	3	4	COM3	0.00	0.00	0.000	0.00	-6.9109
3	3	39	COM3	0.00	0.00	0.000	0.00	-8.2427
3	3	11	LIFTLUG	0.00	0.00	0.000	0.00	4.1072
3	3	12	LIFTLUG	0.00	0.00	0.000	0.00	2.5435
3	3	4	LIFTLUG	0.00	0.00	0.000	0.00	-9.4126
3	3	39	LIFTLUG	0.00	0.00	0.000	0.00	-11.5671

Table 22: Element Forces - Area Shells, Part 3 of 4

Table 22: Element Forces - Area Shells, Part 3 of 4

Area	AreaElem	Joint	OutputCase	M22	M12	MMax	MMin	MAngle
				KN-m/m	KN-m/m	KN-m/m	KN-m/m	Degrees
1	1	2	COM1	-2.9541	-0.2893	-2.6986	-3.2818	-48.562
1	1	5	COM1	-0.3740	-0.2796	2.1272	-0.4053	-6.378
1	1	7	COM1	-0.2241	0.2893	2.0356	-0.2611	7.296
1	1	1	COM1	-3.2217	0.2796	-2.7428	-3.3849	30.274
1	1	2	COM2	-10.2223	-0.8487	-9.8452	-12.1326	-66.044
1	1	5	COM2	-2.8207	-0.6224	5.4965	-2.8672	-4.279
1	1	7	COM2	-2.6227	0.8487	5.3472	-2.7131	6.079
1	1	1	COM2	-11.7897	0.6224	-10.3490	-12.0586	23.364
1	1	2	COM3	-6.9442	-1.1297	-4.6861	-7.5094	-26.579
1	1	5	COM3	0.1979	-1.1382	3.2934	-0.2206	-20.187
1	1	7	COM3	0.6567	1.1297	3.2602	0.1665	23.457
1	1	1	COM3	-7.2596	1.1382	-4.6561	-7.7571	23.613
1	1	2	LIFTLUG	-7.1665	-0.6003	-6.8907	-8.4730	-65.324
1	1	5	LIFTLUG	-1.9250	-0.4482	3.9172	-1.9594	-4.387
1	1	7	LIFTLUG	-1.7752	0.6003	3.8070	-1.8397	6.138
1	1	1	LIFTLUG	-8.2434	0.4482	-7.2269	-8.4410	23.794
2	2	7	COM1	-1.3694	-0.2535	-1.2553	-1.9331	-65.787
2	2	5	COM1	-1.5047	0.2013	-1.3706	-1.8069	56.336
2	2	12	COM1	-1.0807	0.2535	0.3057	-1.1271	10.362
2	2	11	COM1	-3.1591	-0.2013	0.0908	-3.1716	-3.544
2	2	7	COM2	-5.6609	-0.7717	-4.3986	-6.1326	-31.438
2	2	5	COM2	-5.5755	0.7285	-3.4795	-5.8287	19.166
2	2	12	COM2	-6.1390	0.7717	-0.7985	-6.2505	8.222
2	2	11	COM2	-11.4376	-0.7285	-1.1250	-11.4891	-4.041
2	2	7	COM3	-0.6592	-0.2878	-0.5793	-1.6963	-74.488
2	2	5	COM3	-1.1299	0.1966	-1.0523	-1.6285	68.476
2	2	12	COM3	-0.0386	0.2878	0.5429	-0.1811	26.337
2	2	11	COM3	-3.3404	-0.1966	0.0738	-3.3518	-3.296
2	2	7	LIFTLUG	-3.9369	-0.5446	-3.1063	-4.2940	-33.252
2	2	5	LIFTLUG	-3.8961	0.5096	-2.5014	-4.0823	20.072
2	2	12	LIFTLUG	-4.2213	0.5446	-0.4962	-4.3009	8.318
2	2	11	LIFTLUG	-8.0012	-0.5096	-0.7392	-8.0369	-4.014
3	3	11	COM1	-2.5126	0.1924	2.2414	-2.5203	2.318
3	3	12	COM1	-0.7549	0.2094	1.3663	-0.7755	5.638
3	3	4	COM1	-6.4154	0.0485	-4.8904	-6.4169	1.820
3	3	39	COM1	-1.3212	-0.1935	-1.3131	-5.9202	-87.591
3	3	11	COM2	-9.3561	1.8067	5.9748	-9.5690	6.721
3	3	12	COM2	-4.7935	-0.8088	3.6525	-4.8709	-5.470
3	3	4	COM2	-12.1930	-1.2391	-11.3730	-14.0654	-56.504
3	3	39	COM2	-2.5043	0.9219	-2.4429	-16.3563	86.192
3	3	11	COM3	-2.2571	-0.3100	3.6900	-2.2732	-2.984
3	3	12	COM3	0.4972	0.9389	2.6047	0.0789	24.013
3	3	4	COM3	-11.7709	0.7062	-6.8103	-11.8714	8.102
3	3	39	COM3	-1.8286	-0.9641	-1.6869	-8.3845	-81.634
3	3	11	LIFTLUG	-6.5365	1.2273	4.2469	-6.6762	6.493
3	3	12	LIFTLUG	-3.2855	-0.5143	2.5886	-3.3305	-5.003
3	3	4	LIFTLUG	-8.8924	-0.8203	-8.2919	-10.0131	-53.796
3	3	39	LIFTLUG	-1.8268	0.5916	-1.7910	-11.6029	86.537

Table 22: Element Forces - Area Shells, Part 4 of 4

Table 22: Element Forces - Area Shells, Part 4 of 4

Area	AreaElem	Joint	OutputCase	V13 KN/m	V23 KN/m	VMax KN/m	VAngle Degrees
1	1	2	COM1	1.87	-7.422E-02	1.87	-2.271
1	1	5	COM1	1.87	4.666E-02	1.87	1.428
1	1	7	COM1	1.80	4.666E-02	1.80	1.486
1	1	1	COM1	1.80	-7.422E-02	1.80	-2.363
1	1	2	COM2	6.16	-0.38	6.17	-3.514
1	1	5	COM2	6.16	0.13	6.16	1.235
1	1	7	COM2	5.72	0.13	5.72	1.330
1	1	1	COM2	5.72	-0.38	5.73	-3.786
1	1	2	COM3	3.36	-9.408E-02	3.37	-1.602
1	1	5	COM3	3.36	0.13	3.37	2.213
1	1	7	COM3	3.30	0.13	3.30	2.258
1	1	1	COM3	3.30	-9.408E-02	3.30	-1.635
1	1	2	LIFTLUG	4.33	-0.26	4.34	-3.450
1	1	5	LIFTLUG	4.33	9.404E-02	4.33	1.245
1	1	7	LIFTLUG	4.02	9.404E-02	4.03	1.339
1	1	1	LIFTLUG	4.02	-0.26	4.03	-3.710
2	2	7	COM1	0.38	5.340E-02	0.39	7.900
2	2	5	COM1	0.39	5.340E-02	0.40	7.712
2	2	12	COM1	0.39	-0.59	0.71	-56.126
2	2	11	COM1	0.38	-0.59	0.70	-56.768
2	2	7	COM2	0.57	-1.296E-02	0.57	-1.300
2	2	5	COM2	0.33	-1.296E-02	0.33	-2.222
2	2	12	COM2	0.33	-1.52	1.56	-77.618
2	2	11	COM2	0.57	-1.52	1.63	-69.427
2	2	7	COM3	0.32	0.16	0.36	26.950
2	2	5	COM3	0.39	0.16	0.42	22.392
2	2	12	COM3	0.39	-0.93	1.01	-67.222
2	2	11	COM3	0.32	-0.93	0.98	-71.208
2	2	7	LIFTLUG	0.43	-2.284E-03	0.43	-0.307
2	2	5	LIFTLUG	0.27	-2.284E-03	0.27	-0.485
2	2	12	LIFTLUG	0.27	-1.08	1.12	-76.036
2	2	11	LIFTLUG	0.43	-1.08	1.17	-68.527
3	3	11	COM1	-2.96	-0.65	3.03	-167.643
3	3	12	COM1	-2.07	-0.56	2.15	-164.843
3	3	4	COM1	-2.14	1.28	2.49	149.104
3	3	39	COM1	-3.03	1.36	3.33	155.777
3	3	11	COM2	-7.24	-1.64	7.42	-167.233
3	3	12	COM2	-4.82	-1.46	5.03	-163.117
3	3	4	COM2	-4.96	2.48	5.54	153.452
3	3	39	COM2	-7.39	2.66	7.86	160.193
3	3	11	COM3	-4.68	-1.03	4.79	-167.557
3	3	12	COM3	-3.38	-0.87	3.49	-165.507
3	3	4	COM3	-3.50	2.50	4.30	144.515
3	3	39	COM3	-4.82	2.65	5.50	151.212
3	3	11	LIFTLUG	-5.18	-1.17	5.31	-167.261
3	3	12	LIFTLUG	-3.46	-1.04	3.61	-163.239
3	3	4	LIFTLUG	-3.56	1.80	3.99	153.129
3	3	39	LIFTLUG	-5.29	1.94	5.63	159.883

Table 23: Element Stresses - Area Shells, Part 1 of 4

Table 23: Element Stresses - Area Shells, Part 1 of 4									
Area	AreaElement	ShellType	Joint	OutputCase	CaseType	S11Top	S22Top	S12Top	SMaxTop
						KN/m2	KN/m2	KN/m2	KN/m2
1	1	Shell-Thin	2	COM1	Combina tion	1815.83	1772.44	173.60	1969.08
1	1	Shell-Thin	5	COM1	Combina tion	-1257.59	224.43	167.75	243.18
1	1	Shell-Thin	7	COM1	Combina tion	-1199.13	134.44	-173.60	156.66
1	1	Shell-Thin	1	COM1	Combina tion	1743.57	1933.03	-167.75	2030.95
1	1	Shell-Thin	2	COM2	Combina tion	7053.27	6133.36	509.25	7279.53
1	1	Shell-Thin	5	COM2	Combina tion	-3269.96	1692.41	373.42	1720.35
1	1	Shell-Thin	7	COM2	Combina tion	-3154.08	1573.64	-509.25	1627.87
1	1	Shell-Thin	1	COM2	Combina tion	6370.72	7073.83	-373.42	7235.14
1	1	Shell-Thin	2	COM3	Combina tion	3150.76	4166.51	677.84	4505.64
1	1	Shell-Thin	5	COM3	Combina tion	-1724.97	-118.74	682.89	132.34
1	1	Shell-Thin	7	COM3	Combina tion	-1662.00	-394.02	-677.84	-99.89
1	1	Shell-Thin	1	COM3	Combina tion	3092.20	4355.73	-682.89	4654.27
1	1	Shell-Thin	2	LIFTLUG	Combina tion	4918.35	4299.91	360.17	5083.83
1	1	Shell-Thin	5	LIFTLUG	Combina tion	-2329.69	1154.99	268.91	1175.62
1	1	Shell-Thin	7	LIFTLUG	Combina tion	-2245.47	1065.10	-360.17	1103.83
1	1	Shell-Thin	1	LIFTLUG	Combina tion	4454.71	4946.01	-268.91	5064.58
2	2	Shell-Thin	7	COM1	Combina tion	1091.46	821.61	152.11	1159.87
2	2	Shell-Thin	5	COM1	Combina tion	1003.70	902.81	-120.75	1084.12
2	2	Shell-Thin	12	COM1	Combina tion	-155.62	648.45	-152.11	676.26
2	2	Shell-Thin	11	COM1	Combina tion	-46.99	1895.48	120.75	1902.96
2	2	Shell-Thin	7	COM2	Combina tion	2922.17	3396.52	463.00	3679.56
2	2	Shell-Thin	5	COM2	Combina tion	2239.63	3345.28	-437.09	3497.20
2	2	Shell-Thin	12	COM2	Combina tion	546.00	3683.39	-463.00	3750.29
2	2	Shell-Thin	11	COM2	Combina tion	705.88	6862.57	437.09	6893.44
2	2	Shell-Thin	7	COM3	Combina tion	969.85	395.53	172.71	1017.78
2	2	Shell-Thin	5	COM3	Combina tion	930.54	677.92	-117.98	977.07
2	2	Shell-Thin	12	COM3	Combina tion	-240.22	23.16	-172.71	108.66
2	2	Shell-Thin	11	COM3	Combina tion	-37.50	2004.27	117.98	2011.06

Table 23: Element Stresses - Area Shells, Part 1 of 4

Area	AreaElement	ShellType	Joint	OutputCase	CaseType	S11Top	S22Top	S12Top	SMaxTop
						KN/m2	KN/m2	KN/m2	KN/m2
2	2	Shell-Thin	7	LIFTLUG	Combina	2078.05	2362.16	326.77	2576.42
2	2	Shell-Thin	5	LIFTLUG	Combina	1612.58	2337.67	-305.77	2449.39
2	2	Shell-Thin	12	LIFTLUG	Combina	345.48	2532.79	-326.77	2580.56
2	2	Shell-Thin	11	LIFTLUG	Combina	464.99	4800.70	305.77	4822.15
3	3	Shell-Thin	11	COM1	Combina	-1340.15	1507.53	-115.45	1512.21
3	3	Shell-Thin	12	COM1	Combina	-807.38	452.92	-125.64	465.32
3	3	Shell-Thin	4	COM1	Combina	2935.14	3849.23	-29.08	3850.16
3	3	Shell-Thin	39	COM1	Combina	3547.26	792.72	116.08	3552.14
3	3	Shell-Thin	11	COM2	Combina	-3457.14	5613.66	-1083.99	5741.40
3	3	Shell-Thin	12	COM2	Combina	-2145.00	2876.09	485.27	2922.56
3	3	Shell-Thin	4	COM2	Combina	7947.23	7315.82	743.49	8439.26
3	3	Shell-Thin	39	COM2	Combina	9776.98	1502.57	-553.16	9813.80
3	3	Shell-Thin	11	COM3	Combina	-2204.28	1354.23	186.02	1363.93
3	3	Shell-Thin	12	COM3	Combina	-1311.85	-298.33	-563.34	-47.36
3	3	Shell-Thin	4	COM3	Combina	4146.52	7062.53	-423.70	7122.85
3	3	Shell-Thin	39	COM3	Combina	4945.64	1097.19	578.47	5030.71
3	3	Shell-Thin	11	LIFTLUG	Combina	-2464.30	3921.91	-736.40	4005.72
3	3	Shell-Thin	12	LIFTLUG	Combina	-1526.12	1971.31	308.56	1998.32
3	3	Shell-Thin	4	LIFTLUG	Combina	5647.57	5335.46	492.20	6007.86
3	3	Shell-Thin	39	LIFTLUG	Combina	6940.28	1096.08	-354.96	6961.76

Table 23: Element Stresses - Area Shells, Part 2 of 4

Table 23: Element Stresses - Area Shells, Part 2 of 4

Area	AreaElement	Joint	OutputCase	SMinTop	SAngleTop	SVMTop	S11Bot	S22Bot	S12Bot
				KN/m2	Degrees	KN/m2	KN/m2	KN/m2	KN/m2
1	1	2	COM1	1619.19	41.438	1819.54	-1815.83	-1772.44	-173.60
1	1	5	COM1	-1276.34	83.622	1413.70	1257.59	-224.43	-167.75
1	1	7	COM1	-1221.36	-82.704	1306.75	1199.13	-134.44	173.60
1	1	1	COM1	1645.65	-59.726	1868.34	-1743.57	-1933.03	167.75
1	1	2	COM2	5907.10	23.956	6699.59	-7053.27	-6133.36	-509.25
1	1	5	COM2	-3297.90	85.721	4416.93	3269.96	-1692.41	-373.42
1	1	7	COM2	-3208.31	-83.921	4262.15	3154.08	-1573.64	509.25
1	1	1	COM2	6209.41	-66.636	6780.71	-6370.72	-7073.83	373.42
1	1	2	COM3	2811.64	63.421	3941.81	-3150.76	-4166.51	-677.84

Table 23: Element Stresses - Area Shells, Part 2 of 4

Area	AreaElem	Joint	OutputCase	SMinTop KN/m2	SAngleTop Degrees	SVMTop KN/m2	S11Bot KN/m2	S22Bot KN/m2	S12Bot KN/m2
1	1	5	COM3	-1976.05	69.813	2045.44	1724.97	118.74	-682.89
1	1	7	COM3	-1956.14	-66.543	1908.15	1662.00	394.02	677.84
1	1	1	COM3	2793.66	-66.387	4057.63	-3092.20	-4355.73	682.89
1	1	2	LIFTLUG	4134.43	24.676	4681.89	-4918.35	-4299.91	-360.17
1	1	5	LIFTLUG	-2350.32	85.613	3109.53	2329.69	-1154.99	-268.91
1	1	7	LIFTLUG	-2284.20	-83.862	2992.89	2245.47	-1065.10	360.17
1	1	1	LIFTLUG	4336.14	-66.206	4742.51	-4454.71	-4946.01	268.91
2	2	7	COM1	753.21	24.213	1019.31	-1091.46	-821.61	-152.11
2	2	5	COM1	822.39	-33.664	979.83	-1003.70	-902.81	120.75
2	2	12	COM1	-183.43	-79.638	784.24	155.62	-648.45	152.11
2	2	11	COM1	-54.46	86.456	1930.77	46.99	-1895.48	-120.75
2	2	7	COM2	2639.13	58.562	3285.32	-2922.17	-3396.52	-463.00
2	2	5	COM2	2087.71	-70.834	3047.59	-2239.63	-3345.28	437.09
2	2	12	COM2	479.10	-81.778	3535.17	-546.00	-3683.39	463.00
2	2	11	COM2	675.00	85.959	6581.95	-705.88	-6862.57	-437.09
2	2	7	COM3	347.60	15.512	896.06	-969.85	-395.53	-172.71
2	2	5	COM3	631.38	-21.524	858.14	-930.54	-677.92	117.98
2	2	12	COM3	-325.71	-63.663	391.52	240.22	-23.16	172.71
2	2	11	COM3	-44.30	86.704	2033.57	37.50	-2004.27	-117.98
2	2	7	LIFTLUG	1863.79	56.748	2304.29	-2078.05	-2362.16	-326.77
2	2	5	LIFTLUG	1500.85	-69.928	2139.14	-1612.58	-2337.67	305.77
2	2	12	LIFTLUG	297.70	-81.682	2445.34	-345.48	-2532.79	326.77
2	2	11	LIFTLUG	443.54	85.986	4616.39	-464.99	-4800.70	-305.77
3	3	11	COM1	-1344.82	-87.682	2475.67	1340.15	-1507.53	115.45
3	3	12	COM1	-819.79	-84.362	1126.96	807.38	-452.92	125.64
3	3	4	COM1	2934.22	-88.180	3483.70	-2935.14	-3849.23	29.08
3	3	39	COM1	787.84	2.409	3231.08	-3547.26	-792.72	-116.08
3	3	11	COM2	-3584.88	-83.279	8148.45	3457.14	-5613.66	1083.99
3	3	12	COM2	-2191.47	84.530	4443.94	2145.00	-2876.09	-485.27
3	3	4	COM2	6823.79	33.496	7758.70	-7947.23	-7315.82	-743.49
3	3	39	COM2	1465.75	-3.808	9169.21	-9776.98	-1502.57	553.16
3	3	11	COM3	-2213.98	87.016	3127.57	2204.28	-1354.23	-186.02
3	3	12	COM3	-1562.83	-65.987	1539.69	1311.85	298.33	563.34
3	3	4	COM3	4086.20	-81.898	6190.85	-4146.52	-7062.53	423.70
3	3	39	COM3	1012.12	8.366	4608.77	-4945.64	-1097.19	-578.47
3	3	11	LIFTLUG	-2548.12	-83.507	5722.39	2464.30	-3921.91	736.40
3	3	12	LIFTLUG	-1553.13	84.997	3083.70	1526.12	-1971.31	-308.56
3	3	4	LIFTLUG	4975.17	36.204	5563.86	-5647.57	-5335.46	-492.20
3	3	39	LIFTLUG	1074.60	-3.463	6491.51	-6940.28	-1096.08	354.96

Table 23: Element Stresses - Area Shells, Part 3 of 4

Table 23: Element Stresses - Area Shells, Part 3 of 4

Area	AreaElem	Joint	OutputCase	SMaxBot KN/m2	SMinBot KN/m2	SAngleBot Degrees	SVMBot KN/m2	S13Avg KN/m2	S23Avg KN/m2
1	1	2	COM1	-1619.19	-1969.08	-48.562	1819.54	18.72	-0.74
1	1	5	COM1	1276.34	-243.18	-6.378	1413.70	18.72	0.47
1	1	7	COM1	1221.36	-156.66	7.296	1306.75	17.99	0.47
1	1	1	COM1	-1645.65	-2030.95	30.274	1868.34	17.99	-0.74
1	1	2	COM2	-5907.10	-7279.53	-66.044	6699.59	61.59	-3.78
1	1	5	COM2	3297.90	-1720.35	-4.279	4416.93	61.59	1.33
1	1	7	COM2	3208.31	-1627.87	6.079	4262.15	57.16	1.33

Table 23: Element Stresses - Area Shells, Part 3 of 4

Area	AreaElement	Joint	OutputCase	SMaxBot KN/m2	SMinBot KN/m2	SAngleBot Degrees	SVMBot KN/m2	S13Avg KN/m2	S23Avg KN/m2
1	1	1	COM2	-6209.41	-7235.14	23.364	6780.71	57.16	-3.78
1	1	2	COM3	-2811.64	-4505.64	-26.579	3941.81	33.64	-0.94
1	1	5	COM3	1976.05	-132.34	-20.187	2045.44	33.64	1.30
1	1	7	COM3	1956.14	99.89	23.457	1908.15	32.97	1.30
1	1	1	COM3	-2793.66	-4654.27	23.613	4057.63	32.97	-0.94
1	1	2	LIFTLUG	-4134.43	-5083.83	-65.324	4681.89	43.29	-2.61
1	1	5	LIFTLUG	2350.32	-1175.62	-4.387	3109.53	43.29	0.94
1	1	7	LIFTLUG	2284.20	-1103.83	6.138	2992.89	40.25	0.94
1	1	1	LIFTLUG	-4336.14	-5064.58	23.794	4742.51	40.25	-2.61
2	2	7	COM1	-753.21	-1159.87	-65.787	1019.31	3.85	0.53
2	2	5	COM1	-822.39	-1084.12	56.336	979.83	3.94	0.53
2	2	12	COM1	183.43	-676.26	10.362	784.24	3.94	-5.87
2	2	11	COM1	54.46	-1902.96	-3.544	1930.77	3.85	-5.87
2	2	7	COM2	-2639.13	-3679.56	-31.438	3285.32	5.71	-0.13
2	2	5	COM2	-2087.71	-3497.20	19.166	3047.59	3.34	-0.13
2	2	12	COM2	-479.10	-3750.29	8.222	3535.17	3.34	-15.22
2	2	11	COM2	-675.00	-6893.44	-4.041	6581.95	5.71	-15.22
2	2	7	COM3	-347.60	-1017.78	-74.488	896.06	3.17	1.61
2	2	5	COM3	-631.38	-977.07	68.476	858.14	3.91	1.61
2	2	12	COM3	325.71	-108.66	26.337	391.52	3.91	-9.31
2	2	11	COM3	44.30	-2011.06	-3.296	2033.57	3.17	-9.31
2	2	7	LIFTLUG	-1863.79	-2576.42	-33.252	2304.29	4.27	-2.284E-02
2	2	5	LIFTLUG	-1500.85	-2449.39	20.072	2139.14	2.70	-2.284E-02
2	2	12	LIFTLUG	-297.70	-2580.56	8.318	2445.34	2.70	-10.84
2	2	11	LIFTLUG	-443.54	-4822.15	-4.014	4616.39	4.27	-10.84
3	3	11	COM1	1344.82	-1512.21	2.318	2475.67	-29.58	-6.48
3	3	12	COM1	819.79	-465.32	5.638	1126.96	-20.72	-5.61
3	3	4	COM1	-2934.22	-3850.16	1.820	3483.70	-21.41	12.81
3	3	39	COM1	-787.84	-3552.14	-87.591	3231.08	-30.33	13.65
3	3	11	COM2	3584.88	-5741.40	6.721	8148.45	-72.38	-16.40
3	3	12	COM2	2191.47	-2922.56	-5.470	4443.94	-48.16	-14.62
3	3	4	COM2	-6823.79	-8439.26	-56.504	7758.70	-49.57	24.77
3	3	39	COM2	-1465.75	-9813.80	86.192	9169.21	-73.93	26.63
3	3	11	COM3	2213.98	-1363.93	-2.984	3127.57	-46.81	-10.33
3	3	12	COM3	1562.83	47.36	24.013	1539.69	-33.75	-8.72
3	3	4	COM3	-4086.20	-7122.85	8.102	6190.85	-35.03	24.97
3	3	39	COM3	-1012.12	-5030.71	-81.634	4608.77	-48.20	26.49
3	3	11	LIFTLUG	2548.12	-4005.72	6.493	5722.39	-51.77	-11.70
3	3	12	LIFTLUG	1553.13	-1998.32	-5.003	3083.70	-34.57	-10.41
3	3	4	LIFTLUG	-4975.17	-6007.86	-53.796	5563.86	-35.60	18.04
3	3	39	LIFTLUG	-1074.60	-6961.76	86.537	6491.51	-52.90	19.38

Table 23: Element Stresses - Area Shells, Part 4 of 4

Table 23: Element Stresses - Area Shells, Part 4 of 4

Area	AreaElement	Joint	OutputCase	SMaxAvg KN/m2	SAngleAvg Degrees
1	1	2	COM1	18.73	-2.271
1	1	5	COM1	18.72	1.428
1	1	7	COM1	18.00	1.486
1	1	1	COM1	18.00	-2.363
1	1	2	COM2	61.71	-3.514

Table 23: Element Stresses - Area Shells, Part 4 of 4

Area	AreaElem	Joint	OutputCase	SMaxAvg KN/m2	SAngleAvg Degrees
1	1	5	COM2	61.60	1.235
1	1	7	COM2	57.17	1.330
1	1	1	COM2	57.28	-3.786
1	1	2	COM3	33.66	-1.602
1	1	5	COM3	33.67	2.213
1	1	7	COM3	32.99	2.258
1	1	1	COM3	32.98	-1.635
1	1	2	LIFTLUG	43.37	-3.450
1	1	5	LIFTLUG	43.30	1.245
1	1	7	LIFTLUG	40.26	1.339
1	1	1	LIFTLUG	40.33	-3.710
2	2	7	COM1	3.89	7.900
2	2	5	COM1	3.98	7.712
2	2	12	COM1	7.07	-56.126
2	2	11	COM1	7.02	-56.768
2	2	7	COM2	5.71	-1.300
2	2	5	COM2	3.34	-2.222
2	2	12	COM2	15.58	-77.618
2	2	11	COM2	16.26	-69.427
2	2	7	COM3	3.55	26.950
2	2	5	COM3	4.23	22.392
2	2	12	COM3	10.10	-67.222
2	2	11	COM3	9.83	-71.208
2	2	7	LIFTLUG	4.27	-0.307
2	2	5	LIFTLUG	2.70	-0.485
2	2	12	LIFTLUG	11.18	-76.036
2	2	11	LIFTLUG	11.65	-68.527
3	3	11	COM1	30.28	-167.643
3	3	12	COM1	21.46	-164.843
3	3	4	COM1	24.95	149.104
3	3	39	COM1	33.26	155.777
3	3	11	COM2	74.21	-167.233
3	3	12	COM2	50.33	-163.117
3	3	4	COM2	55.42	153.452
3	3	39	COM2	78.58	160.193
3	3	11	COM3	47.94	-167.557
3	3	12	COM3	34.86	-165.507
3	3	4	COM3	43.02	144.515
3	3	39	COM3	55.00	151.212
3	3	11	LIFTLUG	53.08	-167.261
3	3	12	LIFTLUG	36.10	-163.239
3	3	4	LIFTLUG	39.91	153.129
3	3	39	LIFTLUG	56.33	159.883

11. Material take-off

This section provides a material take-off.

Table 24: Material List 2 - By Section Property

Table 24: Material List 2 - By Section Property

Section	ObjectType	NumPieces	TotalLength m	TotalWeight KN
W250X33	Frame	11	36.62500	11.756
W150X22	Frame	8	16.17600	3.549
W100X19	Frame	2	3.45500	0.660
C150X12	Frame	19	32.41600	3.818
Floor	Area			0.000

12. Design preferences

This section provides the design preferences for each type of design, which typically include material reduction factors, framing type, stress ratio limit, deflection limits, and other code specific items.

12.1. Steel design

Table 25: Preferences - Steel Design - CAN-CSA-S16-01, Part 1 of 3

Table 25: Preferences - Steel Design - CAN-CSA-S16-01, Part 1 of 3

THDesign	FrameType	PatLLF	SRatioLimit	MaxIter	AccRat	DuctFact	OverFact	PhiB
Envelopes	Type LD MRF	0.750000	0.950000	1	0.350000	5.000000	1.500000	0.900000

Table 25: Preferences - Steel Design - CAN-CSA-S16-01, Part 2 of 3

Table 25: Preferences - Steel Design - CAN-CSA-S16-01, Part 2 of 3

PhiC	PhiT	PhiV	SlenderMod	SeisCode	SeisLoad	PlugWeld	CheckDefl	DLRat
0.900000	0.900000	0.900000	Modify Geometry	Yes	Yes	Yes	No	120.000000


Table 25: Preferences - Steel Design - CAN-CSA-S16-01, Part 3 of 3

Table 25: Preferences - Steel Design - CAN-CSA-S16-01,
 Part 3 of 3

SDLAndLLR at	LLRat	TotalRat	NetRat
120.000000	360.000000	240.000000	240.000000

DOCUMENT FRONT SHEET

PURCHASERS NAME	National Process Equipment
PURCHASE ORDER NO	PUR630251
EXHEAT REFERENCE	041168
SDR DOCUMENT NO	041168.TASC
CLIENT DOCUMENT NO	
DOCUMENT TITLE	TASC Calculations

Doc Num	Revision	Issue	Date	Initials	Supplier's Approval Signature	Approval By
F05	4	2	22/01/2015	RDav		05/02/2015

To be filled by the reviewer of this document prior to its return

Tick Box	Code	Status	Description
<input type="checkbox"/>	E1	Approved	Approval given, no comments, final issue.
<input type="checkbox"/>	E2	Approved to Proceed	Approval given for work to proceed with document to be submitted as Final Issue providing comments are incorporated
<input type="checkbox"/>	E3	Not Approved	Document rejected and must be re-submitted with incorporation of comments. Work may NOT proceed
<input type="checkbox"/>	E4	Information Only	No comments made or approval given, for information purposes only.
<input type="checkbox"/>	E5	As-Built	Approval given for work to proceed provided comments incorporated in As-Built revision.

PAGES (Including this one)

10

COMMENTS

Please be aware that EXHeat will not be held responsible for late approval of documents and will not be held liable for any liquidated damages as a consequence.

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EXHEAT LTD

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Thermal Details - General

Rating / Checking		Shell Side		Tube Side	
Total mass flow rate	kg/s	0.0187		N/A	
Vapor mass flow rate (In/Out)	kg/s	0.0187	0.0187	N/A	N/A
Liquid mass flow rate	kg/s	0	0	N/A	N/A
Vapor mass quality		1	1	N/A	N/A
Temperatures	°C	-5	70	181	106
Dew / Bubble point	°C				
Operating pressures	bar	85	84.99998	N/A	N/A
Film coefficient (mean)	W/(m² K)	71.2		98399	
Fouling resistance (OD based)	m² K/W	0.0002		0	
Velocity (highest)	m/s	0.05		N/A	
Pressure drop (allow./calc.)	bar	0.5 / 0.00002		N/A / N/A	
Total heat exchanged	kW	3.7		Unit	AEL 1 pass 1 ser 1 par
Overall clean coef (plain/finned)	W/(m² K)	71.2/		Shell size	150— 1038 mm Hor
Overall dirty coef (plain/finned)	W/(m² K)	70.2/		Tubes	Plain
Effective area (plain/finned)	m²	0.5/		Insert	None
Effective MTD	°C	111.24		No.	12 OD 12.5 Tks 0.1 mm
Actual/required area ratio(dirty/clean)		0.99 /	1	Pattern	60 Pitch 24 mm
Vibration problem (Tasc/TEMA)		No /	No	Baffles	Single segmental Cut(%d) 45
RhoV2 problem			No	Total cost	12754 Dollar(US)

Shell side / Fouling / Wall / Fouling / Tube side

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Overall Coefficient/Resistance Summary			Clean	Dirty	Max Dirty
Area required		m ²	0.5	0.5	0.5
Area ratio: actual/required			1	0.99	1.0
Overall coefficient	W/(m ² K)		71.2	70.2	
Overall resistance	m ² K/W		0.01405	0.01425	0.01404
Shell side fouling	m ² K/W		0.0	0.0002	
Tube side fouling*			0.0	0	
Resistance Distribution	W/(m² K)	m² K/W	%	%	%
Shell side film	71.2	0.01404	99.91	98.51	
Shell side fouling	5000	0.0002		1.4	
Tube wall	488916.8	0	0.01	0.01	
Tube side fouling*		0		0	
Tube side film *	98399	0.00001	0.07	0.07	

* Based on outside surface - Area ratio: Ao/Ai = 1.02

Thermal Details

Thermal Details - Hot Side

	Total	Comp 1
Stream mass fractions	1	1
Liquid mass fractions at inlet	1	1
Liquid mass fractions at outlet	1	1
Vapor mass fractions at inlet	0	
Vapor mass fractions at outlet	0	
Liquid 2 mass fractions at inlet		
Liquid 2 mass fractions at outlet		
Stream mole fractions	1	1
Liquid mole fractions at inlet	1	1
Liquid mole fractions at outlet	1	1
Vapor mole fractions at inlet	0	
Vapor mole fractions at outlet	0	
Liquid-2 mole fractions at inlet		
Liquid-2 mole fractions at outlet		
Stream mass flow	kg/s N/A	N/A
Liquid mass flow at inlet	kg/s N/A	N/A
Liquid mass flow at outlet	kg/s N/A	N/A
Vapor mass flow at inlet	kg/s 0	0
Vapor mass flow at outlet	kg/s 0	0
Liquid 2 mass flow at inlet	kg/s	
Liquid 2 mass flow at outlet	kg/s	

Thermal Details - Coefficients

Film Coefficients	W/(m ² K)	Shell Side		Tube Side	
		Bare area (OD) / Finned area		Bare area (OD) / ID area	
Overall film coefficients		71.2	/	98399	/ 99999
Vapor sensible		71.2	/	0	/
Two Phase		0	/	0	/
Liquid sensible		0	/	98399	/ 99999
Heat Transfer Parameters		In	Out	In	Out
Prandtl numbers	Vapor	0.88	0.77		
	Liquid			N/A	N/A
Reynolds numbers	Vapor Nominal	1468.69	1367.79		
	Liquid Nominal			N/A	N/A

Temperature Difference	°C	Heat Flux (based on tube O.D.)	kW/m ²
Overall Effective MTD	111.24	Overall actual flux	7.8
One pass counterflow MTD	111.24	Critical heat flux (at highest ratio)	0
LMTD based on end points	111	Highest actual flux	8.5
Effective MTD correction factor	1	Highest ratio, actual/critical flux	0
Wall Temperatures		°C	
Shell mean metal temperature		143.11	
Tube mean metal temperature		143.11	
Tube wall temperatures (highest / lowest)		180.93 / 105.93	

Heat Load Summary	Shell Side		Tube Side	
	kW	% total	kW	% total
Vapor only	3.7	100	0	0
2-Phase vapor	0	0	0	0
Latent heat	0	0	0	0
2-Phase liquid	0	0	0	0
Liquid only	0	0	3.7	100
Total	3.7	100	3.7	100

Thermal Details - Pressure Drop

Pressure Drop	bar	Shell Side			Tube Side		
Maximum allowed		0.5			N/A		
Total calculated		0.00002			N/A		
Gravitational		0			N/A		
Frictional		0.00002			0.00009		
Momentum change		0			N/A		
Pressure drop distribution		m/s	bar	%dp	m/s	bar	%dp
Inlet nozzle		0.12	0.00001	37.36	0.02	0	1.25
Entering bundle		0.02			0.02	0	1.17
Inside tubes					0.02 0.02	0.00009	95.1
Inlet space Xflow		0.01	0	3.1			
Bundle Xflow		0.02 0.03	0	4.16			
Baffle windows		0.04 0.05	0	11.46			
Outlet space Xflow		0.02	0	4.45			
Exiting bundle		0.04			0.02	0	1.92
Outlet nozzle		0.17	0.00001	39.48	0.02	0	0.56
Liquid outlet nozzle							
Vapor outlet nozzle							
Intermediate nozzles							

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Thermal Details - Shell Side Stream Analysis

Shell Side Flow Fractions	Inlet	Middle	Outlet	Diam. Clearance mm
Crossflow	0.84	0.71	0.84	
Window	0.84	0.71	0.84	
Baffle hole - tube OD	0.04	0.07	0.04	1
Baffle OD - shell ID	0.12	0.21	0.12	6
Shell ID - bundle OTL	0	0	0	10
Pass lanes	0	0	0	

Rho*V2 analysis	Flow Area mm ²	Velocity m/s	Density kg/m ³	Rho*V2 kg/(m s ²)	TEMA limit kg/(m s ²)
Shell inlet nozzle	1963	0.12	82.57	1	2232
Shell entrance	3106	0.07	82.57	0	5953
Bundle entrance	9203	0.02	82.57	0	5953
Bundle exit	9203	0.04	54.7	0	5953
Shell exit	3106	0.11	54.7	1	5953
Shell outlet nozzle	1963	0.17	54.7	2	
	mm ²	m/s	kg/m ³	kg/(m s ²)	kg/(m s ²)
Tube inlet nozzle	N/A	N/A	N/A	N/A	N/A
Tube inlet	N/A	N/A	N/A	N/A	N/A
Tube outlet	N/A	N/A	N/A	N/A	N/A
Tube outlet nozzle	N/A	N/A	N/A	N/A	N/A

Thermosiphons

Thermosiphon stability

Vertical Tube Side Thermosiphons

Flow reversal criterion - top of tubes (should be > 0.5)

Flooding criterion - top of tubes (should be > 1.0)

Fraction of tube length flooded

Kutateladze Number in axial nozzle

Kettles

Recirculation ratio

Quality at top of bundle

Entrainment fraction

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Date: 24/02/2015

Time: 11:16:24

Location in shell	TEMA limit	Natural Fn	Acoustic Fa	Flow velocity	X-flow fraction	RhoV2	Strouhal No.
	mm	cycle/s	cycle/s	m/s		kg/(m s ²)	
Inlet		293.2	1352.75	0.02	1	0	0.52
Inlet		247	1352.75	0.01	0.71	0	0.52
Inlet		695.04	1352.75	0.01	0.71	0	0.52
Inlet		247	1352.75	0	0.71	0	0.52
Midspace		293.2	1539.21	0	0.71	0	0.52
Midspace		247	1539.21	0.02	0.71	0	0.52
Midspace		695.04	1539.21	0.02	0.71	0	0.52
Midspace		247	1539.21	0	0.71	0	0.52
Outlet		293.2	1693.57	0.04	1	0	0.52
Outlet		247	1693.57	0.02	0.71	0	0.52
Outlet		695.04	1693.57	0.02	0.71	0	0.52
Outlet		247	1693.57	0	0.71	0	0.52

Thermal Details - Methods

	Hot Side	Cold Side
Heat transfer coefficient multiplier	No	No
Heat transfer coefficient specified	Yes	No
Pressure drop multiplier	No	No
Pressure drop calculation option	friction+acceleration	friction+acceleration
Calculation method	Standard method	
Desuperheating heat transfer method	Dry wall	
Multicomponent condensing heat transfer method	HTFS - Silver-Bell	
Vapor shear enhanced condensation	Yes	
Liquid subcooling heat transfer (vertical shell)	Not Used	
Subcooled boiling accounted for in	Set default	
Post dryout heat transfer accounted for	No	
Correction to user-supplied boiling curve	Boiling curve not used	
Falling film evaporation method	HTFS recommended method	
Single phase tubeside heat transfer method	HTFS recommended method	
Lowfin Calculation Method	HTFS / ESDU	
Tube pass multiplier	1	

CALCULATION COVER SHEET

CUSTOMER: Shell
PROJECT: Carmon Creek
CALCULATION NAME: NG Pressure Reduction Skid Pkg
CALC#: 0735A-08030_Electrical Room

JOB NUMBER: SLS338716
REVISION: C
NUMBER OF PAGES (excluding cover sheet): 6

PURPOSE / DESCRIPTION:

Calculating HVAC Heating and Cooling Loads, Ventilation Rates, and Equipment Sizing.

ASSUMPTIONS:

- Unclassified building
- Summer Outside DB Design Temperature: 27 C
- Summer Inside DB Design Temperature: 35 C
- Winter Outside DB Design Temperature: -43 C
- Winter Inside DB Design Temperature: 10 C

- Estimated Interior Heat Rejection Loads: 500 W

CONCLUSIONS:

1) This building is considered not occupied.

2) **HVAC Equipment:**

One (1) 38 L/s Supply Fan 3 ACH (Normal Operation) - Intake shall be located away from classified enclosure.

One (1) 105 L/s Supply Fan for SUMMER COOLING - Intake shall be located away from classified enclosure.

One (1) 10 kW electric unit heater, to account for conduction losses, infiltration and 6 ACH ventilation.

3) **Pressure Relief Damper:**

One (1) 305 mm (12") W x 305 mm (12") H BAROMETRIC relief damper for 12 ACH, set at 25 Pa.

COMPUTER PROGRAMS AND / OR DESIGN MANUALS USED:

Excel

REFERENCE / CALCULATION FILES AND LOCATIONS:

THIS REVISION HAS BEEN SUPERSEDED BY REVISION: _____

B

REVISION NOTES:

Revision A: Initial revision
Revision B: Barometric Dampers
Revision C: FINAL



30 MAR 2015

THIS REVISION PREPARED BY: *John Gallagher*
THIS REVISION CHECKED BY: *Adam Robert*
LEAD APPROVAL BY:
PRELIMINARY OR FINAL ? *FINAL*

DATE: 30-Mar-15
DATE:
DATE:

Construction Data

Project: Carmon Creek
 Building: NG Pressure Reduction Skid Pkg

Revision: C

EXTERIOR WALL CONSTRUCTION

ITEM	WALL CONSTRUCTION MATERIAL	THICKNESS, MM	R, M2*°C/W	U, W/°C*M2
1	OUTSIDE SURFACE RESISTANCE	N/A	0.059	
2	STEEL SIDING	1.214	0	
3	INSULATION R = 22	152	3.87442	
4	STEEL SIDING	1.214	0	
5	INSIDE SURFACE RESISTANCE	N/A	0.121	
TOTAL			4.05442	0.246644

DOOR/WINDOW CONSTRUCTION

ITEM	DOOR CONSTRUCTION MATERIAL	THICKNESS, MM	R, M2*°C/W	U, W/°C*M2
1	METAL INSULATED DOOR 6% GLAZING	60		3.5
2	METAL UNINSULATED O/H DOOR 12FTX16FT	2		6.59
3	WINDOW			2.7

ROOF CONSTRUCTION

ITEM	ROOF CONSTRUCTION MATERIAL	THICKNESS, MM	R, M2*°C/W	U, W/°C*M2
1	OUTSIDE SURFACE RESISTANCE	N/A	0.059	
2	STEEL SIDING	1.214	0	
3	INSULATION R = 22	152	3.87442	
4	STEEL SIDING	1.214	0	
5	INSIDE SURFACE RESISTANCE	N/A	0.121	
TOTAL			4.05442	0.246644

ITEM	FLOOR CONSTRUCTION MATERIAL	THICKNESS, MM	R, M2*°C/W	U, W/°C*M2
1	OUTSIDE SURFACE RESISTANCE	N/A	0.059	
3	INSULATION R = 22	152	3.87442	
5	INSIDE SURFACE RESISTANCE	N/A	0.121	
TOTAL			4.05442	0.246644

SUMMER OUTSIDE DB DESIGN TEMP.
 SUMMER INSIDE DESIGN DB TEMP.
 WINTER OUTSIDE DB TEMP.
 WINTER INSIDE DB TEMP.
 ELECTRICAL AREA CLASSIFICATION

27	°C
35	°C
-43	°C
10	°C
Un-Classified	

BUILDING LENGTH
 BUILDING WIDTH
 WALL HEIGHT @ EAVES
 ROOF SLOPE
 HEIGHT ABOVE EAVES

3.048	m
3.454	m
4.013	m
1: 3	
0.58	m

Basic Heat Loss Calculation - Skin Loss (No Air Changes)

Project: **Carmon Creek**
 Building: **NG Pressure Reduction Skid Pkg**

Building Length (m)	3.05
Building Width (m)	3.45
Wall Height at Eaves (m)	4.01
Eave to peak height (m)	0.6

Outside (°C)	-43
Inside (°C)	10
Difference (°C)	53

Conduction: $q = \text{Heat Loss (W)}$
 $U = \text{Heat transfer Coeff. (W/°C*M2)}$
 $q = UA\Delta T$ $A = \text{Area (m2)}$
 $\Delta T = \text{Temp. Diff (°C)}$

Conduction Losses				U	ΔT	A	q (W)
Opening	(m)	(m)	Quantity				
Window#1	0.457	0.457	0	2.70	53.00	0.00	0.00
Window#2	0.91	0.91	0	2.70	53.00	0.00	0.00
Man doors	0.91	2.13	1	3.50	53.00	1.95	361.81
Dbl doors	1.83	2.13	0	3.50	53.00	0.00	0.00
O/H doors	3.66	3.66	0	6.53	53.00	0.00	0.00
Ridge vent	0.23	15.00	0	13.51	53.00	0.00	0.00
Net Exposed Wall Conduction Losses				0.25	53.00	54.17	708.16
Net Exposed Roof Conduction Losses				0.25	53.00	11.10	145.07
Net Internal Wall Conduction Losses				0.25	0	0	0.00
Floor Cond. Loss (assume raised floor)				0.25	10	10.53	25.97
Summary							1,241

Infiltration: leakage flow is estimated as 2.0 CFM / ft of crack length
 (see ventilation formula below for heat loss calculation)

Infiltration Losses				$\rho \times C_p$	Q	ΔT	q (W)
Window #1	0.457	0.457	0	1.23	0.00	53	0.00
Window #2	0.91	0.91	0	1.23	0.00	53	0.00
Man doors	0.91	2.13	1	1.23	5.75	53	375.14
Dbl doors	1.83	2.13	0	1.23	0.00	53	0.00
O/H doors	3.66	3.66	0	1.23	0.00	53	0.00
Ridge vent	0.23	15.00	0	1.23	0.00	53	0.00
Summary							375

Ventilation: $q = \text{Heat Loss (W)}$
 $Q = \text{airflow (L/s)}$
 $q = Q\rho C_p\Delta T$ $\rho \times C_p = \text{air density (kg/m3)} \times \text{Air Specific Heat (KJ/kg °C)} = \text{approx. 1.23}$
 $\Delta T = \text{Temp. Diff (°C)}$

Ventilation Losses		$\rho \times C_p$	Q	ΔT	q (W)
Air Changes/hr = 0 ACH	0	1.230	0	53.00	0

Building Grand Total , W					1,616
Building Grand Total , Btuh					5,514
With safety factor		10%		Watt	1,778
				Btuh	6,066

Basic Heat Loss Calculation - 6 ACH

Project: **Carmon Creek**
 Building: **NG Pressure Reduction Skid Pkg**

Building Length (m)	3.05
Building Width (m)	3.45
Wall Height at Eaves (m)	4.01
Eave to peak height (m)	0.6
Outside (°C)	-43
Inside (°C)	10
Difference (°C)	53

Conduction: q = Heat Loss (W)
 U = Heat transfer Coeff. (W/°C*M2)
 q = UAΔT A = Area (m2)
 ΔT = Temp. Diff (°C)

Conduction Losses				U	ΔT	A	q (W)
Opening	(m)	(m)	Quantity				
Window#1	0.457	0.457	0	2.70	53.00	0.00	0.00
Window#2	0.91	0.91	0	2.70	53.00	0.00	0.00
Man doors	0.91	2.13	1	3.50	53.00	1.95	361.81
Dbl doors	1.83	2.13	0	3.50	53.00	0.00	0.00
O/H doors	3.66	3.66	0	6.53	53.00	0.00	0.00
Ridge vent	0.23	15.00	0	13.51	53.00	0.00	0.00
Net Exposed Wall Conduction Losses				0.25	53.00	54.17	708.16
Net Exposed Roof Conduction Losses				0.25	53.00	11.10	145.07
Net Internal Wall Conduction Losses				0.25	0	0	0.00
Floor Cond. Loss (assume raised floor)				0.25	53	10.53	137.62
Summary							1,353

Infiltration: leakage flow is estimated as 2.0 CFM / ft of crack length
 (see ventilation formula below for heat loss calculation)

Infiltration Losses				ρ x Cp	Q	ΔT	q (W)
Window #1	0.457	0.457	0	1.23	0.00	53	0.00
Window #2	0.91	0.91	0	1.23	0.00	53	0.00
Man doors	0.91	2.13	1	1.23	5.75	53	375.14
Dbl doors	1.83	2.13	0	1.23	0.00	53	0.00
O/H doors	3.66	3.66	0	1.23	0.00	53	0.00
Ridge vent	0.23	15.00	0	1.23	0.00	53	0.00
Summary							375

Ventilation: q = Heat Loss (W)
 Q = airflow (L/s)
 q = QρCpΔT ρ x Cp = air density (kg/m3) x Air Specific Heat (KJ/kg°C) = approx. 1.23
 ΔT = Temp. Diff (°C)

Ventilation Losses		ρ x Cp	Q	ΔT	q (W)
Air Changes/hr =	6	1.230	70	53.00	4,590

Building Grand Total , W					6,318	
Building Grand Total , Btuh					21,557	
With safety factor				10%	Watt	6,950
					Btuh	23,713

Internal Heat Gains Summary

Project: **Carmon Creek**
 Building: **NG Pressure Reduction Skid Pkg**

ITEM	EQUIPMENT LOCATION	TYPE OF EQUIPMENT	ELECTRICAL MOTOR TYPE	POWER kW	EFFICIENCY	UTILITY (USAGE FACTOR)	LOAD	HEAT GAIN, Watt	HEAT GAIN, KCAL/HR	HEAT GAIN, BTU/hr	
1 2 3 4 5 6 7 8 9	Vessels/Piping	Vessels/Hot Surfaces	St.					0	0	0	
		Assumption:						500			
								0		0	
								0		0	
								0	0	0	
			Total:					500	0	0	
1 2 3 4 9		Motors	Motors & Lube Oil Coolers (see motor worksheet for details)	St.					0	0	0
									0	0	0
									0	0	0
			Total:					0	0	0	
	LIGHTING/ Equipment	Fluorescent lamps(As / electrical discipline)	St.		15		1	158	136	539	
									0	0	
		Total:					158	136	539		
	SOLAR	Wall (15 deg C delta T)						200	172	684	
		Roof (21 deg C delta T)						57	49	196	
		Floor (10 deg C delta T)						26	22	89	
		Total:						284	244	969	
Total heat gains								942	810	3,214	
DESIGNED TOTAL PER BUILDING								1,036	891	3,535	
Safety 10%											
Required Total Dilution Air Volume, l/s								105			
Required Total Dilution Air Volume, cfm								223			

Air Changes

Project: **Carmon Creek**
 Building: **NG Pressure Reduction Skid Pkg**

Building length, m	Building width, m	Building eave height, m	Roof pitch	Height above the eave	Building Vol. M3	Air Supply/Exhaust m3/hr	Air Movement per hour ACH
3.048	3.454	4.013	3.000	0.6	45	379	8.4

Air Change Rates

	m3/h	l/s
1 ACH	45	13
2 ACH	91	25
3 ACH	136	38
6 ACH	272	75
12 ACH	543	151
@ 0.3 Q/A		245
5 ACH	226	63
@ 3.5m	111	31

Supply Air

Total	105	l/s (HVAC req'd)
	1	Quantity
Supply Fan 6 ACH	75	l/s per unit
	75	l/s Total SA
	141	l/s min OA per unit
	141	l/s Bldg OA
Cooling Supply Fan	-36	l/s Total SF req'd
	1	Quantity
	75	l/s per fan
	75	l/s (selected fan capacity)
	151	l/s Total Installed Supply

Exhaust Air (Summer)

	Quantity
Wall Exhaust 6 ACH	l/s per fan
Wall Exhaust 12 ACH	Quantity
	l/s per fan
	l/s Required
Local Exhaust	Quantity
	l/s per fan
Other	Quantity
	l/s
	0
	l/s Total Inst. Exh.

0
CFM

Pressure Relief Damper Sizing

Quantity	Device	Area Factor	Size A m	Size B m	Flow l/s	Net Area sq. m	Velocity m/s	Maximum all. Velocity
1	+ve PRD	0.65	0.31	0.31	211	0.06	3.48	5.50

Winter cooling ventilation

Equipment Gain	0.66 kW
minus Building Loss 0 ACH	1.62 kW
Winter Heat Gain	-0.96 kW
Dilution Ventilation (for 40C space temp. in winter)	-26 l/s

Heater Sizing

Project:
 Building:

Air Handling Unit Heating

Indoor air Dry bulb Temperature	Outdoor Dry bulb Temperature	Total Air Flow, l/s	Inside Air Flow, l/s	Outside Air Volume, l/s	Mixed Air Temp.
10	-43	2,690	2,652	38	9.3

Sensible Heat Flow $q = Q\rho C_p \Delta T$
 $\rho \times C_p = \text{air density (kg/m}^3) \times \text{Air Specific Heat (KJ/kg }^\circ\text{C)} = \text{approx. } 1.23$

$Q = \text{airflow (L/s)} = \frac{38}{1} \text{ L/s}$
 $\Delta T = \text{Temp. Diff (}^\circ\text{C)} = \frac{53.00}{1} \text{ }^\circ\text{C}$
 $q = \text{Heat Req'd (W)} = \frac{2,460}{1} \text{ W}$

Mixing Only Unit (ie. No Heater Required) ? 1 = Yes / 0 = No

Installed Heater Capacity kW

Unit Heater Sizing

Total Building Heating Load (3 ACH)	Select one: <input type="text" value="1"/> <input type="text" value="7"/> kW		Ventilation Basis:
Total Building Heating Load (0 ACH)	<input type="text" value="0"/> <input type="text" value="12"/> kW		← Bldg Heat Loss with 6 ACH
			← Bldg Heat Loss with 12 ACH
			← Combustion Air Requirements
Total AHU capacity (output)	cap. Per AHU	Qty of AHUs	
Remaining Unit Heater load	0	1	0.00 kW
			6.95 kW
Required Number of Unit Heaters to Meet Load	<input type="text" value="1"/>		
Per unit Heater Load Required	<input type="text" value="6.95"/> kW		
Selected Unit Heater Capacity (per unit)	<input type="text" value="10.00"/> kW		
Total Number of Unit Heaters Installed	<input type="text" value="1"/>		
Total Installed Unit Heater Capacity	<input type="text" value="10"/> kW		

CALCULATION COVER SHEET

CUSTOMER: Shell
PROJECT: Carmon Creek
CALCULATION NAME: NG Pressure Reduction Skid Pkg
CALC#: 0735A-08030_NG Heater Room

JOB NUMBER: SLS338716

REVISION: C
NUMBER OF PAGES (excluding cover sheet): 7

PURPOSE / DESCRIPTION:

Calculating HVAC Heating and Cooling Loads, Ventilation Rates, and Equipment Sizing.

ASSUMPTIONS:

- CLASSIFIED building
- Summer Outside DB Design Temperature: 27 C
- Summer Inside DB Design Temperature: 35 C
- Winter Outside DB Design Temperature: -43 C
- Winter Inside DB Design Temperature: 10 C

- Estimated Interior Heat Rejection Loads: 500 W

CONCLUSIONS:

1) This building is considered not occupied.

2) **HVAC Equipment:**

One (1) 141 L/s Explosion proof Supply Fan 6 ACH

One (1) 141 L/s Explosion proof Supply Fan 6 ACH for a total of 372 L/s, 12 ACH.

One (1) classified 20 kW electric unit heater, to account for conduction losses, infiltration and 12 ACH ventilation.

*** Heater is sized to maintain above freezing temperature (~5 C) during LEL alarm conditions (12 ACH)***

3) **Pressure Relief Damper:**

One (1) 305 mm (12") W x 305 mm (12") H BAROMETRIC relief damper for 12 ACH, set at +25 Pa.

COMPUTER PROGRAMS AND / OR DESIGN MANUALS USED:

Excel

REFERENCE / CALCULATION FILES AND LOCATIONS:

THIS REVISION HAS BEEN SUPERSEDED BY REVISION:

_____ B _____

REVISION NOTES:

- Revision A: Initial revision
- Revision B: Barometric Relief
- Revision C: FINAL



THIS REVISION PREPARED BY:	John Gallagher
THIS REVISION CHECKED BY:	Adam Robert
LEAD APPROVAL BY:	
PRELIMINARY OR FINAL ?	FINAL

DATE:	30-Mar-15
DATE:	
DATE:	

Construction Data

Project: Carmon Creek

Building: NG Pressure Reduction Skid Pkg

Revision: C

EXTERIOR WALL CONSTRUCTION

ITEM	WALL CONSTRUCTION MATERIAL	THICKNESS, MM		R, M2*°C/W	U, W/°C*M2
1	OUTSIDE SURFACE RESISTANCE	N/A		0.059	
2	STEEL SIDING	1.214		0	
3	INSULATION R = 22	152		3.87442	
4	STEEL SIDING	1.214		0	
5	INSIDE SURFACE RESISTANCE	N/A		0.121	
TOTAL				4.05442	0.246644

DOOR/WINDOW CONSTRUCTION

ITEM	DOOR CONSTRUCTION MATERIAL	THICKNESS, MM		R, M2*°C/W	U, W/°C*M2
1	METAL INSULATED DOOR 6% GLAZING	60			3.5
2	METAL UNINSULATED O/H DOOR 12FTX16FT	2			6.53
3	WINDOW				2.7

ROOF CONSTRUCTION

ITEM	ROOF CONSTRUCTION MATERIAL	THICKNESS, MM		R, M2*°C/W	U, W/°C*M2
1	OUTSIDE SURFACE RESISTANCE	N/A		0.059	
2	STEEL SIDING	1.214		0	
3	INSULATION R = 22	152		3.87442	
4	STEEL SIDING	1.214		0	
5	INSIDE SURFACE RESISTANCE	N/A		0.121	
TOTAL				4.05442	0.246644

ITEM	FLOOR CONSTRUCTION MATERIAL	THICKNESS, MM		R, M2*°C/W	U, W/°C*M2
1	OUTSIDE SURFACE RESISTANCE	N/A		0.059	
3	INSULATION R = 22	152		3.87442	
5	INSIDE SURFACE RESISTANCE	N/A		0.121	
TOTAL				4.05442	0.246644

SUMMER OUTSIDE DB DESIGN TEMP.
 SUMMER INSIDE DESIGN DB TEMP.
 WINTER OUTSIDE DB TEMP.
 WINTER INSIDE DB TEMP.
 ELECTRICAL AREA CLASSIFICATION

27	°C
35	°C
-43	°C
10	°C
CLASSIFIED	

BUILDING LENGTH
 BUILDING WIDTH
 WALL HEIGHT @ EAVES
 ROOF SLOPE
 HEIGHT ABOVE EAVES

5.690	m
3.454	m
4.013	m
1:3	
0.58	m

Basic Heat Loss Calculation - Skin Loss (No Air Changes)

Project: **Carmon Creek**
 Building: **NG Pressure Reduction Skid Pkg**

Building Length (m)	5.69
Building Width (m)	3.45
Wall Height at Eaves (m)	4.01
Eave to peak height (m)	0.6

Outside (°C)	-43
Inside (°C)	10
Difference (°C)	53

Conduction: $q = \text{Heat Loss (W)}$
 $U = \text{Heat transfer Coeff. (W/°C*M2)}$
 $q = UA\Delta T$ $A = \text{Area (m2)}$
 $\Delta T = \text{Temp. Diff (°C)}$

Conduction Losses				U	ΔT	A	q (W)
Opening	(m)	(m)	Quantity				
Window#1	0.457	0.457	0	2.70	53.00	0.00	0.00
Window#2	0.91	0.91	0	2.70	53.00	0.00	0.00
Man doors	0.91	2.13	0	3.50	53.00	0.00	0.00
Dbl doors	1.83	2.13	1	3.50	53.00	3.90	723.94
O/H doors	3.66	3.66	0	6.53	53.00	0.00	0.00
Ridge vent	0.23	15.00	0	13.51	53.00	0.00	0.00
Net Exposed Wall Conduction Losses				0.25	53.00	75.38	985.35
Net Exposed Roof Conduction Losses				0.25	53.00	20.72	270.81
Net Internal Wall Conduction Losses				0.25	0	0	0.00
Floor Cond. Loss (assume raised floor)				0.25	10	19.65	48.47
Summary							2,029

Infiltration: leakage flow is estimated as 2.0 CFM / ft of crack length
 (see ventilation formula below for heat loss calculation)

Infiltration Losses				$\rho \times C_p$	Q	ΔT	q (W)
Window #1	0.457	0.457	0	1.23	0.00	53	0.00
Window #2	0.91	0.91	0	1.23	0.00	53	0.00
Man doors	0.91	2.13	0	1.23	0.00	53	0.00
Dbl doors	1.83	2.13	1	1.23	7.48	53	487.74
O/H doors	3.66	3.66	0	1.23	0.00	53	0.00
Ridge vent	0.23	15.00	0	1.23	0.00	53	0.00
Summary							488

Ventilation: $q = \text{Heat Loss (W)}$
 $Q = \text{airflow (L/s)}$
 $q = Q\rho C_p \Delta T$ $\rho \times C_p = \text{air density (kg/m3) x Air Specific Heat (KJ/kg °C) = approx. 1.23}$
 $\Delta T = \text{Temp. Diff (°C)}$

Ventilation Losses		$\rho \times C_p$	Q	ΔT	q (W)
Air Changes/hr = 0 ACH	0	1.230	0	53.00	0

Building Grand Total , W				2,516
Building Grand Total , Btuh				8,586
With safety factor	10%		Watt	2,768
			Btuh	9,444

Basic Heat Loss Calculation - 6 ACH

Project: **Carmon Creek**
 Building: **NG Pressure Reduction Skid Pkg**

Building Length (m)	5.69
Building Width (m)	3.45
Wall Height at Eaves (m)	4.01
Eave to peak height (m)	0.6
Outside (°C)	-43
Inside (°C)	10
Difference (°C)	53

Conduction:
 $q = UA\Delta T$
 q = Heat Loss (W)
 U = Heat transfer Coeff. (W/°C*M2)
 A = Area (m2)
 ΔT = Temp. Diff (°C)

Conduction Losses				U	ΔT	A	q (W)
Opening	(m)	(m)	Quantity				
Window#1	0.457	0.457	0	2.70	53.00	0.00	0.00
Window#2	0.91	0.91	0	2.70	53.00	0.00	0.00
Man doors	0.91	2.13	0	3.50	53.00	0.00	0.00
Dbl doors	1.83	2.13	1	3.50	53.00	3.90	723.94
O/H doors	3.66	3.66	0	6.53	53.00	0.00	0.00
Ridge vent	0.23	15.00	0	13.51	53.00	0.00	0.00
Net Exposed Wall Conduction Losses				0.25	53.00	75.38	985.35
Net Exposed Roof Conduction Losses				0.25	53.00	20.72	270.81
Net Internal Wall Conduction Losses				0.25	0	0	0.00
Floor Cond. Loss (assume raised floor)				0.25	53	19.65	256.91
Summary							2,237

Infiltration: leakage flow is estimated as 2.0 CFM / ft of crack length
 (see ventilation formula below for heat loss calculation)

Infiltration Losses				$\rho \times C_p$	Q	ΔT	q (W)
Window #1	0.457	0.457	0	1.23	0.00	53	0.00
Window #2	0.91	0.91	0	1.23	0.00	53	0.00
Man doors	0.91	2.13	0	1.23	0.00	53	0.00
Dbl doors	1.83	2.13	1	1.23	7.48	53	487.74
O/H doors	3.66	3.66	0	1.23	0.00	53	0.00
Ridge vent	0.23	15.00	0	1.23	0.00	53	0.00
Summary							488

Ventilation:
 $q = Q\rho C_p \Delta T$
 q = Heat Loss (W)
 Q = airflow (L/s)
 $\rho \times C_p$ = air density (kg/m3) x Air Specific Heat (KJ/kg °C) = approx. 1.23
 ΔT = Temp. Diff (°C)

Ventilation Losses		$\rho \times C_p$	Q	ΔT	q (W)
Air Changes/hr =	6	1.230	131	53.00	8,569

Building Grand Total , W				11,294
Building Grand Total , Btuh				38,535
With safety factor	10%		Watt	12,423
			Btuh	42,388

Basic Heat Loss Calculation - 12 ACH

Project: **Carmon Creek**
 Building: **NG Pressure Reduction Skid Pkg**

Building Length (m)	5.69
Building Width (m)	3.45
Wall Height at Eaves (m)	4.01
Eave to peak height (m)	0.6

Outside (°C)	-43
Emergency Inside (°C)	5
Difference (°C)	48

Conduction: $q = \text{Heat Loss (W)}$
 $U = \text{Heat transfer Coeff. (W/°C*M2)}$
 $q = UA\Delta T$ $A = \text{Area (m2)}$
 $\Delta T = \text{Temp. Diff (°C)}$

Conduction Losses				U	ΔT	A	q (W)
Opening	(m)	(m)	Quantity				
Window#1	0.457	0.457	0	2.70	48.00	0.00	0.00
Window#2	0.91	0.91	0	2.70	48.00	0.00	0.00
Man doors	0.91	2.13	0	3.50	48.00	0.00	0.00
Dbl doors	1.83	2.13	1	3.50	48.00	3.90	655.65
O/H doors	3.66	3.66	0	6.53	48.00	0.00	0.00
Ridge vent	0.23	15.00	0	13.51	48.00	0.00	0.00
Net Exposed Wall Conduction Losses				0.25	48.00	75.38	892.40
Net Exposed Roof Conduction Losses				0.25	48.00	20.72	245.26
Net Internal Wall Conduction Losses				0.25	0	0	0.00
Floor Cond. Loss (assume raised floor)				0.25	48	19.65	232.67
Summary							2,026

Infiltration: leakage flow is estimated as 2.0 CFM / ft of crack length
 (see ventilation formula below for heat loss calculation)

Infiltration Losses				$\rho \times C_p$	Q	ΔT	q (W)
Window #	(m)	(m)	Quantity				
Window #1	0.457	0.457	0	1.23	0.00	48	0.00
Window #2	0.91	0.91	0	1.23	0.00	48	0.00
Man doors	0.91	2.13	0	1.23	0.00	48	0.00
Dbl doors	1.83	2.13	1	1.23	7.48	48	441.72
O/H doors	3.66	3.66	0	1.23	0.00	48	0.00
Ridge vent	0.23	15.00	0	1.23	0.00	48	0.00
Summary							442

Ventilation: $q = \text{Heat Loss (W)}$
 $Q = \text{airflow (L/s)}$
 $q = Q\rho C_p\Delta T$ $\rho \times C_p = \text{air density (kg/m3)} \times \text{Air Specific Heat (KJ/kg°C)} = \text{approx. 1.23}$
 $\Delta T = \text{Temp. Diff (°C)}$

Ventilation Losses		$\rho \times C_p$	Q	ΔT	q (W)
Air Changes/hr =	12	1.230	263	48.00	15,521

Building Grand Total , W				17,989
Building Grand Total , Btuh				61,379
With safety factor	10%		Watt	19,788
			Btuh	67,516

Internal Heat Gains Summary

Project: **Carmon Creek**
 Building: **NG Pressure Reduction Skid Pkg**

ITEM	EQUIPMENT LOCATION	TYPE OF EQUIPMENT	ELECTRICAL MOTOR TYPE	POWER kW	EFFICIENCY	UTILITY (USAGE FACTOR)	LOAD	HEAT GAIN, Watt	HEAT GAIN, KCAL/HR	HEAT GAIN, BTU/hr
1 2 3 4 5 6 7 8 9	Vessels/Piping	Vessels/Hot Surfaces Assumption: Total:	St.					0 500 0 0 500	0 0 0 0 0	0 0 0 0 0
1 2 3 4 9	Motors	Motors & Lube Oil Coolers (see motor worksheet for details) Total:	St.					0 0 0	0 0 0	0 0 0
	LIGHTING/ Equipment	Fluorescent lamps(As / electrical discipline) Total:	St.		15		1	295 295	253 253	1,006 1,006
	SOLAR	Wall (15 deg C delta T) Roof (21 deg C delta T) Floor (10 deg C delta T) Total:						279 107 48 435	240 92 42 374	952 366 165 1,483
Total heat gains								1,229	1,057	4,195
DESIGNED TOTAL PER BUILDING								1,352	1,163	4,615
Safety 10%										
Required Total Dilution Air Volume, l/s								137		
Required Total Dilution Air Volume, cfm								291		

Air Changes

Project:	Carmon Creek
Building:	NG Pressure Reduction Skid Pkg

Building length m	Building width, m	Building eave height, m	Roof pitch	Height above the eave	Building Vol. M3	Air Supply/Exhaust m3/hr	Air Movement per hour ACH
5.690	3.454	4.013	3.000	0.6	85	495	5.9

Air Change Rates

	m3/h	l/s
1 ACH	85	23
2 ACH	169	47
3 ACH	254	70
6 ACH	507	141
12 ACH	1,014	282
@ 0.3 Q/A		245
5 ACH	423	117
@ 3.5m	206	57

Supply Air

	Total	l/s (HVAC req'd)
	137	Quantity
	1	Quantity
Supply Fan 6 ACH	141	l/s per unit
	141	l/s Total SA
	141	l/s min OA per unit
	141	l/s Bldg OA
Cooling Supply Fan	-4	l/s Total SF req'd
	1	Quantity
	141	l/s per fan
	141	l/s (selected fan capacity)
	282	l/s Total Installed Supply

Exhaust Air (Summer)

	Quantity
Wall Exhaust 6 ACH	l/s per fan
Wall Exhaust 12 ACH	Quantity
	l/s per fan
	l/s Required
Local Exhaust	Quantity
	l/s per fan
Other	Quantity
	l/s
	0
	l/s Total Inst. Exh.

0 CFM

Pressure Relief Damper Sizing

Quantity	Device	Area Factor	Size A m	Size B m	Flow l/s	Net Area sq. m	Velocity m/s	Maximum all. Velocity
1	+ve PRD	0.65	0.31	0.31	282	0.06	4.66	5.50

Winter cooling ventilation

Equipment Gain	0.79 kW
minus Building Loss 0 ACH	2.52 kW
Winter Heat Gain	-1.72 kW
Dilution Ventilation (for 40C space temp. in winter)	-47 l/s

Heater Sizing

Project:
 Building:

Air Handling Unit Heating

Indoor air Dry bulb Temperature	Outdoor Dry bulb Temperature	Total Air Flow, l/s	Inside Air Flow, l/s	Outside Air Volume, l/s	Mixed Air Temp.
10	-43	2,690	2,620	70	8.6

Sensible Heat Flow $q = Q\rho C_p\Delta T$
 $\rho \times C_p = \text{air density (kg/m}^3) \times \text{Air Specific Heat (KJ/kg }^\circ\text{C)} = \text{approx. } 1.23$

$Q = \text{airflow (L/s)} =$ L/s
 $\Delta T = \text{Temp. Diff (}^\circ\text{C)} =$ $^\circ\text{C}$
 $q = \text{Heat Req'd (W)} =$ W

Mixing Only Unit (ie. No Heater Required) ? 1 = Yes / 0 = No

Installed Heater Capacity kW

Unit Heater Sizing

Total Building Heating Load (3 ACH)	Select one:			Ventilation Basis:
	<input type="text" value="0"/>	<input type="text" value="12"/>	kW	←Bldg Heat Loss with
Total Building Heating Load (0 ACH)	<input type="text" value="1"/>	<input type="text" value="20"/>	kW	←Bldg Heat Loss with
				←Combustion Air Requirements
Total AHU capacity (output)	cap. Per AHU	Qty of AHUs		
	<input type="text" value="0"/>	<input type="text" value="1"/>	<input type="text" value="0.00"/> kW	
Remaining Unit Heater load			<input type="text" value="19.79"/> kW	
Required Number of Unit Heaters to Meet Load		<input type="text" value="1"/>		
Per unit Heater Load Required		<input type="text" value="19.79"/>	kW	
Selected Unit Heater Capacity (per unit)		<input type="text" value="20.00"/>	kW	
Total Number of Unit Heaters Installed		<input type="text" value="1"/>		
Total Installed Unit Heater Capacity		<input type="text" value="20"/>	kW	

CAESAR II 2014 Ver.7.00.01.1600, (Build 141003) Date: SEP 28, 2015 Time: 22:53
Job Name: 338716-FINAL
Licensed To: ENS CANADA STRUCTURAL ENGG & PROJECT MGMT INC

CAESAR II LOAD CASE REPORT

CASE 1 (HYD) WW+HP

HYDRO TEST CASE

Keep/Discard: Keep
Display: Disp/Force/Stress
Elastic Modulus: EC
Friction Mult.: 1.0000
SUS/OCC case SH: SH_MIN
Flg Analysis Temp: None

CASE 2 (OPE) W+T1+P1

OPERATING CASE CONDITION 1

Keep/Discard: Keep
Display: Disp/Force/Stress
Elastic Modulus: EC
Friction Mult.: 1.0000
SUS/OCC case SH: SH_MIN
Flg Analysis Temp: None

CASE 3 (OPE) W+T2+P1

OPERATING CASE CONDITION 2

Keep/Discard: Keep
Display: Disp/Force/Stress
Elastic Modulus: EC
Friction Mult.: 1.0000
SUS/OCC case SH: SH_MIN
Flg Analysis Temp: None

CASE 4 (SUS) W+P1

SUSTAINED CASE CONDITION 1

Keep/Discard: Keep
Display: Disp/Force/Stress
Elastic Modulus: EC
Friction Mult.: 1.0000
SUS/OCC case SH: SH_MIN
Flg Analysis Temp: None

CASE 5 (EXP) L5=L2-L4

EXPANSION CASE CONDITION 1

Keep/Discard: Keep
Display: Disp/Force/Stress
Combination Method: ALG

SUS/OCC case SH: SH_MIN
Flg Analysis Temp: None

CASE 6 (EXP) L6=L3-L4
EXPANSION CASE CONDITION 2
Keep/Discard: Keep
Display: Disp/Force/Stress
Combination Method: ALG
SUS/OCC case SH: SH_MIN
Flg Analysis Temp: None

CASE 7 (EXP) L7=L2-L3
EXPANSION CASE CONDITION 1-2
Keep/Discard: Keep
Display: Disp/Force/Stress
Combination Method: ALG
SUS/OCC case SH: SH_MIN
Flg Analysis Temp: None

1760 6520 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0
 8510 5750 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0
 1700 6540 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0
 6540 6550 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0
 6550 6560 23300.0 23300.0 22780.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0
 1940 6670 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0
 6670 6680 23300.0 23300.0 22780.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0
 6690 6710 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0
 1360 6720 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0
 6720 6730 23300.0 23300.0 22780.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0
 2150 6750 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0
 990 6920 23300.0 23300.0 22780.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0
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 7100 7120 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0
 330 7140 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0
 7140 7150 23300.0 23300.0 22780.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0
 1790 7160 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0
 7160 7170 23300.0 23300.0 22780.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0
 2210 7180 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0
 7180 7190 23300.0 23300.0 22000.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0
 5480 7230 23300.0 23300.0 22780.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0
 2300 7440 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0
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 7450 7480 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0
 1170 7530 23300.0 23300.0 22000.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0
 7530 7540 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0
 7600 5500 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0
 7930 7600 23300.0 23300.0 22000.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0
 7630 7640 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0
 7150 7700 23300.0 23300.0 22780.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0
 5860 7710 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0
 2490 7970 23300.0 23300.0 22000.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0 23300.0
 7980 5230 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0 20000.0

 CAESAR II C.G. REPORT

Total Wght X cg Y cg Z cg

 (KN.) (ft.) (ft.) (ft.)
 Pipe : 25.5 39.0 5.0 -0.7
 Insulation : 0.0 0.0 0.0 0.0
 Refractory : 0.0 0.0 0.0 0.0

Fluid	:	0.0	0.0	0.0	0.0
Pipe+Insl+Refrty	:	25.5	39.0	5.0	-0.7
Pipe+Fluid	:	25.5	39.0	5.0	-0.7
Pipe+Insl+Refrty+Fluid:		25.5	39.0	5.0	-0.7

Input Echo

PIPE DATA

From 23 To 30 DY= 2.073 ft.

Dia= 8.625 in. Wall= .322 in.

GENERAL

T1= -49 F T2= 200 F P1= 1,360.0000 lb./sq.in.

PHyd= 2,220.0000 lb./sq.in. Mat= (106)A106 B E= 29,500,000 lb./sq.in.

EH1= 29,896,666 lb./sq.in. EH2= 28,800,000 lb./sq.in.

EH3= 29,500,000 lb./sq.in. EH4= 29,500,000 lb./sq.in.

EH5= 29,500,000 lb./sq.in. EH6= 29,500,000 lb./sq.in.

EH7= 29,500,000 lb./sq.in. EH8= 29,500,000 lb./sq.in.

EH9= 29,500,000 lb./sq.in. v = .292 Pipe Den= .2830000 lb./cu.in.

Insul Thk= .000 in.

SIF's & TEE's

Node 30 Unreinforced Tee

From 30 To 31 DY= 1.250 ft.

GENERAL

T1= -49 F

From 31 To 40 DY= .583 ft.

GENERAL

T1= -49 F

SIF's & TEE's

Node 40 Unreinforced Tee

From 40 To 50 DY= 3.667 ft.

GENERAL

T1= -49 F

SIF's & TEE's

Node 50 Unreinforced Tee

From 50 To 60 DY= .417 ft.

From 60 To 70 DY= .672 ft.

GENERAL

T1= -49 F Mat= (103)A105 E= 29,500,000 lb./sq.in.

EH1= 29,896,666 lb./sq.in. EH2= 28,800,000 lb./sq.in.

EH3= 29,500,000 lb./sq.in. EH4= 29,500,000 lb./sq.in.

EH5= 29,500,000 lb./sq.in. EH6= 29,500,000 lb./sq.in.
EH7= 29,500,000 lb./sq.in. EH8= 29,500,000 lb./sq.in.
EH9= 29,500,000 lb./sq.in. v = .292 Pipe Den= .2830000 lb./cu.in.
RIGID Weight= 256.00 lb.

From 80 To 230 DY= .815 ft.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.
Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RESTRAINTS

Node 80 ANC

From 100 To 110 DX= -.677 ft.

Dia= 2.375 in. Wall= .154 in.

GENERAL

T1= -49 F T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Insul Thk= .000 in.
RIGID Weight= 150.00 lb.

From 110 To 120 DX= -.208 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.
RIGID Weight= 6.00 lb.

From 120 To 140 DX= -.200 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 140 To 150 DX= -.200 ft.

From 150 To 160 DX= -.219 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.
RIGID Weight= 6.00 lb.

From 160 To 170 DX= -.802 ft.
RIGID Weight= 150.00 lb.

From 170 To 190 DX= -.260 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

BEND at "TO" end

Radius= 3.000 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 189

From 190 To 210 DZ= -2.024 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RESTRAINTS

Node 190 +Y

From 210 To 220 DZ= -.208 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 6.00 lb.

RESTRAINTS

Node 220 ANC

From 230 To 235 DY= 1.000 ft.

Dia= 8.625 in. Wall= .322 in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.
Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

From 235 To 23 DY= .177 ft.

From 30 To 250 DX= -.542 ft.
Dia= 3.500 in. Wall= .216 in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.
Insul Thk= .000 in.

PIPE DATA

From 250 To 260 DX= -.292 ft.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.
Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 23.00 lb.

From 260 To 270 DX= -.052 ft.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.

RIGID Weight= 3.50 lb.

From 100 To 290 DX= .219 ft.

Dia= 2.375 in. Wall= .154 in.

GENERAL

T1= -49 F T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Insul Thk= .000 in.

RIGID Weight= 6.00 lb.

From 290 To 310 DX= .219 ft.

GENERAL

T1= -49 F T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 310 To 320 DX= .177 ft.

GENERAL

T1= -49 F T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

From 320 To 330 DX= .208 ft.

GENERAL

T1= -49 F T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 330 To 340 DX= .427 ft.

GENERAL

T1= -49 F T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

From 340 To 350 DX= .219 ft.

GENERAL

T1= -49 F T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

From 350 To 360 DX= .802 ft.

GENERAL

T1= -49 F T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 49.91 lb.

From 360 To 370 DX= .219 ft.

GENERAL

T1= -49 F T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

RIGID Weight= 6.00 lb.

From 370 To 400 DX= .557 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.

Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.
Dia= 2.375 in. Wall= .218 in.

GENERAL

T1= -49 F T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

ALLOWABLE STRESSES

From 400 To 410 DX= .031 ft.

Dia= .840 in. Wall= .147 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RIGID Weight= 2.00 lb.

From 420 To 430 DZ= .260 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,000 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.
Dia= 2.375 in. Wall= .218 in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.
Insul Thk= .000 in.

RIGID Weight= 12.00 lb.

RESTRAINTS

Node 420 ANC

ALLOWABLE STRESSES

From 430 To 435 DZ= 2.000 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 20,000 lb./sq.in. Sh1= 20,000 lb./sq.in. Sh2= 20,000 lb./sq.in.
Sh3= 20,000 lb./sq.in. Sh4= 20,000 lb./sq.in. Sh5= 20,000 lb./sq.in.
Sh6= 20,000 lb./sq.in. Sh7= 20,000 lb./sq.in. Sh8= 20,000 lb./sq.in.
Sh9= 20,000 lb./sq.in. Sy= 35,000 lb./sq.in.
Dia= 2.375 in. Wall= .154 in.

GENERAL

T1= -49 F T2= 200 F P1= 1,360.0000 lb./sq.in.
PHyd= 2,220.0000 lb./sq.in. Mat= (106)A106 B E= 29,500,000 lb./sq.in.
EH1= 29,896,666 lb./sq.in. EH2= 28,800,000 lb./sq.in.
EH3= 29,500,000 lb./sq.in. EH4= 29,500,000 lb./sq.in.
EH5= 29,500,000 lb./sq.in. EH6= 29,500,000 lb./sq.in.
EH7= 29,500,000 lb./sq.in. EH8= 29,500,000 lb./sq.in.
EH9= 29,500,000 lb./sq.in. v = .292 Pipe Den= .2830000 lb./cu.in.
Insul Thk= .000 in.

RESTRAINTS

Node 435 +Y

ALLOWABLE STRESSES

From 435 To 450 DZ= 1.339 ft.

From 450 To 460 DZ= 1.302 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.
RIGID Weight= 150.00 lb.

From 460 To 470 DZ= 2.000 ft.

RIGID Weight= 150.00 lb.

PIPE DATA

From 470 To 480 DZ= .271 ft.

RIGID Weight= 12.00 lb.

From 480 To 510 DZ= .812 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 510 To 515 DZ= 2.000 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RESTRAINTS

Node 515 Guide Gap= 3.000 in.
Node 515 +Y

From 515 To 540 DZ= 1.260 ft.

BEND at "TO" end

Radius= 3.000 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 541
Angle/Node @2= .00 538

From 540 To 550 DY= .260 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 550 To 560 DY= 1.229 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 150.00 lb.

From 560 To 570 DY= .271 ft.

RIGID Weight= 12.00 lb.

From 570 To 590 DY= 3.688 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 590 To 600 DY= .250 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

BEND at "TO" end

Radius= 3.000 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 599

From 600 To 610 DX= .833 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RESTRAINTS

Node 610 Guide Gap= 3.000 in.
Node 610 Y

From 610 To 615 DX= 3.000 ft.

RESTRAINTS

Node 615 Guide Gap= 3.000 in.
Node 615 Y

From 615 To 620 DX= 3.604 ft.

From 620 To 630 DX= .260 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 12.00 lb.

From 630 To 640 DX= .271 ft.

RIGID Weight= 12.00 lb.

From 640 To 660 DX= .219 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 660 To 670 DX= .219 ft.

From 670 To 680 DX= .271 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 12.00 lb.

From 680 To 690 DX= .260 ft.

RIGID Weight= 12.00 lb.

From 690 To 695 DX= 5.873 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

RESTRAINTS

Node 695 Guide Gap= 3.000 in.

Node 695 Y

From 695 To 710 DX= .833 ft.

From 710 To 720 DX= .271 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 12.00 lb.

PIPE DATA

From 720 To 730 DX= .260 ft.

RIGID Weight= 12.00 lb.

From 730 To 750 DX= .250 ft. DZ= -.000 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

BEND at "TO" end

Radius= 3.000 in. (LONG) Bend Angle= 89.999 Angle/Node @1= 45.00 749

From 750 To 770 DX= -.000 ft. DZ= -.594 ft.

From 770 To 780 DZ= -.250 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

BEND at "TO" end

Radius= 3.000 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 779

From 780 To 810 DY= -2.859 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 810 To 820 DY= -.365 ft.

Dia= 2.375 in. Wall= .218 in.

GENERAL

T2= 200 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RIGID Weight= 25.00 lb.

RESTRAINTS

Node 820 ANC

From 830 To 840 DX= .219 ft.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in.

RIGID Weight= 6.00 lb.

From 840 To 860 DX= .260 ft.

Dia= 2.375 in. Wall= .154 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

BEND at "TO" end

Radius= 3.000 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 859

RESTRAINTS

Node 860 +Y

From 860 To 880 DZ= .551 ft.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

From 880 To 900 DZ= .727 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON

Sc= 20,000 lb./sq.in. Sh1= 20,000 lb./sq.in. Sh2= 20,000 lb./sq.in.

Sh3= 20,000 lb./sq.in. Sh4= 20,000 lb./sq.in. Sh5= 20,000 lb./sq.in.

Sh6= 20,000 lb./sq.in. Sh7= 20,000 lb./sq.in. Sh8= 20,000 lb./sq.in.

Sh9= 20,000 lb./sq.in. Sy= 35,000 lb./sq.in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

ALLOWABLE STRESSES

From 900 To 910 DZ= .219 ft.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

From 910 To 930 DZ= .547 ft.

Dia= 2.375 in. Wall= .218 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Insul Thk= .000 in.

From 930 To 940 DZ= .630 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RIGID Weight= 23.00 lb.

From 940 To 950 DZ= .026 ft.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

RIGID Weight= 2.00 lb.

From 940 To 980 DZ= .547 ft.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 980 To 990 DZ= .260 ft.

Dia= 2.375 in. Wall= .154 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

From 990 To 1010 DZ= .505 ft.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

PIPE DATA

From 1010 To 1020 DZ= .219 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

ALLOWABLE STRESSES

From 1020 To 1040 DZ= .542 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.
Dia= 2.375 in. Wall= .218 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Insul Thk= .000 in.

ALLOWABLE STRESSES

From 1040 To 1050 DZ= .057 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,780 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.
Dia= 1.315 in. Wall= .179 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RIGID Weight= 3.00 lb.

ALLOWABLE STRESSES

From 20 To 1060 DZ= .703 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,000 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.

GENERAL

T2= 200 F P1= 680.0000 lb./sq.in. PHyd= 1,110.0000 lb./sq.in.

RIGID Weight= 150.00 lb.

SIF's & TEE's

Node 1060 Socket (As welded)

ALLOWABLE STRESSES

From 1060 To 1090 DZ= .557 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.

GENERAL

T2= 200 F P1= 680.0000 lb./sq.in. PHyd= 1,110.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

ALLOWABLE STRESSES

From 1090 To 1100 DZ= .323 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 20,000 lb./sq.in. Sh1= 20,000 lb./sq.in. Sh2= 20,000 lb./sq.in.
Sh3= 20,000 lb./sq.in. Sh4= 20,000 lb./sq.in. Sh5= 20,000 lb./sq.in.
Sh6= 20,000 lb./sq.in. Sh7= 20,000 lb./sq.in. Sh8= 20,000 lb./sq.in.
Sh9= 20,000 lb./sq.in. Sy= 35,000 lb./sq.in.
Dia= 2.375 in. Wall= .154 in.

GENERAL

T2= 200 F P1= 680.0000 lb./sq.in. PHyd= 1,110.0000 lb./sq.in.
Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RESTRAINTS

Node 1090 +Y
ALLOWABLE STRESSES

From 1100 To 1120 DZ= .642 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 20,000 lb./sq.in. Sh1= 20,000 lb./sq.in. Sh2= 20,000 lb./sq.in.
Sh3= 20,000 lb./sq.in. Sh4= 20,000 lb./sq.in. Sh5= 20,000 lb./sq.in.
Sh6= 20,000 lb./sq.in. Sh7= 20,000 lb./sq.in. Sh8= 20,000 lb./sq.in.
Sh9= 20,000 lb./sq.in. Sy= 35,000 lb./sq.in.

GENERAL

T2= 200 F P1= 680.0000 lb./sq.in. PHyd= 1,110.0000 lb./sq.in.

SIF's & TEE's

Node 1120 Welding Tee

ALLOWABLE STRESSES

From 1120 To 1130 DZ= .187 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.

GENERAL

T2= 200 F P1= 680.0000 lb./sq.in. PHyd= 1,110.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

ALLOWABLE STRESSES

From 1130 To 1140 DZ= .229 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,000 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.

GENERAL

T2= 200 F Mat= (103)A105 E= 29,500,000 lb./sq.in.
EH1= 29,896,666 lb./sq.in. EH2= 28,800,000 lb./sq.in.
EH3= 29,500,000 lb./sq.in. EH4= 29,500,000 lb./sq.in.
EH5= 29,500,000 lb./sq.in. EH6= 29,500,000 lb./sq.in.
EH7= 29,500,000 lb./sq.in. EH8= 29,500,000 lb./sq.in.
EH9= 29,500,000 lb./sq.in. v = .292 Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 9.00 lb.

ALLOWABLE STRESSES

From 1140 To 1150 DZ= .240 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,000 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.

GENERAL

T2= 200 F

RIGID Weight= 9.00 lb.

ALLOWABLE STRESSES

PIPE DATA

From 1150 To 1170 DZ= .396 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 20,000 lb./sq.in. Sh1= 20,000 lb./sq.in. Sh2= 20,000 lb./sq.in.
Sh3= 20,000 lb./sq.in. Sh4= 20,000 lb./sq.in. Sh5= 20,000 lb./sq.in.
Sh6= 20,000 lb./sq.in. Sh7= 20,000 lb./sq.in. Sh8= 20,000 lb./sq.in.
Sh9= 20,000 lb./sq.in. Sy= 35,000 lb./sq.in.

GENERAL

T2= 200 F Mat= (106)A106 B E= 29,500,000 lb./sq.in.
EH1= 29,896,666 lb./sq.in. EH2= 28,800,000 lb./sq.in.
EH3= 29,500,000 lb./sq.in. EH4= 29,500,000 lb./sq.in.
EH5= 29,500,000 lb./sq.in. EH6= 29,500,000 lb./sq.in.
EH7= 29,500,000 lb./sq.in. EH8= 29,500,000 lb./sq.in.
EH9= 29,500,000 lb./sq.in. v = .292 Pipe Den= .2830000 lb./cu.in.

ALLOWABLE STRESSES

From 1170 To 1180 DZ= .729 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 20,000 lb./sq.in. Sh1= 20,000 lb./sq.in. Sh2= 20,000 lb./sq.in.
Sh3= 20,000 lb./sq.in. Sh4= 20,000 lb./sq.in. Sh5= 20,000 lb./sq.in.
Sh6= 20,000 lb./sq.in. Sh7= 20,000 lb./sq.in. Sh8= 20,000 lb./sq.in.
Sh9= 20,000 lb./sq.in. Sy= 35,000 lb./sq.in.

GENERAL

T2= 200 F

ALLOWABLE STRESSES

From 1180 To 1190 DX= .000 ft. DZ= .250 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.

GENERAL

T2= 200 F Mat= (321)A234 E= 29,500,000 lb./sq.in.
EH1= 29,896,666 lb./sq.in. EH2= 28,800,000 lb./sq.in.

EH3= 29,500,000 lb./sq.in. EH4= 29,500,000 lb./sq.in.
EH5= 29,500,000 lb./sq.in. EH6= 29,500,000 lb./sq.in.
EH7= 29,500,000 lb./sq.in. EH8= 29,500,000 lb./sq.in.
EH9= 29,500,000 lb./sq.in. v = .292 Pipe Den= .2830000 lb./cu.in.

BEND at "TO" end

Radius= 3.000 in. (LONG) Bend Angle= 90.002 Angle/Node @1= 45.00 1189

ALLOWABLE STRESSES

From 1190 To 1195 DX= -2.104 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 20,000 lb./sq.in. Sh1= 20,000 lb./sq.in. Sh2= 20,000 lb./sq.in.
Sh3= 20,000 lb./sq.in. Sh4= 20,000 lb./sq.in. Sh5= 20,000 lb./sq.in.
Sh6= 20,000 lb./sq.in. Sh7= 20,000 lb./sq.in. Sh8= 20,000 lb./sq.in.
Sh9= 20,000 lb./sq.in. Sy= 35,000 lb./sq.in.

GENERAL

T2= 200 F Mat= (106)A106 B E= 29,500,000 lb./sq.in.
EH1= 29,896,666 lb./sq.in. EH2= 28,800,000 lb./sq.in.
EH3= 29,500,000 lb./sq.in. EH4= 29,500,000 lb./sq.in.
EH5= 29,500,000 lb./sq.in. EH6= 29,500,000 lb./sq.in.
EH7= 29,500,000 lb./sq.in. EH8= 29,500,000 lb./sq.in.
EH9= 29,500,000 lb./sq.in. v = .292 Pipe Den= .2830000 lb./cu.in.

RESTRAINTS

Node 1195 +Y

ALLOWABLE STRESSES

From 1195 To 1210 DX= -1.667 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 20,000 lb./sq.in. Sh1= 20,000 lb./sq.in. Sh2= 20,000 lb./sq.in.
Sh3= 20,000 lb./sq.in. Sh4= 20,000 lb./sq.in. Sh5= 20,000 lb./sq.in.
Sh6= 20,000 lb./sq.in. Sh7= 20,000 lb./sq.in. Sh8= 20,000 lb./sq.in.
Sh9= 20,000 lb./sq.in. Sy= 35,000 lb./sq.in.

GENERAL

T2= 200 F

ALLOWABLE STRESSES

From 1210 To 1230 DX= -.510 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.

GENERAL

T2= 200 F Mat= (321)A234 E= 29,500,000 lb./sq.in.
EH1= 29,896,666 lb./sq.in. EH2= 28,800,000 lb./sq.in.
EH3= 29,500,000 lb./sq.in. EH4= 29,500,000 lb./sq.in.
EH5= 29,500,000 lb./sq.in. EH6= 29,500,000 lb./sq.in.
EH7= 29,500,000 lb./sq.in. EH8= 29,500,000 lb./sq.in.

EH9= 29,500,000 lb./sq.in. v = .292 Pipe Den= .2830000 lb./cu.in.
BEND at "TO" end
Radius= 3.000 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 1219
ALLOWABLE STRESSES

From 1230 To 1250 DZ= -.542 ft.
B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.
Dia= 2.375 in. Wall= .218 in.

GENERAL

T2= 200 F Insul Thk= .000 in.

ALLOWABLE STRESSES

From 1250 To 1260 DZ= -.078 ft.
B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,000 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.
Dia= 1.315 in. Wall= .179 in.

GENERAL

T2= 200 F Mat= (103)A105 E= 29,500,000 lb./sq.in.
EH1= 29,896,666 lb./sq.in. EH2= 28,800,000 lb./sq.in.
EH3= 29,500,000 lb./sq.in. EH4= 29,500,000 lb./sq.in.
EH5= 29,500,000 lb./sq.in. EH6= 29,500,000 lb./sq.in.
EH7= 29,500,000 lb./sq.in. EH8= 29,500,000 lb./sq.in.
EH9= 29,500,000 lb./sq.in. v = .292 Pipe Den= .2830000 lb./cu.in.
Insul Thk= .000 in.

RIGID Weight= 4.00 lb.

ALLOWABLE STRESSES

From 1260 To 1270 DZ= -.766 ft.
B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,000 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.

GENERAL

T2= 200 F

RIGID Weight= 150.00 lb.

SIF's & TEE's

Node 1270 Socket (As welded)

ALLOWABLE STRESSES

From 1270 To 1300 DZ= -.557 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.

GENERAL

T2= 200 F Mat= (321)A234 E= 29,500,000 lb./sq.in.
EH1= 29,896,666 lb./sq.in. EH2= 28,800,000 lb./sq.in.
EH3= 29,500,000 lb./sq.in. EH4= 29,500,000 lb./sq.in.
EH5= 29,500,000 lb./sq.in. EH6= 29,500,000 lb./sq.in.
EH7= 29,500,000 lb./sq.in. EH8= 29,500,000 lb./sq.in.
EH9= 29,500,000 lb./sq.in. v = .292 Pipe Den= .2830000 lb./cu.in.

RESTRAINTS

Node 1300 +Y

ALLOWABLE STRESSES

From 1300 To 1310 DZ= -.365 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,000 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.

PIPE DATA

Dia= 2.375 in. Wall= .154 in.

GENERAL

T2= 200 F Mat= (103)A105 E= 29,500,000 lb./sq.in.
EH1= 29,896,666 lb./sq.in. EH2= 28,800,000 lb./sq.in.
EH3= 29,500,000 lb./sq.in. EH4= 29,500,000 lb./sq.in.
EH5= 29,500,000 lb./sq.in. EH6= 29,500,000 lb./sq.in.
EH7= 29,500,000 lb./sq.in. EH8= 29,500,000 lb./sq.in.
EH9= 29,500,000 lb./sq.in. v = .292 Pipe Den= .2830000 lb./cu.in.
Insul Thk= .000 in.

RIGID Weight= 25.00 lb.

ALLOWABLE STRESSES

From 5240 To 1330 DX= .219 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,780 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

RIGID Weight= 6.00 lb.

ALLOWABLE STRESSES

From 1330 To 1350 DX= .219 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

ALLOWABLE STRESSES

From 1350 To 1360 DX= .427 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

ALLOWABLE STRESSES

From 1360 To 1370 DX= .219 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

ALLOWABLE STRESSES

From 1370 To 5830 DX= .219 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,780 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 6.00 lb.

ALLOWABLE STRESSES

From 510 To 1390 DX= .219 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

SIF's & TEE's

Node 510 Welding Tee

ALLOWABLE STRESSES

From 1390 To 1400 DX= .271 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 12.00 lb.

From 1400 To 1410 DX= 1.031 ft.

RIGID Weight= 150.00 lb.

From 1410 To 1420 DX= .333 ft.

RIGID Weight= 12.00 lb.

From 1420 To 1430 DX= .010 ft.

From 1430 To 1440 DX= .250 ft. DY= .000 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

BEND at "TO" end

Radius= 3.000 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 1439

From 1440 To 1450 DX= -.000 ft. DY= .260 ft.

From 1450 To 1460 DY= 1.229 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 56.00 lb.

From 1460 To 1470 DY= .042 ft.

RIGID Weight= 2.00 lb.

From 1470 To 1480 DY= .271 ft.

RIGID Weight= 12.00 lb.

From 1480 To 1510 DY= .378 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

PIPE DATA

From 1510 To 1540 DY= 4.417 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 1540 To 1560 DY= 3.000 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 1560 To 1580 DY= .547 ft.

Dia= 2.375 in. Wall= .218 in.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

From 1580 To 1590 DY= .078 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RIGID Weight= 4.00 lb.

From 40 To 1600 DZ= .542 ft.

Dia= 3.500 in. Wall= .216 in.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

From 1600 To 1610 DZ= .292 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 23.00 lb.

From 1610 To 1620 DZ= .135 ft.
RIGID Weight= 20.00 lb.

From 1630 To 1640 DX= .344 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.
Dia= 2.375 in. Wall= .154 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

ALLOWABLE STRESSES

From 1640 To 1645 DX= 1.250 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 20,000 lb./sq.in. Sh1= 20,000 lb./sq.in. Sh2= 20,000 lb./sq.in.
Sh3= 20,000 lb./sq.in. Sh4= 20,000 lb./sq.in. Sh5= 20,000 lb./sq.in.
Sh6= 20,000 lb./sq.in. Sh7= 20,000 lb./sq.in. Sh8= 20,000 lb./sq.in.
Sh9= 20,000 lb./sq.in. Sy= 35,000 lb./sq.in.

GENERAL

T2= 140 F Mat= (106)A106 B E= 29,500,000 lb./sq.in.
EH1= 29,896,666 lb./sq.in. EH2= 29,160,000 lb./sq.in.
EH3= 29,500,000 lb./sq.in. EH4= 29,500,000 lb./sq.in.
EH5= 29,500,000 lb./sq.in. EH6= 29,500,000 lb./sq.in.
EH7= 29,500,000 lb./sq.in. EH8= 29,500,000 lb./sq.in.
EH9= 29,500,000 lb./sq.in. v = .292 Pipe Den= .2830000 lb./cu.in.

RESTRAINTS

Node 1645 +Y

ALLOWABLE STRESSES

From 1645 To 1660 DX= 8.146 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 20,000 lb./sq.in. Sh1= 20,000 lb./sq.in. Sh2= 20,000 lb./sq.in.
Sh3= 20,000 lb./sq.in. Sh4= 20,000 lb./sq.in. Sh5= 20,000 lb./sq.in.
Sh6= 20,000 lb./sq.in. Sh7= 20,000 lb./sq.in. Sh8= 20,000 lb./sq.in.
Sh9= 20,000 lb./sq.in. Sy= 35,000 lb./sq.in.

GENERAL

T2= 140 F

ALLOWABLE STRESSES

From 1660 To 1670 DX= .219 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 6.00 lb.

From 1670 To 1680 DX= .208 ft.

RIGID Weight= 6.00 lb.

From 1680 To 1700 DX= .219 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 1700 To 1705 DX= 2.500 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RESTRAINTS

Node 1705 +Y

From 1705 To 1720 DX= .533 ft.

From 1720 To 1730 DX= .250 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

BEND at "TO" end

Radius= 3.000 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 1729

PIPE DATA

From 1730 To 1760 DZ= -1.562 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 1760 To 1770 DZ= -.219 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 1770 To 1775 DZ= -.750 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RESTRAINTS

Node 1775 +Y

From 1775 To 1780 DZ= -.750 ft.

From 1780 To 1790 DZ= -.208 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 1790 To 1800 DZ= -.219 ft.

From 1800 To 1810 DZ= -.667 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 1810 To 1820 DZ= -.208 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 1820 To 1830 DZ= -.219 ft.

From 1830 To 1835 DZ= -.500 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RESTRAINTS

Node 1835 +Y

From 1835 To 1840 DZ= -.724 ft.

From 1840 To 1850 DZ= -.219 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 6.00 lb.

From 1850 To 1860 DZ= -.208 ft.

RIGID Weight= 6.00 lb.

From 1860 To 1870 DZ= -.010 ft.

From 1870 To 1880 DZ= -.208 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 1880 To 1890 DZ= -.219 ft.

From 1890 To 1900 DZ= -.219 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 1900 To 1910 DZ= -.208 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 1910 To 1920 DZ= -.219 ft.

From 1920 To 1930 DZ= -.383 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 1930 To 1940 DZ= -.208 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 1940 To 1950 DX= -.000 ft. DZ= -.469 ft.

BEND at "TO" end

Radius= 3.000 in. (LONG) Bend Angle= 90.001 Angle/Node @1= 45.00 1949

Angle/Node @2= .00 1948

From 1950 To 4850 DX= -.260 ft. DZ= .000 ft.

From 50 To 1970 DX= .542 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON

Sc= 20,000 lb./sq.in. Sh1= 20,000 lb./sq.in. Sh2= 20,000 lb./sq.in.

Sh3= 20,000 lb./sq.in. Sh4= 20,000 lb./sq.in. Sh5= 20,000 lb./sq.in.

Sh6= 20,000 lb./sq.in. Sh7= 20,000 lb./sq.in. Sh8= 20,000 lb./sq.in.

PIPE DATA

Sh9= 20,000 lb./sq.in. Sy= 35,000 lb./sq.in.

Dia= 3.500 in. Wall= .216 in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

ALLOWABLE STRESSES

From 1970 To 1980 DX= .292 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON

Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,000 lb./sq.in.

Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.

Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.

Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 23.00 lb.

ALLOWABLE STRESSES

From 2020 To 2030 DZ= -.365 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON

Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,000 lb./sq.in.

Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.

Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.
Dia= 2.375 in. Wall= .154 in.

GENERAL

T2= 200 F P1= 2,035.0000 lb./sq.in. PHyd= 3,330.0000 lb./sq.in.
Insul Thk= .000 in.

RIGID Weight= 25.00 lb.

ALLOWABLE STRESSES

From 2030 To 2050 DZ= -.260 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.
Dia= 2.375 in. Wall= .218 in.

GENERAL

T2= 200 F P1= 2,035.0000 lb./sq.in. PHyd= 3,330.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

BEND at "TO" end

Radius= 3.000 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 2049

RESTRAINTS

Node 2050 +Y

ALLOWABLE STRESSES

From 2050 To 2070 DY= 1.315 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 20,000 lb./sq.in. Sh1= 20,000 lb./sq.in. Sh2= 20,000 lb./sq.in.
Sh3= 20,000 lb./sq.in. Sh4= 20,000 lb./sq.in. Sh5= 20,000 lb./sq.in.
Sh6= 20,000 lb./sq.in. Sh7= 20,000 lb./sq.in. Sh8= 20,000 lb./sq.in.
Sh9= 20,000 lb./sq.in. Sy= 35,000 lb./sq.in.

GENERAL

T2= 200 F P1= 2,035.0000 lb./sq.in. PHyd= 3,330.0000 lb./sq.in.
Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

ALLOWABLE STRESSES

From 2070 To 2080 DY= 2.899 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 20,000 lb./sq.in. Sh1= 20,000 lb./sq.in. Sh2= 20,000 lb./sq.in.
Sh3= 20,000 lb./sq.in. Sh4= 20,000 lb./sq.in. Sh5= 20,000 lb./sq.in.
Sh6= 20,000 lb./sq.in. Sh7= 20,000 lb./sq.in. Sh8= 20,000 lb./sq.in.
Sh9= 20,000 lb./sq.in. Sy= 35,000 lb./sq.in.

GENERAL

T2= 200 F P1= 2,035.0000 lb./sq.in. PHyd= 3,330.0000 lb./sq.in.

ALLOWABLE STRESSES

From 2080 To 2100 DY= .510 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.

GENERAL

T2= 200 F P1= 2,035.0000 lb./sq.in. PHyd= 3,330.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

BEND at "TO" end

Radius= 3.000 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 2089

ALLOWABLE STRESSES

From 2100 To 2110 DZ= .365 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,000 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.

GENERAL

T2= 200 F P1= 2,035.0000 lb./sq.in. PHyd= 3,330.0000 lb./sq.in.
Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 25.00 lb.

ALLOWABLE STRESSES

From 2110 To 2120 DZ= .354 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,000 lb./sq.in.

Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.

GENERAL

T2= 200 F P1= 2,035.0000 lb./sq.in. PHyd= 3,330.0000 lb./sq.in.

RIGID Weight= 25.00 lb.

ALLOWABLE STRESSES

From 2120 To 2125 DZ= 1.500 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 20,000 lb./sq.in. Sh1= 20,000 lb./sq.in. Sh2= 20,000 lb./sq.in.
Sh3= 20,000 lb./sq.in. Sh4= 20,000 lb./sq.in. Sh5= 20,000 lb./sq.in.
Sh6= 20,000 lb./sq.in. Sh7= 20,000 lb./sq.in. Sh8= 20,000 lb./sq.in.
Sh9= 20,000 lb./sq.in. Sy= 35,000 lb./sq.in.

GENERAL

T2= 200 F P1= 2,035.0000 lb./sq.in. PHyd= 3,330.0000 lb./sq.in.
Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

PIPE DATA

RESTRAINTS

Node 2125 +Y

ALLOWABLE STRESSES

From 2125 To 2150 DZ= 1.458 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 20,000 lb./sq.in. Sh1= 20,000 lb./sq.in. Sh2= 20,000 lb./sq.in.
Sh3= 20,000 lb./sq.in. Sh4= 20,000 lb./sq.in. Sh5= 20,000 lb./sq.in.
Sh6= 20,000 lb./sq.in. Sh7= 20,000 lb./sq.in. Sh8= 20,000 lb./sq.in.
Sh9= 20,000 lb./sq.in. Sy= 35,000 lb./sq.in.

GENERAL

T2= 200 F P1= 2,035.0000 lb./sq.in. PHyd= 3,330.0000 lb./sq.in.

ALLOWABLE STRESSES

From 2150 To 2170 DZ= .729 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 20,000 lb./sq.in. Sh1= 20,000 lb./sq.in. Sh2= 20,000 lb./sq.in.
Sh3= 20,000 lb./sq.in. Sh4= 20,000 lb./sq.in. Sh5= 20,000 lb./sq.in.
Sh6= 20,000 lb./sq.in. Sh7= 20,000 lb./sq.in. Sh8= 20,000 lb./sq.in.
Sh9= 20,000 lb./sq.in. Sy= 35,000 lb./sq.in.

GENERAL

T2= 200 F P1= 2,035.0000 lb./sq.in. PHyd= 3,330.0000 lb./sq.in.
Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

ALLOWABLE STRESSES

From 2170 To 2180 DZ= .250 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.

GENERAL

T2= 200 F P1= 2,035.0000 lb./sq.in. PHyd= 3,330.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

BEND at "TO" end

Radius= 3.000 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 2179

ALLOWABLE STRESSES

From 2180 To 2210 DX= .951 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.

GENERAL

T2= 200 F P1= 2,035.0000 lb./sq.in. PHyd= 3,330.0000 lb./sq.in.

ALLOWABLE STRESSES

From 2210 To 2220 DX= .469 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.

GENERAL

T2= 200 F P1= 2,035.0000 lb./sq.in. PHyd= 3,330.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.
BEND at "TO" end
Radius= 3.000 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 2219
Angle/Node @2= .00 2218

ALLOWABLE STRESSES

From 2220 To 2240 DY= -1.625 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 20,000 lb./sq.in. Sh1= 20,000 lb./sq.in. Sh2= 20,000 lb./sq.in.
Sh3= 20,000 lb./sq.in. Sh4= 20,000 lb./sq.in. Sh5= 20,000 lb./sq.in.
Sh6= 20,000 lb./sq.in. Sh7= 20,000 lb./sq.in. Sh8= 20,000 lb./sq.in.
Sh9= 20,000 lb./sq.in. Sy= 35,000 lb./sq.in.

GENERAL

T2= 200 F P1= 2,035.0000 lb./sq.in. PHyd= 3,330.0000 lb./sq.in.
Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

ALLOWABLE STRESSES

From 2240 To 2250 DY= -.365 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,000 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.

GENERAL

T2= 200 F P1= 2,035.0000 lb./sq.in. PHyd= 3,330.0000 lb./sq.in.
Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 25.00 lb.

RESTRAINTS

Node 2250 ANC

ALLOWABLE STRESSES

From 270 To 2260 DX= -.302 ft.

Dia= 3.500 in. Wall= .216 in.

GENERAL

P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.
Insul Thk= .000 in.

RIGID Weight= 23.00 lb.

From 2260 To 2280 DX= -.302 ft.

GENERAL

P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in. Mat= (321)A234
E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 2280 To 1510 DX= -.219 ft.

Dia= 2.375 in. Wall= .154 in.

GENERAL

P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.
Insul Thk= .000 in.

SIF's & TEE's

Node 1510 Welding Tee

From 2300 To 2310 DY= -.073 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

DOUBLE FLANGED BEND at "TO" end

Radius= .875 in. (user) Bend Angle= 90.000 Angle/Node @1= 45.00 2309

PIPE DATA

From 2310 To 2340 DX= -1.112 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 2340 To 2350 DX= -.073 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

DOUBLE FLANGED BEND at "TO" end

Radius= .875 in. (user) Bend Angle= 90.000 Angle/Node @1= 45.00 2349

From 2350 To 2390 DZ= .417 ft.

Dia= 1.315 in. Wall= .358 in.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

From 2390 To 2400 DZ= .068 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RIGID Weight= 4.00 lb.

From 2400 To 2410 DZ= .078 ft.

RIGID Weight= 4.00 lb.

SIF's & TEE's

Node 2410 Socket (As welded)

From 2410 To 2415 DZ= .833 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RESTRAINTS

Node 2415 +Y

From 2415 To 2440 DZ= .806 ft.

From 2440 To 2490 DZ= .490 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 2490 To 2540 DZ= .490 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

From 2540 To 2545 DZ= 1.000 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RESTRAINTS

Node 2545 +Y

From 2545 To 2570 DZ= .297 ft.

From 2570 To 2580 DZ= .073 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

DOUBLE FLANGED BEND at "TO" end

Radius= .875 in. (user) Bend Angle= 90.000 Angle/Node @1= 45.00 2579

From 2580 To 2610 DX= .385 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 2610 To 2620 DX= .078 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 4.00 lb.

From 2620 To 2640 DX= .999 ft.

RIGID Weight= 49.91 lb.

From 2640 To 2650 DX= .833 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 2650 To 2660 DX= .278 ft.

RIGID Weight= 8.29 lb.

From 2660 To 2690 DX= .510 ft.

Dia= 1.315 in. Wall= .358 in.

Insul Thk= .000 in.

From 2690 To 2700 DX= .078 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RIGID Weight= 4.00 lb.

PIPE DATA

From 2700 To 2710 DX= .068 ft.

RIGID Weight= 4.00 lb.

SIF's & TEE's

Node 2710 Socket (As welded)

From 2710 To 2730 DX= .958 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

SIF's & TEE's

Node 2730 Socket (As welded)

From 1350 To 2820 DY= .219 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON

Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.

Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.

Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.

Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.

Dia= 2.375 in. Wall= .154 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

SIF's & TEE's

Node 1350 Welding Tee

ALLOWABLE STRESSES

From 2820 To 2830 DY= 1.032 ft.

GENERAL

P1= 260.0000 lb./sq.in. Mat= (106)A106 B E= 29,500,000 lb./sq.in.

EH1= 29,896,666 lb./sq.in. EH2= 29,160,000 lb./sq.in.

EH3= 29,500,000 lb./sq.in. EH4= 29,500,000 lb./sq.in.

EH5= 29,500,000 lb./sq.in. EH6= 29,500,000 lb./sq.in.

EH7= 29,500,000 lb./sq.in. EH8= 29,500,000 lb./sq.in.

EH9= 29,500,000 lb./sq.in. v = .292 Pipe Den= .2830000 lb./cu.in.

From 2830 To 2840 DY= .250 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

BEND at "TO" end

Radius= 3.000 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 2839

From 2840 To 2845 DX= -2.000 ft.

GENERAL

P1= 260.0000 lb./sq.in. Mat= (106)A106 B E= 29,500,000 lb./sq.in.
EH1= 29,896,666 lb./sq.in. EH2= 29,160,000 lb./sq.in.
EH3= 29,500,000 lb./sq.in. EH4= 29,500,000 lb./sq.in.
EH5= 29,500,000 lb./sq.in. EH6= 29,500,000 lb./sq.in.
EH7= 29,500,000 lb./sq.in. EH8= 29,500,000 lb./sq.in.
EH9= 29,500,000 lb./sq.in. v = .292 Pipe Den= .2830000 lb./cu.in.

RESTRAINTS

Node 2845 +Y

From 2845 To 2860 DX= -1.701 ft.

From 2860 To 2870 DX= -.219 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 6.00 lb.

From 2870 To 2880 DX= -.802 ft.

RIGID Weight= 150.00 lb.

From 2880 To 2900 DX= -.260 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

BEND at "TO" end

Radius= 3.000 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 2899

From 2900 To 2920 DY= -1.292 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 2920 To 340 DY= -.208 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

SIF's & TEE's

Node 340 Welding Tee

From 1880 To 2930 DX= .219 ft.

SIF's & TEE's

Node 1880 Welding Tee

From 2930 To 2940 DX= .530 ft. DZ= .000 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 2940 To 2950 DX= .250 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

BEND at "TO" end

Radius= 3.000 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 2949

From 2950 To 2960 DY= -.260 ft.

From 2960 To 2970 DY= -1.938 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 2970 To 2980 DY= -.219 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

PIPE DATA

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 6.00 lb.

From 2980 To 2990 DY= -1.479 ft.

RIGID Weight= 150.00 lb.

From 2990 To 3000 DY= -.010 ft.

From 3000 To 3010 DY= -.677 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 3010 To 3020 DY= -.250 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

BEND at "TO" end

Radius= 3.000 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 3019

From 3020 To 3030 DZ= -.260 ft.

From 3030 To 3040 DY= -.000 ft. DZ= -.177 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 3040 To 3050 DZ= -.208 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

SIF's & TEE's

Node 3050 Welding Tee

From 1980 To 3060 DX= .344 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,000 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.
Dia= 3.500 in. Wall= .216 in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.
Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RIGID Weight= 26.50 lb.

ALLOWABLE STRESSES

From 3060 To 3090 DX= .312 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

ALLOWABLE STRESSES

From 3090 To 3100 DX= 1.302 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,000 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.
Dia= 2.375 in. Wall= .154 in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.
Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RIGID Weight= 150.00 lb.

ALLOWABLE STRESSES

From 3100 To 3110 DX= 1.031 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,000 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.

RIGID Weight= 150.00 lb.

ALLOWABLE STRESSES

From 3110 To 3120 DX= .271 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,000 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.

RIGID Weight= 12.00 lb.

ALLOWABLE STRESSES

From 3120 To 3140 DX= .260 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.

Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

BEND at "TO" end

Radius= 3.000 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 3139

ALLOWABLE STRESSES

From 3140 To 3145 DZ= .667 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 20,000 lb./sq.in. Sh1= 20,000 lb./sq.in. Sh2= 20,000 lb./sq.in.
Sh3= 20,000 lb./sq.in. Sh4= 20,000 lb./sq.in. Sh5= 20,000 lb./sq.in.

PIPE DATA

Sh6= 20,000 lb./sq.in. Sh7= 20,000 lb./sq.in. Sh8= 20,000 lb./sq.in.
Sh9= 20,000 lb./sq.in. Sy= 35,000 lb./sq.in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.
Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RESTRAINTS

Node 3145 Guide Gap= 3.000 in.
Node 3145 +Y

ALLOWABLE STRESSES

From 3145 To 3160 DZ= 2.333 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 20,000 lb./sq.in. Sh1= 20,000 lb./sq.in. Sh2= 20,000 lb./sq.in.
Sh3= 20,000 lb./sq.in. Sh4= 20,000 lb./sq.in. Sh5= 20,000 lb./sq.in.
Sh6= 20,000 lb./sq.in. Sh7= 20,000 lb./sq.in. Sh8= 20,000 lb./sq.in.
Sh9= 20,000 lb./sq.in. Sy= 35,000 lb./sq.in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.

ALLOWABLE STRESSES

From 3160 To 3170 DZ= .267 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

BEND at "TO" end

Radius= 3.000 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 3169

ALLOWABLE STRESSES

From 3170 To 660 DY= -1.982 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 20,000 lb./sq.in. Sh1= 20,000 lb./sq.in. Sh2= 20,000 lb./sq.in.
Sh3= 20,000 lb./sq.in. Sh4= 20,000 lb./sq.in. Sh5= 20,000 lb./sq.in.
Sh6= 20,000 lb./sq.in. Sh7= 20,000 lb./sq.in. Sh8= 20,000 lb./sq.in.
Sh9= 20,000 lb./sq.in. Sy= 35,000 lb./sq.in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.
Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

SIF's & TEE's

Node 660 Welding Tee

ALLOWABLE STRESSES

From 900 To 3200 DY= .219 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

SIF's & TEE's

Node 900 Welding Tee

ALLOWABLE STRESSES

From 3200 To 3210 DY= .219 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,780 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 6.00 lb.

ALLOWABLE STRESSES

From 3210 To 3220 DY= .208 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,780 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

RIGID Weight= 6.00 lb.

ALLOWABLE STRESSES

From 3220 To 3050 DY= .219 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

ALLOWABLE STRESSES

From 3050 To 3250 DY= 3.917 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 20,000 lb./sq.in. Sh1= 20,000 lb./sq.in. Sh2= 20,000 lb./sq.in.
Sh3= 20,000 lb./sq.in. Sh4= 20,000 lb./sq.in. Sh5= 20,000 lb./sq.in.
Sh6= 20,000 lb./sq.in. Sh7= 20,000 lb./sq.in. Sh8= 20,000 lb./sq.in.
Sh9= 20,000 lb./sq.in. Sy= 35,000 lb./sq.in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

ALLOWABLE STRESSES

From 3250 To 3270 DY= .547 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 23,300 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Eff= .0000 Sy= 40,000 lb./sq.in.
Dia= 2.375 in. Wall= .218 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

PIPE DATA

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

ALLOWABLE STRESSES

From 3270 To 3280 DY= .026 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RIGID Weight= 2.00 lb.

From 3280 To 3290 DY= .344 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,780 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.
Dia= 2.375 in. Wall= .154 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Insul Thk= .000 in.

RIGID Weight= 9.57 lb.

ALLOWABLE STRESSES

From 3290 To 3300 DX= -.375 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,780 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.
Dia= 2.375 in. Wall= .154 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Insul Thk= .000 in.

RIGID Weight= 10.43 lb.

ALLOWABLE STRESSES

From 3300 To 3310 DX= -.219 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,780 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.
Dia= 2.375 in. Wall= .218 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Insul Thk= .000 in.

RIGID Weight= 6.00 lb.

ALLOWABLE STRESSES

From 3310 To 1910 DX= -.405 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,780 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.

Dia= 2.375 in. Wall= .154 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

Insul Thk= .000 in.

SIF's & TEE's

Node 1910 Welding Tee

ALLOWABLE STRESSES

From 2540 To 3390 DX= .417 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

SIF's & TEE's

Node 2540 Welding Tee

From 3390 To 3400 DX= .120 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RIGID Weight= 1.31 lb.

From 3400 To 3420 DX= .797 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

From 3420 To 3430 DX= .277 ft.

RIGID Weight= 6.05 lb.

From 3430 To 3470 DX= .417 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

From 3470 To 3475 DX= .250 ft.

SIF's & TEE's

Node 3470 Unreinforced Tee

From 3475 To 3500 DX= .250 ft.

RESTRAINTS

Node 3475 +Y

From 3500 To 3510 DX= .078 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.
RIGID Weight= 4.00 lb.

From 3510 To 3520 DX= .999 ft.

RIGID Weight= 49.91 lb.

From 3520 To 3550 DX= .344 ft.

Dia= 1.315 in. Wall= .358 in.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

PIPE DATA

From 3550 To 3560 DX= .073 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.
DOUBLE FLANGED BEND at "TO" end
Radius= .875 in. (user) Bend Angle= 90.000 Angle/Node @1= 45.00 3559

From 3560 To 3590 DY= .384 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 3590 To 3600 DY= .277 ft.

RIGID Weight= 8.29 lb.

From 3600 To 3630 DY= .266 ft.

Dia= 1.315 in. Wall= .358 in.
Insul Thk= .000 in.

From 3630 To 3640 DY= .073 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

DOUBLE FLANGED BEND at "TO" end

Radius= .875 in. (user) Bend Angle= 90.000 Angle/Node @1= 45.00 3639

From 3640 To 3670 DZ= .432 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

SIF's & TEE's

Node 3670 Socket (As welded)

From 3670 To 3680 DZ= .078 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 4.00 lb.

From 3680 To 8030 DZ= .068 ft.

RIGID Weight= 4.00 lb.

From 310 To 3720 DY= .412 ft.

Dia= .840 in. Wall= .147 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

Insul Thk= .000 in.

SIF's & TEE's

Node 310 Welding Tee

From 3720 To 3730 DY= .179 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

RIGID Weight= .50 lb.

SIF's & TEE's

Node 3730 Socket (As welded)

From 3730 To 3760 DY= .302 ft.

From 3760 To 3770 DY= .120 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RIGID Weight= 1.31 lb.

SIF's & TEE's

Node 3770 Socket (As welded)

From 3770 To 3820 DY= 1.159 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

BEND at "TO" end

Radius= 1.500 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 3819
Angle/Node @2= .00 3818

From 3820 To 3827 DX= 4.000 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RESTRAINTS

Node 3827 +Y

From 3827 To 3830 DX= 1.160 ft.

From 3830 To 3840 DX= .120 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 1.31 lb.

SIF's & TEE's

Node 3840 Socket (As welded)

From 3840 To 3890 DX= .417 ft.

BEND at "TO" end

Radius= 1.500 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 3871
Angle/Node @2= .00 3868

From 3890 To 3900 DZ= -2.097 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

PIPE DATA

From 3900 To 3910 DZ= -.073 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

DOUBLE FLANGED BEND at "TO" end

Radius= .875 in. (user) Bend Angle= 90.000 Angle/Node @1= 45.00 3909

From 3910 To 3940 DY= -.615 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 3940 To 3950 DY= -.120 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 1.31 lb.

SIF's & TEE's

Node 3950 Socket (As welded)

From 3950 To 3970 DY= -.344 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 3970 To 3980 DY= -.233 ft.

RIGID Weight= 1.40 lb.

SIF's & TEE's

Node 3980 Socket (As welded)

From 3980 To 3990 DY= -.344 ft.

From 3990 To 4000 DY= -.073 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

DOUBLE FLANGED BEND at "TO" end

Radius= .875 in. (user) Bend Angle= 90.000 Angle/Node @1= 45.00 3999

From 4000 To 4030 DX= -.417 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

From 4030 To 4040 DX= -.057 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 3.00 lb.

RESTRAINTS

Node 4040 ANC

From 140 To 4070 DY= .412 ft.

Dia= .840 in. Wall= .147 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

Insul Thk= .000 in.

SIF's & TEE's

Node 140 Welding Tee

From 4070 To 4080 DY= .179 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= .50 lb.

SIF's & TEE's

Node 4080 Socket (As welded)

From 4080 To 4110 DY= .302 ft.

From 4110 To 4120 DY= .120 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RIGID Weight= 1.31 lb.

SIF's & TEE's

Node 4120 Socket (As welded)

From 4120 To 4140 DY= 1.336 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 4140 To 4150 DY= .073 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

DOUBLE FLANGED BEND at "TO" end

Radius= .875 in. (user) Bend Angle= 90.000 Angle/Node @1= 45.00 4149

From 4150 To 4190 DX= 3.833 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 4190 To 4200 DX= .120 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

PIPE DATA

Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 1.31 lb.

SIF's & TEE's

Node 4200 Socket (As welded)

From 4200 To 4220 DX= .344 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 4220 To 4230 DX= .073 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

DOUBLE FLANGED BEND at "TO" end

Radius= .875 in. (user) Bend Angle= 90.000 Angle/Node @1= 45.00 4229

From 4230 To 4260 DZ= -1.685 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 4260 To 4270 DZ= -.073 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

DOUBLE FLANGED BEND at "TO" end

Radius= .875 in. (user) Bend Angle= 90.000 Angle/Node @1= 45.00 4269

From 4270 To 4300 DY= -.453 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 4300 To 4310 DY= -.120 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 1.31 lb.

SIF's & TEE's

Node 4310 Socket (As welded)

From 4310 To 4330 DY= -.344 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 4330 To 4340 DY= -.233 ft.

RIGID Weight= 1.40 lb.

SIF's & TEE's

Node 4340 Socket (As welded)

From 4340 To 4350 DY= -.344 ft.

From 4350 To 4360 DY= -.073 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

DOUBLE FLANGED BEND at "TO" end

Radius= .875 in. (user) Bend Angle= 90.000 Angle/Node @1= 45.00 4359

From 4360 To 4400 DZ= -.490 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 3470 To 4580 DY= .417 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.
Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

From 4580 To 4590 DY= .120 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RIGID Weight= 1.31 lb.

From 4590 To 4610 DY= .594 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 4610 To 4620 DY= .073 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

DOUBLE FLANGED BEND at "TO" end

Radius= .875 in. (user) Bend Angle= 90.000 Angle/Node @1= 45.00 4619

From 4620 To 4650 DX= 1.921 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

PIPE DATA

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 4650 To 4660 DX= .073 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

DOUBLE FLANGED BEND at "TO" end

Radius= .875 in. (user) Bend Angle= 90.000 Angle/Node @1= 45.00 4659

From 4660 To 4690 DY= 1.177 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 4690 To 4700 DY= .078 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 4.00 lb.

From 4700 To 4710 DY= .999 ft.

RIGID Weight= 49.91 lb.

From 4710 To 4740 DY= .344 ft.

Dia= 1.315 in. Wall= .358 in.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

From 4740 To 4750 DY= .278 ft.

Dia= 1.315 in. Wall= .179 in.

Insul Thk= .000 in.

RIGID Weight= 8.29 lb.

From 4750 To 4780 DY= .349 ft.

Dia= 1.315 in. Wall= .358 in.

Insul Thk= .000 in.

From 4780 To 4790 DY= .073 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

DOUBLE FLANGED BEND at "TO" end

Radius= .875 in. (user) Bend Angle= 90.000 Angle/Node @1= 45.00 4789

From 4790 To 4820 DZ= .432 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

SIF's & TEE's

Node 4820 Socket (As welded)

From 4820 To 4830 DZ= .078 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 4.00 lb.

From 4830 To 4840 DZ= .068 ft.

RIGID Weight= 4.00 lb.

From 4850 To 4857 DX= -2.794 ft.

Dia= 2.375 in. Wall= .154 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RESTRAINTS

Node 4850 +Y
Node 4857 +Y

From 4857 To 4860 DX= -.833 ft.

From 4860 To 4870 DX= -.250 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

BEND at "TO" end

Radius= 3.000 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 4869

From 4870 To 4890 DZ= -1.654 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

From 4890 To 4900 DZ= -.219 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 6.00 lb.

From 4900 To 4910 DZ= -.375 ft.

Dia= 2.375 in. Wall= .154 in.

Insul Thk= .000 in.

RIGID Weight= 10.43 lb.

From 4910 To 4920 DY= -.344 ft.

Dia= 2.375 in. Wall= .154 in.

Insul Thk= .000 in.

RIGID Weight= 9.57 lb.

PIPE DATA

From 4920 To 4400 DY= -4.500 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

From 4400 To 4980 DY= -.417 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 4980 To 4990 DY= -.073 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

DOUBLE FLANGED BEND at "TO" end

Radius= .875 in. (user) Bend Angle= 90.000 Angle/Node @1= 45.00 4989

From 4990 To 5020 DX= .373 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 5020 To 5030 DX= .057 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 3.00 lb.

RESTRAINTS

Node 5030 ANC

From 5040 To 5050 DZ= -.014 ft.

Dia= 3.500 in. Wall= .216 in.

Insul Thk= .000 in.

RIGID Weight= 8.00 lb.

RESTRAINTS

Node 5040 ANC

From 5050 To 5060 DZ= -.667 ft.

Dia= 3.500 in. Wall= .300 in.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

SIF's & TEE's

Node 5060 Threaded Joint

From 5060 To 5070 DZ= -.093 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RIGID Weight= 1.31 lb.

SIF's & TEE's

Node 5070 Threaded Joint

From 5070 To 5080 DZ= -.782 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

SIF's & TEE's

Node 5080 Threaded Joint

From 5080 To 5090 DZ= -.091 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

DOUBLE FLANGED BEND at "TO" end

Radius= 1.089 in. (user) Bend Angle= 90.000 Angle/Node @1= 45.00 5089

From 5090 To 5110 DX= -1.161 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

SIF's & TEE's

Node 5110 Threaded Joint

From 5110 To 5120 DX= -.091 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

DOUBLE FLANGED BEND at "TO" end

Radius= 1.089 in. (user) Bend Angle= 90.000 Angle/Node @1= 45.00 5119

From 5120 To 5140 DZ= -.591 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

SIF's & TEE's

Node 5140 Threaded Joint

From 5140 To 5150 DZ= -.093 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 1.31 lb.

SIF's & TEE's

Node 5150 Threaded Joint

PIPE DATA

From 5150 To 5155 DZ= -2.000 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RESTRAINTS

Node 5155 +Y

From 5155 To 5157 DZ= -3.333 ft.

RESTRAINTS

Node 5157 +Y

From 5157 To 5160 DZ= -2.855 ft.

SIF's & TEE's

Node 5160 Threaded Joint

From 5160 To 5170 DZ= -.091 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

DOUBLE FLANGED BEND at "TO" end

Radius= 1.089 in. (user) Bend Angle= 90.000 Angle/Node @1= 45.00 5169

From 5170 To 5190 DY= .265 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

SIF's & TEE's

Node 5190 Threaded Joint

From 5190 To 5200 DY= .091 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.
DOUBLE FLANGED BEND at "TO" end
Radius= 1.089 in. (user) Bend Angle= 90.000 Angle/Node @1= 45.00 5199

From 5200 To 5220 DX= 1.144 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

SIF's & TEE's

Node 5220 Threaded Joint

From 5220 To 5230 DX= .182 ft.

RIGID Weight= 1.40 lb.

SIF's & TEE's

Node 5230 Threaded Joint

From 5240 To 5250 DX= -.594 ft.

Dia= 2.375 in. Wall= .154 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Insul Thk= .000 in.

RIGID Weight= 150.00 lb.

From 5250 To 5260 DX= -.208 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 6.00 lb.

From 5260 To 5290 DX= -.557 ft.

Dia= 2.375 in. Wall= .218 in.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

From 5290 To 5300 DX= -.031 ft.

Dia= .840 in. Wall= .147 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RIGID Weight= 2.00 lb.

From 5300 To 410 DX= -1.326 ft.

RIGID Weight= 134.89 lb.

From 1010 To 5320 DY= 4.782 ft.

Dia= 2.375 in. Wall= .154 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

SIF's & TEE's

Node 1010 Welding Tee

From 5320 To 5340 DY= .547 ft.

Dia= 2.375 in. Wall= .218 in.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

From 5340 To 5350 DY= .026 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RIGID Weight= 2.00 lb.

From 5350 To 5360 DY= .344 ft.

Dia= 2.375 in. Wall= .154 in.

Insul Thk= .000 in.

RIGID Weight= 9.57 lb.

PIPE DATA

From 5360 To 5370 DX= -.375 ft.

Dia= 2.375 in. Wall= .154 in.

Insul Thk= .000 in.

RIGID Weight= 10.43 lb.

From 5370 To 5380 DX= -.219 ft.

Dia= 2.375 in. Wall= .218 in.

Insul Thk= .000 in.

RIGID Weight= 6.00 lb.

From 5380 To 1820 DX= -.405 ft.

Dia= 2.375 in. Wall= .154 in.

Insul Thk= .000 in.

SIF's & TEE's

Node 1820 Welding Tee

From 1640 To 5410 DY= .219 ft.

GENERAL

P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in. Mat= (321)A234

E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

SIF's & TEE's

Node 1640 Welding Tee

From 5410 To 5420 DY= .208 ft.

GENERAL

P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in. Mat= (103)A105

E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 6.00 lb.

From 5420 To 5440 DY= .219 ft.

GENERAL

P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
RIGID Weight= 6.00 lb.

From 5440 To 5450 DY= 3.689 ft.

GENERAL

P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in. Mat= (106)A106 B
E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 5450 To 5470 DY= .250 ft.

GENERAL

P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in. Mat= (321)A234
E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

BEND at "TO" end

Radius= 3.000 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 5459

From 5470 To 5480 DZ= -1.037 ft.

GENERAL

P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in. Mat= (106)A106 B
E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 5480 To 5485 DZ= -.500 ft.

GENERAL

P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
RESTRAINTS
Node 5485 +Y

From 5485 To 5500 DZ= -.495 ft.

GENERAL

P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

From 5500 To 5510 DZ= -.219 ft.

GENERAL

P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in. Mat= (321)A234
E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 5510 To 5520 DZ= -.219 ft.

GENERAL

P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in. Mat= (103)A105
E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 6.00 lb.

From 5520 To 8000 DZ= -.375 ft.

GENERAL

P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

RIGID Weight= 50.00 lb.

From 8000 To 1590 DY= -.417 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON
Sc= 23,300 lb./sq.in. Sh1= 23,300 lb./sq.in. Sh2= 22,000 lb./sq.in.
Sh3= 23,300 lb./sq.in. Sh4= 23,300 lb./sq.in. Sh5= 23,300 lb./sq.in.
Sh6= 23,300 lb./sq.in. Sh7= 23,300 lb./sq.in. Sh8= 23,300 lb./sq.in.
Sh9= 23,300 lb./sq.in. Sy= 36,000 lb./sq.in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.

RIGID Weight= 50.00 lb.

ALLOWABLE STRESSES

From 5530 To 5550 DY= .260 ft.

Dia= 2.375 in. Wall= .436 in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.
Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RESTRAINTS

Node 5530 ANC

From 5550 To 5560 DY= .260 ft.

Dia= 2.375 in. Wall= .154 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RIGID Weight= 12.00 lb.

From 5560 To 5570 DY= .271 ft.

RIGID Weight= 12.00 lb.

PIPE DATA

From 5570 To 5600 DY= .557 ft.

Dia= 2.375 in. Wall= .218 in.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

From 5600 To 5610 DY= .073 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

DOUBLE FLANGED BEND at "TO" end

Radius= .875 in. (user) Bend Angle= 90.000 Angle/Node @1= 45.00 5609

From 5610 To 5640 DX= -1.282 ft. DZ= .657 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 5640 To 5650 DX= -.066 ft. DZ= .032 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

DOUBLE FLANGED BEND at "TO" end

Radius= .875 in. (user) Bend Angle= 90.000 Angle/Node @1= 45.00 5649

From 5650 To 7490 DY= -1.100 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 1120 To 5720 DY= 4.750 ft.

Dia= 2.375 in. Wall= .154 in.

GENERAL

T2= 200 F P1= 680.0000 lb./sq.in. PHyd= 1,110.0000 lb./sq.in.
Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

From 5720 To 5740 DY= .547 ft.

Dia= 2.375 in. Wall= .218 in.

GENERAL

T2= 200 F P1= 680.0000 lb./sq.in. PHyd= 1,110.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

From 5740 To 5750 DY= .057 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RIGID Weight= 3.00 lb.

From 5760 To 5770 DZ= -.115 ft.

Dia= 2.375 in. Wall= .218 in.

GENERAL

P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.

Insul Thk= .000 in.

RIGID Weight= 10.00 lb.

From 5770 To 5780 DZ= -.260 ft.

GENERAL

P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.

RIGID Weight= 12.00 lb.

From 5780 To 23 DZ= -.682 ft.

Dia= 2.375 in. Wall= .154 in.

GENERAL

P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.

Insul Thk= .000 in.

From 1310 To 5860 DZ= -1.281 ft.

GENERAL

P1= 2,035.0000 lb./sq.in. PHyd= 3,330.0000 lb./sq.in. Mat= (106)A106 B

E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 125.00 lb.

From 5830 To 830 DX= .844 ft.

B31.3 (2012) Cycle Max Switch = --- App.P Sy/St Switch = ON

Sc= 20,000 lb./sq.in. Sh1= 20,000 lb./sq.in. Sh2= 20,000 lb./sq.in.

Sh3= 20,000 lb./sq.in. Sh4= 20,000 lb./sq.in. Sh5= 20,000 lb./sq.in.

Sh6= 20,000 lb./sq.in. Sh7= 20,000 lb./sq.in. Sh8= 20,000 lb./sq.in.

Sh9= 20,000 lb./sq.in. Sy= 35,000 lb./sq.in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

RIGID Weight= 150.00 lb.

ALLOWABLE STRESSES

From 2020 To 5860 DZ= 1.281 ft.

GENERAL

T2= 200 F P1= 2,035.0000 lb./sq.in. PHyd= 3,330.0000 lb./sq.in.
RIGID Weight= 125.00 lb.

From 1540 To 6190 DZ= .812 ft.

Dia= 2.375 in. Wall= .154 in.

GENERAL

P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in. Mat= (321)A234
E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

BEND at "TO" end

Radius= 3.000 in. (LONG) Bend Angle= 90.000 Angle/Node @1= 45.00 6189
Angle/Node @2= .00 6188

SIF's & TEE's

Node 1540 Welding Tee

From 6190 To 6200 DY= .260 ft.

GENERAL

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

PIPE DATA

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 6200 To 6210 DY= .271 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 12.00 lb.

From 2070 To 6420 DZ= .490 ft.

Dia= 1.050 in. Wall= .308 in.

GENERAL

T2= 200 F P1= 2,035.0000 lb./sq.in. PHyd= 3,330.0000 lb./sq.in.
Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

SIF's & TEE's

Node 2070 Welding Tee

From 6420 To 6430 DZ= .062 ft.

Dia= 1.050 in. Wall= .154 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

DOUBLE FLANGED BEND at "TO" end

Radius= .750 in. (user) Bend Angle= 90.000 Angle/Node @1= 45.00 6429

From 6430 To 6460 DY= .406 ft.

Dia= 1.050 in. Wall= .308 in.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

From 6460 To 6470 DY= .099 ft.

RIGID Weight= 6.00 lb.

From 6470 To 6480 DY= .109 ft.

RIGID Weight= 6.00 lb.

SIF's & TEE's

Node 6480 Socket (As welded)

From 6480 To 6490 DY= .260 ft.

From 6490 To 6500 DY= .198 ft.

RIGID Weight= 4.90 lb.

SIF's & TEE's

Node 6500 Socket (As welded)

From 1760 To 6520 DX= .405 ft.

Dia= 2.375 in. Wall= .154 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

From 6520 To 8500 DX= .219 ft.

RIGID Weight= 15.00 lb.

From 8500 To 8510 DX= .375 ft.

RIGID Weight= 25.00 lb.

From 8510 To 5750 DY= -.344 ft.

GENERAL

T2= 200 F P1= 680.0000 lb./sq.in. PHyd= 1,110.0000 lb./sq.in.

RIGID Weight= 15.00 lb.

From 1700 To 6540 DZ= -.219 ft.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

SIF's & TEE's

Node 1700 Welding Tee

From 6540 To 6550 DZ= -.406 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

From 6550 To 6560 DZ= -.240 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.
RIGID Weight= 9.00 lb.

From 6560 To 6780 DZ= -.484 ft.
RIGID Weight= 15.00 lb.

From 1940 To 6670 DY= .219 ft.
Dia= 2.375 in. Wall= .154 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

SIF's & TEE's

Node 1940 Welding Tee

From 6670 To 6680 DY= .219 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 6.00 lb.

From 6680 To 6690 DY= .208 ft.

RIGID Weight= 6.00 lb.

From 6690 To 6710 DY= 6.085 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

PIPE DATA

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 1360 To 6720 DY= .203 ft.

Dia= 1.900 in. Wall= .200 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

SIF's & TEE's

Node 1360 Welding Tee

From 6720 To 6730 DY= .234 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 8.00 lb.

From 6730 To 6740 DY= .028 ft.

Dia= 2.375 in. Wall= .154 in.

Insul Thk= .000 in.

RIGID Weight= 2.27 lb.

From 2150 To 6750 DY= .219 ft.

Dia= 2.375 in. Wall= .218 in.

GENERAL

T2= 200 F P1= 2,035.0000 lb./sq.in. PHyd= 3,330.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

SIF's & TEE's

Node 2150 Welding Tee

From 6750 To 6770 DY= .630 ft.

Dia= 2.375 in. Wall= .436 in.

GENERAL

T2= 200 F P1= 2,035.0000 lb./sq.in. PHyd= 3,330.0000 lb./sq.in.
Insul Thk= .000 in.

From 6770 To 6780 DY= .125 ft.

Dia= 1.900 in. Wall= .400 in.
Insul Thk= .000 in.
RIGID Weight= 7.00 lb.

From 990 To 6920 DY= .490 ft.

Dia= 1.050 in. Wall= .154 in.
GENERAL
T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

SIF's & TEE's
Node 990 Welding Tee

From 6920 To 6930 DY= .047 ft.

GENERAL
Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 3.00 lb.

From 6930 To 6940 DY= .057 ft.

RIGID Weight= 3.00 lb.
SIF's & TEE's
Node 6940 Socket (As welded)

From 6940 To 6960 DY= .308 ft.

GENERAL
Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 6960 To 6970 DY= .198 ft.

RIGID Weight= 4.90 lb.

From 880 To 7000 DY= .490 ft.

GENERAL
Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

SIF's & TEE's

Node 880 Welding Tee

From 7000 To 7010 DY= .047 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 3.00 lb.

From 7010 To 7020 DY= .057 ft.

RIGID Weight= 3.00 lb.

SIF's & TEE's

Node 7020 Socket (As welded)

From 7020 To 7040 DY= .260 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

From 7040 To 7050 DY= .198 ft.

RIGID Weight= 4.90 lb.

From 1100 To 7080 DY= .490 ft.

GENERAL

T2= 200 F P1= 680.0000 lb./sq.in. PHyd= 1,110.0000 lb./sq.in.
Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

SIF's & TEE's

Node 1100 Welding Tee

PIPE DATA

From 7080 To 7090 DY= .068 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 3.00 lb.

From 7090 To 7100 DY= .078 ft.

RIGID Weight= 3.00 lb.

SIF's & TEE's

Node 7100 Socket (As welded)

From 7100 To 7120 DY= .260 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

From 7120 To 7130 DY= .198 ft.

RIGID Weight= 4.90 lb.

From 330 To 7140 DY= .203 ft.

Dia= 1.900 in. Wall= .200 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

SIF's & TEE's

Node 330 Welding Tee

From 7140 To 7150 DY= .234 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.
RIGID Weight= 8.00 lb.

From 1790 To 7160 DY= .219 ft.
Dia= 2.375 in. Wall= .154 in.

GENERAL

T2= 140 F Mat= (321)A234 E= 29,500,000 lb./sq.in.
EH1= 29,896,666 lb./sq.in. EH2= 29,160,000 lb./sq.in.
EH3= 29,500,000 lb./sq.in. EH4= 29,500,000 lb./sq.in.
EH5= 29,500,000 lb./sq.in. EH6= 29,500,000 lb./sq.in.
EH7= 29,500,000 lb./sq.in. EH8= 29,500,000 lb./sq.in.
EH9= 29,500,000 lb./sq.in. v = .292 Pipe Den= .2830000 lb./cu.in.
Insul Thk= .000 in.

SIF's & TEE's

Node 1790 Welding Tee

From 7160 To 7170 DY= .427 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 12.00 lb.

From 2210 To 7180 DZ= -.203 ft.

Dia= 1.900 in. Wall= .400 in.

GENERAL

T2= 200 F P1= 2,035.0000 lb./sq.in. PHyd= 3,330.0000 lb./sq.in.
Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

SIF's & TEE's

Node 2210 Welding Tee

From 7180 To 7190 DZ= -.302 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.
RIGID Weight= 14.00 lb.

From 7190 To 7200 DZ= -.125 ft.
RIGID Weight= 14.00 lb.

From 5480 To 7230 DY= .510 ft.
Dia= 1.315 in. Wall= .179 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Insul Thk= .000 in.

SIF's & TEE's

Node 5480 Welding Tee

From 7230 To 7240 DY= .500 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 12.50 lb.

From 2300 To 7440 DY= 2.091 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.
Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

From 7440 To 7450 DY= .120 ft.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 1.31 lb.

SIF's & TEE's

Node 7450 Socket (As welded)

From 7450 To 7480 DY= .344 ft.

Dia= 1.315 in. Wall= .358 in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

PIPE DATA

From 7480 To 7490 DY= .278 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.

Insul Thk= .000 in.

RIGID Weight= 8.29 lb.

SIF's & TEE's

Node 7490 Socket (As welded)

From 1170 To 7530 DY= -.490 ft.

Dia= 1.050 in. Wall= .154 in.

GENERAL

P1= 680.0000 lb./sq.in. PHyd= 1,110.0000 lb./sq.in. Mat= (103)A105

E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

SIF's & TEE's

Node 1170 Welding Tee

From 7530 To 7540 DY= -.198 ft.

Dia= 1.050 in. Wall= .154 in.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RIGID Weight= 4.90 lb.

SIF's & TEE's

Node 7540 Socket (As welded)

From 7870 To 7580 DY= .073 ft.

Dia= 2.375 in. Wall= .154 in.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.

Insul Thk= .000 in.

RIGID Weight= 15.00 lb.

From 7580 To 7590 DY= .073 ft.

GENERAL

P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.

RIGID Weight= 15.00 lb.

From 7600 To 5500 DY= .219 ft.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.

Mat= (321)A234 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

SIF's & TEE's

Node 5500 Welding Tee

From 7930 To 7600 DY= .271 ft.

GENERAL

T2= 200 F P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.

EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.

EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.

EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292

Pipe Den= .2830000 lb./cu.in.

RIGID Weight= 12.00 lb.

From 2440 To 7620 DY= -.073 ft.

Dia= 1.050 in. Wall= .154 in.

Insul Thk= .000 in.

From 7620 To 7630 DY= -.005 ft.

From 7630 To 7640 DY= -.250 ft.

Dia= 1.050 in. Wall= .308 in.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.

EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

From 7640 To 7650 DY= -.005 ft.
Dia= 1.050 in. Wall= .154 in.
Insul Thk= .000 in.

SIF's & TEE's

Node 7650 Socket (As welded)

From 7650 To 7660 DY= -.198 ft.
RIGID Weight= 4.90 lb.

SIF's & TEE's

Node 7660 Socket (As welded)

From 7150 To 7700 DY= .028 ft.
Dia= 2.375 in. Wall= .154 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RIGID Weight= 2.27 lb.

From 5860 To 7710 DY= -.594 ft.
Dia= 1.050 in. Wall= .308 in.

GENERAL

T2= 200 F P1= 2,035.0000 lb./sq.in. PHyd= 3,330.0000 lb./sq.in.
Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

SIF's & TEE's

Node 7710 Socket (As welded)

From 7710 To 7720 DY= -.281 ft.
RIGID Weight= 15.20 lb.

SIF's & TEE's

Node 7720 Socket (As welded)

From 1410 To 7750 DY= -.422 ft.

Dia= 1.050 in. Wall= .308 in.

GENERAL

P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.

Insul Thk= .000 in.

From 7750 To 7760 DY= -.005 ft.

Dia= 1.050 in. Wall= .154 in.

Insul Thk= .000 in.

SIF's & TEE's

Node 7760 Socket (As welded)

From 7760 To 7770 DY= -.198 ft.

RIGID Weight= 4.90 lb.

SIF's & TEE's

Node 7770 Socket (As welded)

From 460 To 7790 DY= -.422 ft.

Dia= 1.050 in. Wall= .308 in.

GENERAL

P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.

Insul Thk= .000 in.

SIF's & TEE's

Node 460 Welding Tee

PIPE DATA

From 7790 To 7800 DY= -.198 ft.

Dia= 1.050 in. Wall= .154 in.

Insul Thk= .000 in.

RIGID Weight= 4.90 lb.

SIF's & TEE's

Node 7800 Socket (As welded)

From 6210 To 7870 DY= .958 ft.

Dia= 2.375 in. Wall= .154 in.

GENERAL

P1= 1,360.0000 lb./sq.in. PHyd= 2,220.0000 lb./sq.in.

Insul Thk= .000 in.

RIGID Weight= 150.00 lb.

From 7590 To 7900 DY= .958 ft.

RIGID Weight= 150.00 lb.

From 7900 To 7930 DY= .958 ft.

RIGID Weight= 150.00 lb.

From 2490 To 7970 DY= .083 ft.

Dia= .840 in. Wall= .147 in.

GENERAL

Mat= (103)A105 E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 28,800,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

From 7980 To 5230 DX= -.333 ft.

Dia= 1.315 in. Wall= .179 in.

GENERAL

T2= 140 F P1= 260.0000 lb./sq.in. PHyd= 413.0000 lb./sq.in.
Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in. Insul Thk= .000 in.

RESTRAINTS

Node 7980 ANC

From 235 To 8030 DZ= -.791 ft.

GENERAL

Mat= (106)A106 B E= 29,500,000 lb./sq.in. EH1= 29,896,666 lb./sq.in.
EH2= 29,160,000 lb./sq.in. EH3= 29,500,000 lb./sq.in.
EH4= 29,500,000 lb./sq.in. EH5= 29,500,000 lb./sq.in.
EH6= 29,500,000 lb./sq.in. EH7= 29,500,000 lb./sq.in.
EH8= 29,500,000 lb./sq.in. EH9= 29,500,000 lb./sq.in. v = .292
Pipe Den= .2830000 lb./cu.in.

SIF's & TEE's

Node 235 Welding Tee

From 31 To 8050 DZ= -.786 ft.

RESTRAINTS

NODE	TYPE	CNODE	Len		MU		Dir	Force	Vectors
			GAP	YIELD	STIF1	STIF2			
80	ANC				.000	.000	.000		
190	+Y				.000	1.000	.000		
220	ANC				.000	.000	.000		
420	ANC				.000	.000	.000		
435	+Y				.000	1.000	.000		
515	Guide		3.00		.000	.000	.000		
515	+Y				.000	1.000	.000		

610	Guide	3.00	.000	.000	.000
610	Y		.000	1.000	.000
615	Guide	3.00	.000	.000	.000
615	Y		.000	1.000	.000
695	Guide	3.00	.000	.000	.000
695	Y		.000	1.000	.000
820	ANC		.000	.000	.000
860	+Y		.000	1.000	.000
1090	+Y		.000	1.000	.000
1195	+Y		.000	1.000	.000
1300	+Y		.000	1.000	.000
1645	+Y		.000	1.000	.000
1705	+Y		.000	1.000	.000
1775	+Y		.000	1.000	.000
1835	+Y		.000	1.000	.000
2050	+Y		.000	1.000	.000
2125	+Y		.000	1.000	.000
2250	ANC		.000	.000	.000
2415	+Y		.000	1.000	.000
2545	+Y		.000	1.000	.000
2845	+Y		.000	1.000	.000
3145	Guide	3.00	.000	.000	.000
3145	+Y		.000	1.000	.000
3475	+Y		.000	1.000	.000
3827	+Y		.000	1.000	.000
4040	ANC		.000	.000	.000
4850	+Y		.000	1.000	.000
4857	+Y		.000	1.000	.000
5030	ANC		.000	.000	.000
5040	ANC		.000	.000	.000
5155	+Y		.000	1.000	.000
5157	+Y		.000	1.000	.000
5485	+Y		.000	1.000	.000
5530	ANC	3.00	.000	.000	.000
7980	ANC		.000	.000	.000

INPUT UNITS USED...

UNITS= ENGLISH NOM/SCH INPUT= ON

LENGTH inches x 1.000 = in.
 FORCE pounds x 1.000 = lb.
 MASS(dynamics) pounds x 1.000 = lbm
 MOMENTS(INPUT) inch-pounds x 1.000 = in.lb.
 MOMENTS(OUTPUT) inch-pounds x 0.083 = ft.lb.
 STRESS lbs./sq.in. x 1.000 = lb./sq.in.
 TEMP. SCALE degrees F. x 1.000 = F
 PRESSURE psig x 1.000 = lb./sq.in.

ELASTIC MODULUS lbs./sq.in. x 1.000 = lb./sq.in.
 PIPE DENSITY lbs./cu.in. x 1.000 = lb./cu.in.
 INSULATION DENS. lbs./cu.in. x 1.000 = lb./cu.in.
 FLUID DENSITY lbs./cu.in. x 1.000 = lb./cu.in.
 TRANSL. STIF lbs./in. x 1.000 = lb./in.
 ROTATIONAL STIF in.lb./deg. x 1.000 = in.lb./deg
 UNIFORM LOAD lb./in. x 1.000 = lb./in.
 G LOAD g's x 1.000 = g's
 WIND LOAD lbs./sq.in. x 144.000 = lb./sq.ft.
 ELEVATION inches x 0.083 = ft.
 COMPOUND LENGTH inches x 0.083 = ft.
 DIAMETER inches x 1.000 = in.
 WALL THICKNESS inches x 1.000 = in.

EXECUTION CONTROL PARAMETERS

Rigid/ExpJt Print Flag 1.000
 Bourdon Option000
 Loop Closure Flag 2.000
 Thermal Bowing Delta Temp .. .000 F
 Liberal Allowable Flag 1.000
 Uniform Load Option000

 Ambient Temperature 70.000 F
 Plastic (FRP) Alpha 12.000
 Plastic (FRP) G_{MOD}/E_{MODa}250
 Plastic (FRP) Laminate Type. 3.000
 Eqn Optimizer000
 Node Selection000
 Eqn Ordering000
 Collins000
 Degree Determination000
 User Eqn Control000

CAESAR II 2014 Ver.7.00.01.1600, (Build 141003) Date: SEP 28, 2015 Time: 22:53

Job Name: 338716-FINAL

Licensed To: ENS CANADA STRUCTURAL ENGG & PROJECT MGMT INC

STRESS SUMMARY REPORT: Highest Stresses Mini Statement

Various Load Cases

LOAD CASE DEFINITION KEY

CASE 1 (HYD) WW+HP

CASE 2 (OPE) W+T1+P1

CASE 3 (OPE) W+T2+P1

CASE 4 (SUS) W+P1

CASE 5 (EXP) L5=L2-L4

CASE 6 (EXP) L6=L3-L4

CASE 7 (EXP) L7=L2-L3

Piping Code: B31.3 = B31.3 -2012, Jan 10, 2013

CODE STRESS CHECK PASSED : LOADCASE 1 (HYD) WW+HP

Highest Stresses: (lb./sq.in.) LOADCASE 1 (HYD) WW+HP

Ratio (%): 63.0 @Node 3470
Code Stress: 22666.3 Allowable Stress: 36000.0
Axial Stress: 13190.4 @Node 60
Bending Stress: 20301.6 @Node 3470
Torsion Stress: 4267.3 @Node 2545
Hoop Stress: 27512.1 @Node 30
Max Stress Intensity: 30885.2 @Node 30

NO CODE STRESS CHECK PROCESSED: LOADCASE 2 (OPE) W+T1+P1

Highest Stresses: (lb./sq.in.) LOADCASE 2 (OPE) W+T1+P1

Ratio (%): 0.0 @Node 3470
OPE Stress: 21353.2 Allowable Stress: 0.0
Axial Stress: 8069.8 @Node 60
Bending Stress: 19953.6 @Node 3470
Torsion Stress: 4175.4 @Node 2545
Hoop Stress: 16854.3 @Node 30
Max Stress Intensity: 21353.2 @Node 3470

NO CODE STRESS CHECK PROCESSED: LOADCASE 3 (OPE) W+T2+P1

Highest Stresses: (lb./sq.in.) LOADCASE 3 (OPE) W+T2+P1

Ratio (%): 0.0 @Node 30
OPE Stress: 26067.8 Allowable Stress: 0.0

Axial Stress: 8069.8 @Node 60
Bending Stress: 21520.6 @Node 30
Torsion Stress: 4175.4 @Node 2545
Hoop Stress: 16854.3 @Node 30
Max Stress Intensity: 26046.8 @Node 30

CODE STRESS CHECK PASSED : LOADCASE 4 (SUS) W+P1

Highest Stresses: (lb./sq.in.) LOADCASE 4 (SUS) W+P1
Ratio (%): 97.1 @Node 3470
Code Stress: 21353.2 Allowable Stress: 22000.0
Axial Stress: 8069.8 @Node 60
Bending Stress: 19953.6 @Node 3470
Torsion Stress: 4175.4 @Node 2545
Hoop Stress: 16854.3 @Node 30
Max Stress Intensity: 21353.2 @Node 3470

CODE STRESS CHECK PASSED : LOADCASE 5 (EXP) L5=L2-L4

Highest Stresses: (lb./sq.in.) LOADCASE 5 (EXP) L5=L2-L4
Ratio (%): 34.2 @Node 50
Code Stress: 14387.9 Allowable Stress: 42097.5
Axial Stress: 232.3 @Node 540
Bending Stress: 14281.1 @Node 50
Torsion Stress: 1224.1 @Node 1439
Hoop Stress: 0.0 @Node 30
Max Stress Intensity: 14304.1 @Node 50

CODE STRESS CHECK PASSED : LOADCASE 6 (EXP) L6=L3-L4

Highest Stresses: (lb./sq.in.) LOADCASE 6 (EXP) L6=L3-L4
Ratio (%): 38.0 @Node 50
Code Stress: 15976.6 Allowable Stress: 42097.5
Axial Stress: 302.0 @Node 1540
Bending Stress: 15850.7 @Node 50
Torsion Stress: 1583.9 @Node 2280
Hoop Stress: 0.0 @Node 30
Max Stress Intensity: 15878.1 @Node 50

CODE STRESS CHECK PASSED : LOADCASE 7 (EXP) L7=L2-L3

Highest Stresses: (lb./sq.in.) LOADCASE 7 (EXP) L7=L2-L3
Ratio (%): 72.1 @Node 50
Code Stress: 30362.8 Allowable Stress: 42097.5
Axial Stress: 514.4 @Node 540
Bending Stress: 30130.0 @Node 50
Torsion Stress: 2702.2 @Node 1439

Hoop Stress: 0.0 @Node 30
Max Stress Intensity: 30180.4 @Node 50

Job Name: 338716-FINAL

Licensed To: ENS CANADA STRUCTURAL ENGG & PROJECT MGMT INC

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints

Various Load Cases

Node	Load Case	FX lb.	FY lb.	FZ lb.	MX ft.lb.	MY ft.lb.	MZ ft.lb.	DX in.	DY in.	DZ in.
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LOAD CASE DEFINITION KEY

CASE 1 (HYD) WW+HP

CASE 2 (OPE) W+T1+P1

CASE 3 (OPE) W+T2+P1

CASE 4 (SUS) W+P1

CASE 5 (EXP) L5=L2-L4

CASE 6 (EXP) L6=L3-L4

CASE 7 (EXP) L7=L2-L3

80	Rigid ANC									
1(HYD)	1	-1612	-21	-90.6	-58.8	491.4	0	0	0	
2(OPE)	53	-1014	-202	-906.5	-249.8	507.7	0	0	0	
3(OPE)	-58	-1811	189	799.5	161.8	576.5	0	0	0	
4(SUS)	1	-1350	-20	-100.6	-55.7	466	0	0	0	
5(EXP)	52	336	-181	-805.9	-194.1	41.7	0	0	0	
6(EXP)	-59	-460	209	900.1	217.5	110.5	0	0	0	
7(EXP)	111	797	-390	-1706	-411.6	-68.7	0	0	0	
MAX	111/L7	-1811/L3	-390/L7	-1706.0/L	-411.6/L7	576.5/L3	0.0000/L	-0.0000/L	-0.0000/L7	
190	Rigid +Y									
1(HYD)	0	-385	0	0	0	0	-0.0009	0	0	
2(OPE)	0	-331	0	0	0	0	-0.0016	0	-0.0164	
3(OPE)	0	-401	0	0	0	0	0	0	0.0104	
4(SUS)	0	-374	0	0	0	0	-0.0008	0	0	
5(EXP)	0	43	0	0	0	0	-0.0008	0	-0.0164	
6(EXP)	0	-27	0	0	0	0	0.0008	0	0.0104	
7(EXP)	0	70	0	0	0	0	-0.0016	0	-0.0268	
MAX		-401/L3					-0.0016/L	-0.0000/L	-0.0268/L7	
220	Rigid ANC									
1(HYD)	-10	56	-2	-48.4	-14.7	-132.7	0	0	0	
2(OPE)	6	32	-1	-29.6	-6.7	-118.9	0	0	0	
3(OPE)	-19	69	-2	-58.1	-14.7	-136.2	0	0	0	
4(SUS)	-9	55	-1	-47.1	-13	-129.5	0	0	0	
5(EXP)	15	-23	1	17.6	6.3	10.7	0	0	0	
6(EXP)	-10	14	-1	-10.9	-1.7	-6.7	0	0	0	
7(EXP)	25	-37	1	28.5	7.9	17.3	0	0	0	
MAX	25/L7	69/L3	-2/L3	-58.1/L3	-14.7/L1	-136.2/L3	0.0000/L	0.0000/L	-0.0000/L3	
420	Rigid ANC									
1(HYD)	7	84	25	-87	22.5	13.8	0	0	0	
2(OPE)	42	102	206	-102.3	101.7	19	0	0	0	
3(OPE)	-32	64	-184	-68.2	-68.9	6.1	0	0	0	
4(SUS)	7	84	24	-86	21.9	13.7	0	0	0	
5(EXP)	35	18	182	-16.3	79.8	5.3	0	0	0	
6(EXP)	-40	-20	-208	17.8	-90.8	-7.7	0	0	0	

7(EXP)	74	38	389	-34.1	170.6	12.9	0	0	0
MAX	74/L7	102/L2	389/L7	-102.3/L2	170.6/L7	19.0/L2	0.0000/L7	0.0000/L7	0.0000/L7
435	Rigid +Y								
1(HYD)	0	-321	0	0	0	0	0.0028	0	0
2(OPE)	0	-335	0	0	0	0	0.0112	0	-0.0186
3(OPE)	0	-288	0	0	0	0	-0.007	0	0.0224
4(SUS)	0	-312	0	0	0	0	0.0027	0	0
5(EXP)	0	-24	0	0	0	0	0.0085	0	-0.0186
6(EXP)	0	24	0	0	0	0	-0.0097	0	0.0223
7(EXP)	0	-48	0	0	0	0	0.0182	0	-0.0409
MAX		-335/L2					0.0182/L7	-0.0000/L7	-0.0409/L7
515	Rigid GUI w/gap; Rigid +Y								
1(HYD)	0	-407	0	0	0	0	0.0161	0	0
2(OPE)	0	-82	0	0	0	0	0.0285	0	-0.0824
3(OPE)	0	-767	0	0	0	0	-0.0016	0	0.0991
4(SUS)	0	-390	0	0	0	0	0.0155	0	0
5(EXP)	0	308	0	0	0	0	0.013	0	-0.0824
6(EXP)	0	-377	0	0	0	0	-0.0171	0	0.099
7(EXP)	0	685	0	0	0	0	0.03	0	-0.1814
MAX		-767/L3					0.0300/L7	-0.0000/L7	-0.1814/L7
610	Rigid GUI w/gap; Rigid Y								
1(HYD)	0	3	0	0	0	0	-0.0042	0	0.0207
2(OPE)	0	-290	0	0	0	0	0.0967	0	-0.1651
3(OPE)	0	360	0	0	0	0	-0.1247	0	0.2389
4(SUS)	0	5	0	0	0	0	-0.0035	0	0.0193
5(EXP)	0	-295	0	0	0	0	0.1002	0	-0.1844
6(EXP)	0	356	0	0	0	0	-0.1211	0	0.2196
7(EXP)	0	-650	0	0	0	0	0.2213	0	-0.404
MAX		-650/L7					0.2213/L7	-0.0000/L7	-0.4040/L7
615	Rigid GUI w/gap; Rigid Y								
1(HYD)	0	-58	0	0	0	0	-0.0042	0	0.0029
2(OPE)	0	6	0	0	0	0	0.0718	0	-0.1128
3(OPE)	0	-102	0	0	0	0	-0.0948	0	0.14
4(SUS)	0	-46	0	0	0	0	-0.0035	0	0.0033
5(EXP)	0	52	0	0	0	0	0.0754	0	-0.1161
6(EXP)	0	-56	0	0	0	0	-0.0913	0	0.1367
7(EXP)	0	108	0	0	0	0	0.1667	0	-0.2528
MAX		108/L7					0.1667/L7	0.0000/L7	-0.2528/L7
695	Rigid GUI w/gap; Rigid Y								
1(HYD)	0	-77	0	0	0	0	-0.0042	0	-0.008
2(OPE)	0	-109	0	0	0	0	-0.0189	0	-0.0354
3(OPE)	0	0	0	0	0	0	0.0142	0	0.0277
4(SUS)	0	-62	0	0	0	0	-0.0035	0	-0.0065
5(EXP)	0	-47	0	0	0	0	-0.0153	0	-0.0289
6(EXP)	0	62	0	0	0	0	0.0177	0	0.0342
7(EXP)	0	-109	0	0	0	0	-0.033	0	-0.0631
MAX		-109/L7					-0.0330/L7	-0.0000/L7	-0.0631/L7
820	Rigid ANC								
1(HYD)	-5	-27	-3	-11.4	-7.2	12.2	0	0	0
2(OPE)	-80	31	2	-26.5	-43	163.8	0	0	0

3(OPE)	84	-100	-9	14.6	35.7	-172.1	0	0	0
4(SUS)	-5	-27	-2	-8.4	-6.4	10.2	0	0	0
5(EXP)	-75	58	5	-18.1	-36.6	153.5	0	0	0
6(EXP)	89	-73	-6	23	42.1	-182.3	0	0	0
7(EXP)	-164	131	11	-41.1	-78.7	335.8	0	0	0
MAX	-164/L7	131/L7	11/L7	-41.1/L7	-78.7/L7	335.8/L7	-0.0000/L	0.0000/L	0.0000/L7
860	Rigid +Y								
1(HYD)	0	-255	0	0	0	0	-0.0021	0	0.0043
2(OPE)	0	-110	0	0	0	0	-0.0969	0	0.0872
3(OPE)	0	-332	0	0	0	0	0.0591	0	-0.0648
4(SUS)	0	-238	0	0	0	0	-0.0018	0	0.0027
5(EXP)	0	128	0	0	0	0	-0.0951	0	0.0845
6(EXP)	0	-94	0	0	0	0	0.0609	0	-0.0675
7(EXP)	0	222	0	0	0	0	-0.156	0	0.152
MAX		-332/L3					-0.1560/L	-0.0000/L	0.1520/L7
1090	Rigid +Y								
1(HYD)	0	-295	0	0	0	0	0.012	0	0.0373
2(OPE)	0	-191	0	0	0	0	-0.0601	0	0.0765
3(OPE)	0	-342	0	0	0	0	0.0718	0	0.0038
4(SUS)	0	-286	0	0	0	0	0.0161	0	0.0351
5(EXP)	0	96	0	0	0	0	-0.0762	0	0.0414
6(EXP)	0	-56	0	0	0	0	0.0557	0	-0.0313
7(EXP)	0	152	0	0	0	0	-0.1319	0	0.0727
MAX		-342/L3					-0.1319/L	-0.0000/L	0.0765/L2
1195	Rigid +Y								
1(HYD)	0	-45	0	0	0	0	-0.0124	0	0.0176
2(OPE)	0	0	0	0	0	0	-0.0544	0.0139	0.0389
3(OPE)	0	-62	0	0	0	0	0.0221	0	0.0122
4(SUS)	0	-33	0	0	0	0	-0.0073	0	0.0163
5(EXP)	0	33	0	0	0	0	-0.0471	0.0139	0.0226
6(EXP)	0	-29	0	0	0	0	0.0294	0	-0.0041
7(EXP)	0	62	0	0	0	0	-0.0765	0.0139	0.0267
MAX		-62/L3					-0.0765/L	0.0139/L	0.0389/L2
1300	Rigid +Y								
1(HYD)	0	-354	0	0	0	0	0.0069	0	-0.004
2(OPE)	0	-343	0	0	0	0	-0.0121	0	0.0365
3(OPE)	0	-348	0	0	0	0	0.0073	0	-0.0257
4(SUS)	0	-353	0	0	0	0	0.0101	0	-0.0039
5(EXP)	0	11	0	0	0	0	-0.0222	0	0.0404
6(EXP)	0	5	0	0	0	0	-0.0028	0	-0.0218
7(EXP)	0	5	0	0	0	0	-0.0194	0	0.0622
MAX		-354/L1					-0.0222/L	-0.0000/L	0.0622/L7
1645	Rigid +Y								
1(HYD)	0	-21	0	0	0	0	-0.0159	0	-0.0405
2(OPE)	0	0	0	0	0	0	0.0898	0.1374	-0.1895
3(OPE)	0	-175	0	0	0	0	-0.0679	0	0.1403
4(SUS)	0	-5	0	0	0	0	-0.0141	0	-0.0381
5(EXP)	0	5	0	0	0	0	0.1039	0.1374	-0.1514
6(EXP)	0	-170	0	0	0	0	-0.0538	0	0.1784
7(EXP)	0	175	0	0	0	0	0.1577	0.1374	-0.3298
MAX		-175/L3					0.1577/L	0.1374/L	-0.3298/L7

1705	Rigid +Y									
1(HYD)	0	-25	0	0	0	0	-0.0159	0	0.0204	
2(OPE)	0	-69	0	0	0	0	-0.0037	0	0.0053	
3(OPE)	0	0	0	0	0	0	-0.0088	0.0355	0.0078	
4(SUS)	0	-17	0	0	0	0	-0.0141	0	0.0178	
5(EXP)	0	-52	0	0	0	0	0.0104	0	-0.0125	
6(EXP)	0	17	0	0	0	0	0.0053	0.0355	-0.01	
7(EXP)	0	-69	0	0	0	0	0.0051	-0.0355	-0.0025	
MAX		-69/L2					-0.0159/L	0.0355/L	0.0204/L1	
1775	Rigid +Y									
1(HYD)	0	-18	0	0	0	0	0.0021	0	0.0259	
2(OPE)	0	-138	0	0	0	0	0.0024	0	0.0306	
3(OPE)	0	0	0	0	0	0	0.0042	0.0236	-0.0039	
4(SUS)	0	-9	0	0	0	0	0.0014	0	0.0226	
5(EXP)	0	-128	0	0	0	0	0.0009	0	0.008	
6(EXP)	0	9	0	0	0	0	0.0027	0.0236	-0.0266	
7(EXP)	0	-138	0	0	0	0	-0.0018	-0.0236	0.0345	
MAX		-138/L2					0.0042/L	0.0236/L	0.0345/L7	
1835	Rigid +Y									
1(HYD)	0	-238	0	0	0	0	0.0165	0	0.0259	
2(OPE)	0	-238	0	0	0	0	0.0154	0	0.0535	
3(OPE)	0	-116	0	0	0	0	0.009	0	-0.0184	
4(SUS)	0	-215	0	0	0	0	0.0136	0	0.0226	
5(EXP)	0	-23	0	0	0	0	0.0017	0	0.0309	
6(EXP)	0	99	0	0	0	0	-0.0046	0	-0.041	
7(EXP)	0	-122	0	0	0	0	0.0064	0	0.0719	
MAX		-238/L1					0.0165/L	-0.0000/L	0.0719/L7	
2050	Rigid +Y									
1(HYD)	0	-176	0	0	0	0	0.0399	0	-0.0038	
2(OPE)	0	-101	0	0	0	0	0.0364	0	0.0659	
3(OPE)	0	-223	0	0	0	0	0.0107	0	-0.0608	
4(SUS)	0	-169	0	0	0	0	0.0391	0	-0.0037	
5(EXP)	0	69	0	0	0	0	-0.0028	0	0.0696	
6(EXP)	0	-53	0	0	0	0	-0.0285	0	-0.0571	
7(EXP)	0	122	0	0	0	0	0.0257	0	0.1267	
MAX		-223/L3					0.0399/L	-0.0000/L	0.1267/L7	
2125	Rigid +Y									
1(HYD)	0	-114	0	0	0	0	0.0047	0	-0.0019	
2(OPE)	0	-262	0	0	0	0	0.0373	0	0.0103	
3(OPE)	0	0	0	0	0	0	-0.026	0.0228	-0.0167	
4(SUS)	0	-102	0	0	0	0	0.0047	0	-0.0019	
5(EXP)	0	-160	0	0	0	0	0.0326	0	0.0122	
6(EXP)	0	102	0	0	0	0	-0.0307	0.0228	-0.0147	
7(EXP)	0	-262	0	0	0	0	0.0634	-0.0228	0.027	
MAX		-262/L2					0.0634/L	0.0228/L	0.0270/L7	
2250	Rigid ANC									
1(HYD)	-2	-97	2	12	-9.8	52.5	0	0	0	
2(OPE)	-20	44	-22	-27.7	-35.2	-45.9	0	0	0	
3(OPE)	12	-111	22	43	21.3	36.2	0	0	0	
4(SUS)	-2	-89	2	9.8	-9.2	46.9	0	0	0	

5(EXP)	-18	133	-24	-37.5	-25.9	-92.8	0	0	0
6(EXP)	15	-23	20	33.3	30.5	-10.7	0	0	0
7(EXP)	-32	156	-44	-70.7	-56.5	-82.1	0	0	0
MAX	-32/L7	156/L7	-44/L7	-70.7/L7	-56.5/L7	-92.8/L5	-0.0000/L	0.0000/L	-0.0000/L7
2415	Rigid +Y								
1(HYD)	0	0	0	0	0	0	-0.0249	0.0504	0.0322
2(OPE)	0	0	0	0	0	0	0.0104	0.0642	0.0363
3(OPE)	0	0	0	0	0	0	-0.0696	0.0363	0.0324
4(SUS)	0	0	0	0	0	0	-0.0262	0.0515	0.0337
5(EXP)	0	0	0	0	0	0	0.0365	0.0127	0.0026
6(EXP)	0	0	0	0	0	0	-0.0434	-0.0152	-0.0013
7(EXP)	0	0	0	0	0	0	0.0799	0.0279	0.0039
							0.0799/L	0.0642/L	0.0363/L2
2545	Rigid +Y								
1(HYD)	0	-28	0	0	0	0	-0.0009	0	0.0322
2(OPE)	0	-25	0	0	0	0	0.0288	0	0.0133
3(OPE)	0	-28	0	0	0	0	-0.0358	0	0.0601
4(SUS)	0	-27	0	0	0	0	-0.0004	0	0.0337
5(EXP)	0	1	0	0	0	0	0.0292	0	-0.0204
6(EXP)	0	-1	0	0	0	0	-0.0354	0	0.0264
7(EXP)	0	2	0	0	0	0	0.0646	0	-0.0469
MAX		-28/L3					0.0646/L	-0.0000/L	0.0601/L3
2845	Rigid +Y								
1(HYD)	0	-677	0	0	0	0	-0.0139	0	0.0147
2(OPE)	0	-687	0	0	0	0	-0.0697	0	0.0364
3(OPE)	0	-644	0	0	0	0	0.0228	0	-0.0095
4(SUS)	0	-659	0	0	0	0	-0.0133	0	0.013
5(EXP)	0	-27	0	0	0	0	-0.0563	0	0.0234
6(EXP)	0	16	0	0	0	0	0.0361	0	-0.0226
7(EXP)	0	-43	0	0	0	0	-0.0925	0	0.046
MAX		-687/L2					-0.0925/L	-0.0000/L	0.0460/L7
3145	Rigid GUI w/gap; Rigid +Y								
1(HYD)	0	-230	0	0	0	0	-0.0088	0	0.0013
2(OPE)	0	-419	0	0	0	0	-0.0458	0	-0.0328
3(OPE)	0	0	0	0	0	0	0.0321	0.0092	0.0402
4(SUS)	0	-218	0	0	0	0	-0.0082	0	0.0008
5(EXP)	0	-202	0	0	0	0	-0.0375	0	-0.0337
6(EXP)	0	218	0	0	0	0	0.0403	0.0092	0.0394
7(EXP)	0	-419	0	0	0	0	-0.0779	-0.0092	-0.0731
MAX		-419/L2					-0.0779/L	0.0092/L	-0.0731/L7
3475	Rigid +Y								
1(HYD)	0	-194	0	0	0	0	-0.0089	0	0.0175
2(OPE)	0	-191	0	0	0	0	0.005	0	0.0168
3(OPE)	0	-187	0	0	0	0	-0.0258	0	0.0221
4(SUS)	0	-189	0	0	0	0	-0.009	0	0.0179
5(EXP)	0	-2	0	0	0	0	0.014	0	-0.0011
6(EXP)	0	2	0	0	0	0	-0.0168	0	0.0042
7(EXP)	0	-4	0	0	0	0	0.0308	0	-0.0053
MAX		-194/L1					0.0308/L	-0.0000/L	0.0221/L3
3827	Rigid +Y								

1(HYD)	0	-27	0	0	0	0	-0.0047	0	-0.0045
2(OPE)	0	-33	0	0	0	0	-0.0451	0	-0.0391
3(OPE)	0	-21	0	0	0	0	0.0211	0	0.0165
4(SUS)	0	-25	0	0	0	0	-0.0046	0	-0.0047
5(EXP)	0	-7	0	0	0	0	-0.0405	0	-0.0345
6(EXP)	0	5	0	0	0	0	0.0257	0	0.0211
7(EXP)	0	-12	0	0	0	0	-0.0662	0	-0.0556
MAX		-33/L2					-0.0662/L	-0.0000/L	-0.0556/L7
4040	Rigid ANC								
1(HYD)	-1	-8	0	-6.3	-0.3	2.8	0	0	0
2(OPE)	-12	-4	3	-9.6	-12.9	20.9	0	0	0
3(OPE)	6	-9	-1	-4.4	7.7	-8.3	0	0	0
4(SUS)	-1	-7	0	-6.3	-0.3	3.2	0	0	0
5(EXP)	-11	4	3	-3.3	-12.6	17.7	0	0	0
6(EXP)	7	-2	-2	2	8	-11.4	0	0	0
7(EXP)	-19	6	5	-5.2	-20.7	29.2	0	0	0
MAX	-19/L7	-9/L3	5/L7	-9.6/L2	-20.7/L7	29.2/L7	-0.0000/L	-0.0000/L	0.0000/L7
4850	Rigid +Y								
1(HYD)	0	-81	0	0	0	0	0.0276	0	0.0254
2(OPE)	0	-187	0	0	0	0	0.0381	0	0.0784
3(OPE)	0	-7	0	0	0	0	0.0048	0	-0.0342
4(SUS)	0	-68	0	0	0	0	0.0231	0	0.0222
5(EXP)	0	-119	0	0	0	0	0.015	0	0.0562
6(EXP)	0	61	0	0	0	0	-0.0183	0	-0.0565
7(EXP)	0	-180	0	0	0	0	0.0333	0	0.1127
MAX		-187/L2					0.0381/L	-0.0000/L	0.1127/L7
4857	Rigid +Y								
1(HYD)	0	-4	0	0	0	0	0.0276	0	0.0248
2(OPE)	0	-4	0	0	0	0	0.0612	0	0.0485
3(OPE)	0	0	0	0	0	0	-0.0098	0	-0.0095
4(SUS)	0	-1	0	0	0	0	0.0231	0	0.0219
5(EXP)	0	-3	0	0	0	0	0.0381	0	0.0266
6(EXP)	0	1	0	0	0	0	-0.0329	0	-0.0315
7(EXP)	0	-4	0	0	0	0	0.0711	0	0.0581
MAX		-4/L1					0.0711/L	-0.0000/L	0.0581/L7
5030	Rigid ANC								
1(HYD)	8	-62	-2	16.4	5.2	12.9	0	0	0
2(OPE)	9	-25	12	37.1	0.4	-10.1	0	0	0
3(OPE)	6	-78	-12	-3	7.8	29.3	0	0	0
4(SUS)	7	-57	-2	14.8	5	12.2	0	0	0
5(EXP)	1	32	13	22.4	-4.6	-22.2	0	0	0
6(EXP)	-2	-21	-10	-17.7	2.9	17.1	0	0	0
7(EXP)	3	53	24	40.1	-7.4	-39.4	0	0	0
MAX	9/L2	-78/L3	24/L7	40.1/L7	7.8/L3	-39.4/L7	0.0000/L	-0.0000/L	0.0000/L7
5040	Rigid ANC								
1(HYD)	0	-21	0	-10.8	0	3.9	0	0	0
2(OPE)	-2	-19	-56	-8.9	-45.6	3.6	0	0	0
3(OPE)	1	-19	35	-9.9	28.8	3.5	0	0	0
4(SUS)	0	-19	0	-9.6	0	3.5	0	0	0
5(EXP)	-2	0	-56	0.6	-45.6	0.1	0	0	0
6(EXP)	1	0	35	-0.4	28.8	0	0	0	0

7(EXP)	-3	1	-91	1	-74.4	0.1	0	0	0
MAX	-3/L7	-21/L1	-91/L7	-10.8/L1	-74.4/L7	3.9/L1	-0.0000/L	-0.0000/L	-0.0000/L7
5155	Rigid +Y								
1(HYD)	0	-11	0	0	0	0	0.0002	0	0
2(OPE)	0	-11	0	0	0	0	0.0917	0	-0.014
3(OPE)	0	-8	0	0	0	0	-0.0576	0	0.0089
4(SUS)	0	-9	0	0	0	0	0.0002	0	0
5(EXP)	0	-1	0	0	0	0	0.0915	0	-0.014
6(EXP)	0	1	0	0	0	0	-0.0578	0	0.0089
7(EXP)	0	-2	0	0	0	0	0.1493	0	-0.0229
MAX		-11/L2					0.1493/L	-0.0000/L	-0.0229/L7
5157	Rigid +Y								
1(HYD)	0	-8	0	0	0	0	0.0007	0	0
2(OPE)	0	-1	0	0	0	0	0.0827	0	0.0135
3(OPE)	0	-11	0	0	0	0	-0.0512	0	-0.0085
4(SUS)	0	-7	0	0	0	0	0.0006	0	0
5(EXP)	0	6	0	0	0	0	0.0821	0	0.0135
6(EXP)	0	-4	0	0	0	0	-0.0519	0	-0.0085
7(EXP)	0	10	0	0	0	0	0.1339	0	0.022
MAX		-11/L3					0.1339/L	-0.0000/L	0.0220/L7
5485	Rigid +Y								
1(HYD)	0	-482	0	0	0	0	0.0085	0	-0.0633
2(OPE)	0	-684	0	0	0	0	0.1796	0	-0.531
3(OPE)	0	0	0	0	0	0	-0.2142	0.0413	0.2949
4(SUS)	0	-471	0	0	0	0	0.0096	0	-0.0605
5(EXP)	0	-213	0	0	0	0	0.1699	0	-0.4705
6(EXP)	0	471	0	0	0	0	-0.2238	0.0413	0.3554
7(EXP)	0	-684	0	0	0	0	0.3937	-0.0413	-0.8259
MAX		-684/L2					0.3937/L	0.0413/L	-0.8259/L7
5530	Rigid ANC								
1(HYD)	1	-46	0	4.4	2.8	7.4	0	0	0
2(OPE)	2	-44	2	3.7	5.8	7.7	0	0	0
3(OPE)	1	-41	-2	3	-0.1	2.6	0	0	0
4(SUS)	2	-42	0	3.4	3	5.3	0	0	0
5(EXP)	0	-1	2	0.3	2.7	2.3	0	0	0
6(EXP)	-1	1	-2	-0.4	-3.1	-2.7	0	0	0
7(EXP)	1	-3	4	0.7	5.9	5.1	0	0	0
MAX	2/L2	-46/L1	4/L7	4.4/L1	5.9/L7	7.7/L2	0.0000/L	-0.0000/L	0.0000/L7
7980	Rigid ANC								
1(HYD)	0	-8	0	-0.3	-0.2	9.3	0	0	0
2(OPE)	2	-13	56	-7.5	86.5	17.1	0	0	0
3(OPE)	-1	-4	-35	4.4	-55	2.6	0	0	0
4(SUS)	0	-7	0	-0.2	-0.2	8.2	0	0	0
5(EXP)	2	-5	56	-7.3	86.7	8.9	0	0	0
6(EXP)	-1	3	-35	4.6	-54.8	-5.6	0	0	0
7(EXP)	3	-9	91	-11.9	141.5	14.5	0	0	0
MAX	3/L7	-13/L2	91/L7	-11.9/L7	141.5/L7	17.1/L2	0.0000/L	-0.0000/L	0.0000/L7

Job Name: 338716-FINAL

Licensed To: ENS CANADA STRUCTURAL ENGG & PROJECT MGMT INC

DISPLACEMENTS REPORT: Nodal Movements

CASE 7 (EXP) L7=L2-L3

Node	DX in.	DY in.	DZ in.	RX deg.	RY deg.	RZ deg.
20	-0.1389	-0.0281	0.0957	-0.1066	0.0266	-0.0038
23	0	-0.0363	-0.0025	-0.0101	-0.0041	0.0003
30	-0.0004	-0.074	-0.0083	-0.0145	-0.0083	0.0025
31	-0.0018	-0.0968	-0.0123	-0.0162	-0.0061	0.0083
40	-0.003	-0.1074	-0.0143	-0.0169	-0.0051	0.0112
50	-0.0193	-0.1742	-0.0287	-0.02	0.0013	0.0323
60	-0.0221	-0.1818	-0.0304	-0.02	0.0013	0.0323
70	-0.0267	-0.1941	-0.0332	-0.02	0.0013	0.0323
80	0	0	0	0	0	0
100	-0.0377	0.0157	-0.0029	-0.0388	-0.0569	0.0255
110	-0.0285	0.0121	-0.011	-0.0386	-0.0567	0.0257
120	-0.0257	0.011	-0.0135	-0.0385	-0.0566	0.0257
140	-0.023	0.0098	-0.0157	-0.0347	-0.0525	0.0269
150	-0.0203	0.0087	-0.0179	-0.0307	-0.0486	0.0293
160	-0.0173	0.0073	-0.0201	-0.0306	-0.0485	0.0293
170	-0.0065	0.0024	-0.0282	-0.0303	-0.0482	0.0293
189	-0.0034	0.0009	-0.0288	-0.0234	-0.0308	0.0225
190	-0.0016	0	-0.0268	-0.0089	-0.0147	0.0167
210	0	0	-0.0028	0	0	0
220	0	0	0	0	0	0
230	0	-0.0148	-0.0005	-0.0049	-0.0017	-0.0001
235	0.0001	-0.033	-0.0021	-0.0095	-0.0037	0.0002
250	0.0094	-0.0722	-0.0114	0.0009	-0.0415	-0.0294
260	0.0148	-0.0703	-0.0139	0.0011	-0.0418	-0.0297
270	0.0157	-0.07	-0.0144	0.0011	-0.0418	-0.0297
290	-0.0406	0.0169	-0.0003	-0.0389	-0.057	0.0254
310	-0.0436	0.018	0.0024	-0.043	-0.0609	0.0204
320	-0.046	0.0187	0.0047	-0.0455	-0.0643	0.0173
330	-0.0488	0.0193	0.0076	-0.0483	-0.0682	0.0134
340	-0.0546	0.0201	0.0141	-0.0542	-0.0757	0.0037
350	-0.0575	0.0203	0.0176	-0.0559	-0.0789	0.0043
360	-0.0684	0.0211	0.0309	-0.056	-0.0791	0.0043
370	-0.0713	0.0213	0.0345	-0.056	-0.0791	0.0043
400	-0.0789	0.0217	0.0444	-0.0745	-0.0985	-0.0005
410	-0.0793	0.0217	0.045	-0.0745	-0.0985	-0.0005
420	0	0	0	0	0	0
430	0	0	-0.0047	0	0.0002	0

435	0.0182	0	-0.0409	0.0113	0.0646	0.014
450	0.0341	-0.0069	-0.0651	0.0364	0.0378	0.0234
460	0.0442	-0.0168	-0.0889	0.0367	0.0363	0.0236
470	0.0586	-0.0323	-0.1253	0.0369	0.0318	0.0239
480	0.0604	-0.0344	-0.1303	0.0369	0.031	0.0239
510	0.0546	-0.0407	-0.145	0.0362	-0.1035	0.0296
515	0.03	0	-0.1814	-0.27	-0.0339	-0.1102
538	0.0227	0.0722	-0.1998	-0.3625	-0.0414	-0.1809
540	0.031	0.0854	-0.2205	-0.2601	-0.0497	-0.2263
541	0.0239	0.0839	-0.2083	-0.3233	-0.0491	-0.1954
550	0.0315	0.0852	-0.221	-0.2593	-0.0501	-0.2268
560	0.09	0.0628	-0.2875	-0.2575	-0.051	-0.2275
570	0.1029	0.0578	-0.3021	-0.2572	-0.0512	-0.2276
590	0.2367	-0.0086	-0.4368	-0.1217	-0.1876	-0.0542
599	0.236	-0.0118	-0.4381	-0.1081	-0.1997	0.0254
600	0.232	-0.0108	-0.4319	-0.0996	-0.2208	0.0826
610	0.2213	0	-0.404	-0.0926	-0.2334	0.071
615	0.1667	0	-0.2528	-0.0562	-0.2279	-0.0076
620	0.1011	0.0353	-0.1311	-0.0124	-0.0658	0.0915
630	0.0963	0.0403	-0.1275	-0.0124	-0.0654	0.0916
640	0.0914	0.0455	-0.1238	-0.0123	-0.065	0.0917
660	0.0874	0.0498	-0.1212	-0.0096	-0.0482	0.0954
670	0.0834	0.0538	-0.1191	-0.0136	-0.0452	0.0804
680	0.0785	0.0583	-0.1165	-0.0137	-0.0452	0.08
690	0.0737	0.0627	-0.114	-0.0138	-0.0451	0.0797
695	-0.033	0	-0.0631	-0.1194	-0.0652	-0.1276
710	-0.0482	-0.0219	-0.0504	-0.1344	-0.0814	-0.115
720	-0.0531	-0.0285	-0.0457	-0.1345	-0.0815	-0.1148
730	-0.0579	-0.0347	-0.0413	-0.1346	-0.0816	-0.1145
749	-0.0596	-0.0401	-0.0366	-0.1253	-0.1005	-0.0642
750	-0.0569	-0.0453	-0.0317	-0.1143	-0.1123	-0.0369
770	-0.0487	-0.0536	-0.0255	-0.1111	-0.1109	-0.0009
779	-0.0445	-0.056	-0.0207	-0.0913	-0.1095	0.0231
780	-0.041	-0.0541	-0.0165	-0.0659	-0.1117	0.0683
810	0	-0.0066	0	-0.0001	-0.0001	0.0004
820	0	0	0	0	0	0
830	-0.1451	0	0.146	-0.1049	-0.0969	-0.0473
840	-0.148	-0.0022	0.1505	-0.1049	-0.0969	-0.0473
859	-0.152	-0.0028	0.1531	-0.1039	-0.0875	-0.0658
860	-0.156	0	0.152	-0.1077	-0.0775	-0.073
880	-0.1608	0.007	0.1479	-0.1076	-0.0737	-0.0831
900	-0.1713	0.0217	0.1381	-0.0751	-0.0636	-0.1074
910	-0.1741	0.025	0.1352	-0.0678	-0.0622	-0.1096
930	-0.181	0.0314	0.1278	-0.0332	-0.0542	-0.1234
940	-0.1881	0.0357	0.1192	-0.0329	-0.0541	-0.1236
950	-0.1884	0.0359	0.1189	-0.0329	-0.0541	-0.1236
980	-0.1938	0.0385	0.1118	-0.0217	-0.048	-0.1375

990	-0.1964	0.0396	0.1083	-0.0218	-0.0471	-0.1402
1010	-0.2013	0.042	0.1015	-0.0255	-0.0455	-0.1453
1020	-0.2034	0.0432	0.0985	-0.0255	-0.0455	-0.1453
1040	-0.2085	0.0461	0.0912	-0.0255	-0.0455	-0.1453
1050	-0.2091	0.0464	0.0904	-0.0255	-0.0455	-0.1453
1060	-0.135	-0.0124	0.0829	-0.1066	0.0266	-0.0038
1090	-0.1319	0	0.0727	-0.1066	0.0266	-0.0038
1100	-0.1301	0.0072	0.0668	-0.1033	0.0266	-0.0038
1120	-0.1265	0.0198	0.0551	-0.077	0.0266	-0.0038
1130	-0.1255	0.0226	0.0517	-0.068	0.0273	0.0021
1140	-0.1241	0.0259	0.0475	-0.0678	0.0273	0.0022
1150	-0.1228	0.0293	0.0432	-0.0676	0.0273	0.0024
1170	-0.1205	0.0343	0.0359	-0.0554	0.0278	0.0148
1180	-0.1162	0.0415	0.0226	-0.0421	0.0274	0.0376
1189	-0.1139	0.0422	0.0198	-0.0316	0.0257	0.0476
1190	-0.1103	0.0406	0.0194	-0.0257	0.0233	0.0638
1195	-0.0765	0.0139	0.0267	-0.0149	0.0125	0.0599
1210	-0.0461	-0.001	0.0281	-0.0052	-0.0057	0.0269
1219	-0.0378	-0.0029	0.0285	0.0008	-0.0213	0.0104
1230	-0.0355	-0.0029	0.0313	0.0066	-0.0334	0.0043
1250	-0.0332	-0.0024	0.0367	0.0086	-0.0432	-0.0098
1260	-0.0325	-0.0023	0.0381	0.0087	-0.0432	-0.0098
1270	-0.0256	-0.0009	0.0521	0.0087	-0.0435	-0.0103
1300	-0.0194	0	0.0622	0.007	-0.0573	-0.0372
1310	-0.015	0.0005	0.0689	0.0069	-0.0574	-0.0373
1330	-0.119	0.016	0.1065	-0.0941	-0.101	-0.0185
1350	-0.122	0.0151	0.1111	-0.0957	-0.0997	-0.021
1360	-0.1278	0.0124	0.12	-0.1016	-0.0982	-0.0383
1370	-0.1307	0.0104	0.1244	-0.1046	-0.0971	-0.0466
1390	0.0506	-0.039	-0.1389	0.063	-0.1526	0.0414
1400	0.0457	-0.0366	-0.1302	0.0637	-0.1536	0.0416
1410	0.0269	-0.0276	-0.0968	0.0662	-0.1554	0.0418
1420	0.0208	-0.0247	-0.0859	0.067	-0.1554	0.0416
1430	0.0206	-0.0246	-0.0856	0.0683	-0.155	0.0412
1439	0.0171	-0.0249	-0.0789	0.0901	-0.1331	0.0068
1440	0.0162	-0.0282	-0.0727	0.1279	-0.1208	-0.0328
1450	0.0163	-0.0284	-0.0725	0.1285	-0.1198	-0.0333
1460	0.025	-0.0508	-0.0394	0.1276	-0.1173	-0.0344
1470	0.0253	-0.0516	-0.0382	0.1275	-0.1172	-0.0345
1480	0.0273	-0.0565	-0.031	0.1266	-0.1167	-0.0347
1510	0.0307	-0.0634	-0.0237	0.0491	-0.0789	-0.051
1540	0.1823	-0.1431	-0.2699	-0.6016	-0.0395	-0.2452
1560	0.3449	-0.1977	-0.6672	-0.6481	-0.0335	-0.2649
1580	0.3752	-0.2077	-0.7414	-0.6448	-0.0307	-0.2612
1590	0.3794	-0.2091	-0.7519	-0.6447	-0.0307	-0.2612
1600	-0.0036	-0.1055	-0.0242	-0.0169	-0.0051	0.0112
1610	-0.0039	-0.1044	-0.0295	-0.0169	-0.0051	0.0112

1620	-0.004	-0.104	-0.032	-0.0169	-0.0051	0.0112
1630	0.1792	0.2167	-0.3881	-0.4502	-0.1659	-0.2361
1640	0.1745	0.1997	-0.3762	-0.4502	-0.1659	-0.2361
1645	0.1577	0.1374	-0.3298	-0.3997	-0.1865	-0.2198
1660	0.0476	-0.0058	-0.0379	-0.0708	-0.0883	-0.0337
1670	0.0446	-0.0074	-0.0339	-0.0706	-0.0881	-0.0338
1680	0.0418	-0.0088	-0.03	-0.0704	-0.088	-0.0338
1700	0.0389	-0.0104	-0.0262	-0.0616	-0.0792	-0.0366
1705	0.0051	-0.0355	-0.0025	0.0025	-0.0216	-0.0813
1720	-0.0021	-0.0458	-0.0004	0.0162	-0.017	-0.1033
1729	-0.0043	-0.0499	0.0011	0.0162	-0.0126	-0.128
1730	-0.0049	-0.0512	0.0037	0.0249	-0.0093	-0.1374
1760	-0.0029	-0.0398	0.0214	0.0609	-0.0055	-0.1999
1770	-0.0026	-0.0367	0.0244	0.0724	-0.0053	-0.198
1775	-0.0018	-0.0236	0.0345	0.0834	-0.0062	-0.1913
1780	-0.0006	-0.0116	0.0446	0.067	-0.0093	-0.1846
1790	-0.0002	-0.0088	0.0475	0.0605	-0.0105	-0.1828
1800	0.0003	-0.0061	0.0504	0.0528	-0.012	-0.1809
1810	0.0024	-0.0007	0.0594	0.0233	-0.0178	-0.1749
1820	0.0032	0.0001	0.0622	0.0122	-0.02	-0.1731
1830	0.0041	0.0005	0.0652	0.0043	-0.0206	-0.176
1835	0.0064	0	0.0719	-0.0143	-0.0226	-0.1827
1840	0.0101	-0.0038	0.0817	-0.0288	-0.0266	-0.1924
1850	0.0113	-0.0051	0.0847	-0.0288	-0.0266	-0.1925
1860	0.0124	-0.0063	0.0875	-0.0287	-0.0266	-0.1925
1870	0.0125	-0.0064	0.0876	-0.0285	-0.0267	-0.1927
1880	0.0137	-0.0076	0.0904	-0.0235	-0.0283	-0.1955
1890	0.015	-0.0086	0.0934	-0.0171	-0.0302	-0.1979
1900	0.0165	-0.0092	0.0963	-0.009	-0.0321	-0.2003
1910	0.0179	-0.0094	0.0992	0.0004	-0.034	-0.2026
1920	0.0195	-0.0091	0.1021	0.0096	-0.0365	-0.1883
1930	0.0226	-0.0078	0.1073	0.0195	-0.0417	-0.1631
1940	0.0245	-0.0069	0.1101	0.0215	-0.0449	-0.1493
1948	0.0266	-0.0058	0.1131	0.0211	-0.0487	-0.1349
1949	0.0297	-0.0034	0.1145	0.0014	-0.0643	-0.1131
1950	0.0332	-0.0001	0.1128	-0.017	-0.0798	-0.0645
1970	-0.0292	-0.1658	-0.0298	-0.0294	0.0183	0.1111
1980	-0.0345	-0.159	-0.0309	-0.0295	0.0185	0.1119
2020	0.0159	0.0041	0.1156	0.0063	-0.0576	-0.0383
2030	0.0203	0.0046	0.1223	0.0062	-0.0575	-0.0384
2049	0.0231	0.0033	0.1257	-0.0038	-0.0579	-0.0419
2050	0.0257	0	0.1267	-0.014	-0.0584	-0.0473
2070	0.0374	-0.0194	0.1213	-0.035	-0.0557	-0.0574
2080	0.0775	-0.0721	0.0798	-0.1048	-0.0484	-0.0711
2089	0.0833	-0.0782	0.0681	-0.1271	-0.0471	-0.0717
2100	0.0827	-0.0746	0.0629	-0.1392	-0.0463	-0.0718
2110	0.0816	-0.0712	0.0608	-0.1392	-0.0463	-0.0718

2120	0.0781	-0.0609	0.0543	-0.1392	-0.0463	-0.0718
2125	0.0634	-0.0228	0.027	-0.0851	-0.0487	-0.0718
2150	0.0475	-0.0081	0.0004	-0.0274	-0.0563	-0.0717
2170	0.0392	-0.0058	-0.0129	-0.0088	-0.053	-0.0943
2179	0.0359	-0.0071	-0.0153	-0.0053	-0.053	-0.1014
2180	0.0319	-0.011	-0.0147	-0.0048	-0.0527	-0.1091
2210	0.0191	-0.0271	-0.0072	-0.0097	-0.048	-0.1048
2218	0.0151	-0.0319	-0.005	-0.0112	-0.0452	-0.0985
2219	0.0106	-0.0338	-0.0033	-0.0111	-0.0376	-0.0765
2220	0.0069	-0.0317	-0.0023	-0.0109	-0.0324	-0.0516
2240	0	-0.0066	0	-0.0001	-0.0001	-0.0001
2250	0	0	0	0	0	0
2260	0.0212	-0.0681	-0.017	0.0013	-0.0421	-0.0299
2280	0.0267	-0.0657	-0.0203	0.0209	-0.0601	-0.0419
2300	0.0567	0.0428	0.0248	-0.0223	0.0203	0.0378
2309	0.0575	0.0436	0.0252	-0.0192	0.0198	0.0374
2310	0.0586	0.0436	0.0254	-0.0172	0.0192	0.0369
2340	0.0775	0.0362	0.0292	0.0137	0.0132	0.0297
2349	0.0785	0.0358	0.0289	0.0154	0.0115	0.0288
2350	0.079	0.0355	0.028	0.0183	0.0097	0.0284
2390	0.0796	0.034	0.0218	0.0238	0.0066	0.0247
2400	0.0797	0.0337	0.0205	0.0238	0.0066	0.0247
2410	0.0798	0.0333	0.0191	0.0238	0.0066	0.0247
2415	0.0799	0.0279	0.0039	0.0372	-0.0053	0.0128
2440	0.078	0.0208	-0.0108	0.0456	-0.0185	0.0013
2490	0.0756	0.0159	-0.0197	0.0485	-0.0273	-0.0057
2540	0.0723	0.0109	-0.0286	0.0498	-0.0368	-0.0126
2545	0.0646	0	-0.0469	0.053	-0.0368	-0.0126
2570	0.0623	-0.0033	-0.0523	0.053	-0.0368	-0.0126
2579	0.0616	-0.0039	-0.0531	0.053	-0.0368	-0.0126
2580	0.0604	-0.0043	-0.0531	0.053	-0.0368	-0.0126
2610	0.0547	-0.0051	-0.0507	0.053	-0.0368	-0.0126
2620	0.0533	-0.0053	-0.0501	0.053	-0.0368	-0.0126
2640	0.0351	-0.008	-0.0424	0.053	-0.0368	-0.0126
2650	0.0199	-0.0102	-0.0359	0.053	-0.0368	-0.0126
2660	0.0148	-0.0109	-0.0338	0.053	-0.0368	-0.0126
2690	0.0055	-0.0123	-0.0299	0.053	-0.0368	-0.0126
2700	0.0041	-0.0125	-0.0293	0.053	-0.0368	-0.0126
2710	0.0029	-0.0127	-0.0287	0.053	-0.0368	-0.0126
2730	-0.0146	-0.0152	-0.0214	0.053	-0.0368	-0.0126
2820	-0.1212	0.0121	0.1067	-0.0947	-0.0987	-0.0151
2830	-0.1198	-0.0018	0.0868	-0.0899	-0.0942	-0.0036
2839	-0.1186	-0.0041	0.0821	-0.086	-0.0921	-0.0073
2840	-0.1161	-0.0048	0.0775	-0.0837	-0.0887	-0.0128
2845	-0.0925	0	0.046	-0.0739	-0.0834	-0.0074
2860	-0.0695	0.0002	0.017	-0.0643	-0.0791	0.0023
2870	-0.0666	0.0001	0.0134	-0.0643	-0.0791	0.0023

2880	-0.0557	-0.0003	0.0001	-0.0642	-0.0791	0.0022
2899	-0.0533	0.0007	-0.002	-0.0629	-0.0785	-0.0055
2900	-0.0526	0.0033	-0.0009	-0.06	-0.0787	-0.011
2920	-0.0546	0.0173	0.0117	-0.0552	-0.0762	-0.0015
2930	0.0107	-0.0166	0.0917	-0.0224	-0.0284	-0.1956
2940	0.0036	-0.0382	0.0949	-0.0198	-0.0295	-0.1932
2949	-0.0017	-0.0442	0.0964	-0.0191	-0.0314	-0.1853
2950	-0.0094	-0.0447	0.0975	-0.0175	-0.0323	-0.1759
2960	-0.0098	-0.0445	0.0976	-0.0175	-0.0323	-0.1758
2970	-0.0764	-0.0183	0.1046	-0.02	-0.0427	-0.1523
2980	-0.0834	-0.0154	0.1055	-0.02	-0.0427	-0.1522
2990	-0.1305	0.0046	0.1117	-0.0203	-0.0429	-0.1518
3000	-0.1308	0.0047	0.1118	-0.0204	-0.0429	-0.1517
3010	-0.1516	0.0139	0.1153	-0.0297	-0.0466	-0.1419
3019	-0.1559	0.0157	0.1176	-0.0428	-0.051	-0.13
3020	-0.1559	0.0148	0.1207	-0.0548	-0.057	-0.1238
3030	-0.1557	0.0147	0.1209	-0.055	-0.0571	-0.1236
3040	-0.1536	0.0126	0.1233	-0.057	-0.0578	-0.1202
3050	-0.1511	0.0101	0.1261	-0.059	-0.0588	-0.1162
3060	-0.0408	-0.1509	-0.0323	-0.0296	0.0187	0.1127
3090	-0.0465	-0.1415	-0.034	-0.042	0.038	0.1884
3100	-0.0702	-0.0887	-0.0448	-0.0441	0.0408	0.1976
3110	-0.089	-0.0455	-0.0538	-0.0457	0.0426	0.201
3120	-0.0939	-0.0341	-0.0562	-0.0461	0.0431	0.2013
3139	-0.0961	-0.0246	-0.0604	-0.07	0.103	0.2274
3140	-0.0925	-0.0178	-0.0655	-0.0951	0.1558	0.2346
3145	-0.0779	-0.0092	-0.0731	-0.0893	0.1769	0.2319
3160	0.0149	0.0132	-0.1157	-0.0156	0.1638	0.2165
3169	0.024	0.015	-0.1191	-0.0039	0.1199	0.2033
3170	0.0328	0.0182	-0.1205	0.004	0.0954	0.1832
3200	-0.1663	0.0188	0.1349	-0.0665	-0.0612	-0.1114
3210	-0.1612	0.0158	0.1318	-0.0664	-0.0612	-0.1115
3220	-0.1563	0.013	0.1289	-0.0662	-0.0611	-0.1116
3250	-0.0346	-0.0425	0.1063	-0.0026	-0.0403	-0.1806
3270	-0.0126	-0.0499	0.1062	0.0006	-0.0338	-0.219
3280	-0.0114	-0.0502	0.1062	0.0006	-0.0338	-0.2191
3290	0.0044	-0.0549	0.1062	0.0006	-0.0338	-0.2193
3300	0.0095	-0.0376	0.1036	0.0006	-0.0338	-0.2194
3310	0.0124	-0.0276	0.102	0.0006	-0.0338	-0.2194
3390	0.0647	0.0096	-0.0251	0.0466	-0.0443	-0.0172
3400	0.0626	0.0092	-0.024	0.0466	-0.0443	-0.0172
3420	0.048	0.0056	-0.0158	0.0407	-0.0527	-0.0257
3430	0.043	0.0041	-0.0127	0.0407	-0.0527	-0.0257
3470	0.0354	0.0016	-0.0081	0.0376	-0.0534	-0.03
3475	0.0308	0	-0.0053	0.0357	-0.053	-0.0325
3500	0.0262	-0.0018	-0.0025	0.0338	-0.052	-0.0347
3510	0.0248	-0.0023	-0.0017	0.0338	-0.052	-0.0347

3520	0.0066	-0.0096	0.0092	0.0338	-0.0519	-0.0347
3550	0.0003	-0.012	0.0128	0.0319	-0.0473	-0.0325
3559	-0.0005	-0.0128	0.0134	0.0308	-0.0444	-0.0309
3560	-0.0005	-0.0138	0.0139	0.0295	-0.0424	-0.0291
3590	0.0012	-0.0195	0.0158	0.027	-0.0342	-0.0254
3600	0.0027	-0.0246	0.0173	0.0269	-0.0342	-0.0254
3630	0.004	-0.0294	0.0188	0.0242	-0.0289	-0.0227
3639	0.0042	-0.0305	0.0186	0.0218	-0.0274	-0.0213
3640	0.004	-0.0311	0.0178	0.0194	-0.025	-0.0206
3670	0.0024	-0.0323	0.0112	0.0126	-0.0179	-0.0141
3680	0.0021	-0.0325	0.0098	0.0125	-0.0179	-0.0141
3720	-0.041	0.0124	-0.0035	-0.0914	-0.0182	-0.0723
3730	-0.0383	0.01	-0.0069	-0.0915	-0.0182	-0.0723
3760	-0.0331	0.0059	-0.0132	-0.1036	-0.0033	-0.0864
3770	-0.0309	0.0043	-0.0158	-0.1036	-0.0033	-0.0864
3818	-0.0136	-0.0097	-0.0392	-0.1092	0.0171	-0.0635
3819	-0.013	-0.0113	-0.0413	-0.1092	0.0191	-0.0539
3820	-0.0138	-0.0127	-0.0425	-0.1091	0.0217	-0.0438
3827	-0.0662	0	-0.0556	-0.095	-0.0216	0.0345
3830	-0.0818	0.0076	-0.0446	-0.0908	-0.072	0.0319
3840	-0.0835	0.0084	-0.0428	-0.0908	-0.072	0.0319
3868	-0.0874	0.0105	-0.0379	-0.0897	-0.0879	0.035
3871	-0.0879	0.0105	-0.0357	-0.089	-0.0988	0.0375
3890	-0.0864	0.0091	-0.0337	-0.0879	-0.1092	0.0396
3900	-0.0333	-0.0212	-0.0071	-0.0489	-0.1156	0.0772
3909	-0.0318	-0.0214	-0.0062	-0.0436	-0.1096	0.0773
3910	-0.0304	-0.0209	-0.0055	-0.0382	-0.1056	0.0778
3940	-0.0215	-0.0136	-0.0021	-0.0211	-0.0716	0.0767
3950	-0.0196	-0.012	-0.0016	-0.0211	-0.0715	0.0767
3970	-0.0144	-0.0073	-0.0004	-0.0127	-0.0499	0.0665
3980	-0.0111	-0.0042	0.0002	-0.0127	-0.0498	0.0664
3990	-0.007	0.0005	0.0009	-0.0069	-0.0282	0.0465
3999	-0.0063	0.001	0.0009	-0.0061	-0.0243	0.0361
4000	-0.0054	0.0009	0.0007	-0.0061	-0.0178	0.0254
4030	-0.0008	0	0	0	0	0
4040	0	0	0	0	0	0
4070	-0.0204	0.0043	-0.019	-0.0401	-0.0408	-0.0821
4080	-0.0173	0.0019	-0.0205	-0.0401	-0.0408	-0.0822
4110	-0.011	-0.0022	-0.023	-0.0387	-0.0367	-0.107
4120	-0.0083	-0.0038	-0.024	-0.0387	-0.0367	-0.107
4140	0.0228	-0.0219	-0.0332	-0.0243	-0.0295	-0.1043
4149	0.0236	-0.0231	-0.0333	-0.022	-0.0295	-0.1002
4150	0.0233	-0.0244	-0.0331	-0.0206	-0.0294	-0.0959
4190	-0.0275	-0.0668	0.0015	0.0639	-0.0796	-0.0225
4200	-0.0291	-0.0674	0.0035	0.0639	-0.0796	-0.0225
4220	-0.0337	-0.0689	0.0096	0.0716	-0.0909	-0.0191
4229	-0.034	-0.0688	0.0109	0.0734	-0.0961	-0.0175

4230	-0.0332	-0.068	0.012	0.076	-0.1012	-0.0163
4260	0.0047	-0.0384	0.0338	0.0976	-0.1074	0.0017
4269	0.0058	-0.037	0.0341	0.0991	-0.104	0.0018
4270	0.0063	-0.0359	0.0333	0.1005	-0.1018	0.0021
4300	0.0065	-0.0308	0.0251	0.1032	-0.0884	0.0018
4310	0.0066	-0.0291	0.0226	0.1032	-0.0884	0.0018
4330	0.0065	-0.0245	0.0151	0.1042	-0.0762	-0.0043
4340	0.0063	-0.0213	0.01	0.1042	-0.0762	-0.0043
4350	0.0056	-0.0167	0.0025	0.1033	-0.064	-0.0175
4359	0.0056	-0.0155	0.0017	0.1027	-0.0604	-0.0245
4360	0.0061	-0.0141	0.0019	0.102	-0.0552	-0.0293
4400	0.0103	-0.0053	0.0076	0.0995	-0.0397	-0.0546
4580	0.038	-0.006	-0.0048	0.0376	-0.0534	-0.03
4590	0.0387	-0.0081	-0.0039	0.0376	-0.0534	-0.03
4610	0.0425	-0.019	0.0008	0.0376	-0.0534	-0.03
4619	0.0424	-0.0201	0.0015	0.0376	-0.0534	-0.03
4620	0.0416	-0.0208	0.0022	0.0376	-0.0534	-0.03
4650	0.0079	-0.0324	0.0229	0.0376	-0.0534	-0.03
4659	0.0071	-0.0331	0.0236	0.0376	-0.0534	-0.03
4660	0.007	-0.0342	0.0243	0.0376	-0.0534	-0.03
4690	0.0139	-0.0543	0.033	0.0376	-0.0534	-0.03
4700	0.0144	-0.0557	0.0336	0.0376	-0.0534	-0.03
4710	0.0207	-0.0739	0.0414	0.0376	-0.0534	-0.03
4740	0.0229	-0.0802	0.0441	0.0376	-0.0534	-0.03
4750	0.0246	-0.0853	0.0463	0.0376	-0.0534	-0.03
4780	0.0268	-0.0916	0.0491	0.0376	-0.0534	-0.03
4789	0.0269	-0.0928	0.0491	0.0376	-0.0534	-0.03
4790	0.0265	-0.0935	0.0483	0.0376	-0.0534	-0.03
4820	0.0224	-0.0964	0.0417	0.0376	-0.0534	-0.03
4830	0.0216	-0.097	0.0403	0.0376	-0.0534	-0.03
4840	0.0208	-0.0975	0.0391	0.0376	-0.0534	-0.03
4850	0.0333	0	0.1127	-0.0173	-0.08	-0.0638
4857	0.0711	0	0.0581	-0.0949	-0.0952	0.0353
4860	0.0823	-0.0062	0.0421	-0.118	-0.0869	0.0321
4869	0.0859	-0.0091	0.04	-0.1225	-0.0749	0.0246
4870	0.0894	-0.0142	0.0413	-0.1323	-0.0626	0.0215
4890	0.1056	-0.0543	0.0603	-0.1318	-0.0498	-0.0131
4900	0.1079	-0.0603	0.0633	-0.1317	-0.0498	-0.0132
4910	0.1118	-0.0707	0.0683	-0.1315	-0.0498	-0.0134
4920	0.1108	-0.066	0.0778	-0.1313	-0.0498	-0.0135
4980	0.0063	0.0003	0.0004	0.0626	-0.0146	-0.0371
4989	0.0057	0.0008	-0.0002	0.0494	-0.0132	-0.0303
4990	0.0048	0.0008	-0.0003	0.0412	-0.0098	-0.0226
5020	0.0008	0	0	0	0	0
5030	0	0	0	0	0	0
5040	0	0	0	0	0	0
5050	0	0	0.0002	0	0	0

5060	0.001	0	0.0092	0.0003	-0.0329	0.0001
5070	0.0016	0	0.0104	0.0003	-0.033	0.0001
5080	0.0201	0.0001	0.021	0.0011	-0.1938	0.0003
5089	0.0233	0.0002	0.0206	0.0011	-0.2278	0.0003
5090	0.0255	0.0002	0.0177	0.0011	-0.2599	0.0004
5110	0.04	0	-0.0531	0.0015	-0.3219	0.0016
5119	0.0426	-0.0001	-0.057	0.0015	-0.3089	0.0019
5120	0.047	0	-0.0578	0.0015	-0.2939	0.0021
5140	0.0754	0.0001	-0.0511	0.0014	-0.2485	0.0035
5150	0.0802	0.0001	-0.0498	0.0014	-0.2484	0.0035
5155	0.1493	0	-0.0229	-0.003	-0.0866	0.0089
5157	0.1339	0	0.022	0.0121	0.1167	0.0178
5160	0.0288	-0.0004	0.0604	-0.0445	0.2248	0.0255
5169	0.0256	-0.0014	0.061	-0.0528	0.229	0.0263
5170	0.0239	-0.0025	0.0606	-0.0595	0.2318	0.0272
5190	0.023	-0.0049	0.0583	-0.0614	0.2378	0.0273
5199	0.0222	-0.0056	0.0561	-0.0593	0.2398	0.0272
5200	0.0212	-0.0056	0.0526	-0.0566	0.2411	0.0269
5220	0.007	-0.0009	0.0084	-0.0136	0.1117	0.0115
5230	0.0045	-0.0004	0.0041	-0.0136	0.1115	0.0115
5240	-0.1161	0.0168	0.1019	-0.094	-0.101	-0.0184
5250	-0.108	0.0191	0.0893	-0.094	-0.101	-0.0183
5260	-0.1052	0.0199	0.0849	-0.0939	-0.101	-0.0183
5290	-0.0977	0.0215	0.0731	-0.0754	-0.0991	-0.001
5300	-0.0972	0.0215	0.0725	-0.0754	-0.0991	-0.001
5320	-0.0424	-0.0227	0.0683	-0.02	-0.028	-0.1667
5340	-0.0233	-0.0301	0.0668	0.002	-0.0229	-0.1675
5350	-0.0224	-0.0304	0.0668	0.002	-0.0229	-0.1675
5360	-0.0103	-0.0351	0.0669	0.0021	-0.0229	-0.1675
5370	-0.0052	-0.0219	0.0651	0.0023	-0.0229	-0.1675
5380	-0.0023	-0.0143	0.0641	0.0023	-0.0229	-0.1675
5410	0.1852	0.1967	-0.397	-0.4569	-0.1601	-0.2302
5420	0.1953	0.1939	-0.4169	-0.457	-0.16	-0.2301
5440	0.2058	0.191	-0.4379	-0.4571	-0.1599	-0.23
5450	0.3689	0.1413	-0.8194	-0.5166	-0.0633	-0.2143
5459	0.3779	0.131	-0.8376	-0.5218	-0.0589	-0.2211
5470	0.3833	0.1105	-0.8433	-0.5337	-0.0478	-0.2231
5480	0.3902	0.0204	-0.8326	-0.5697	-0.0367	-0.2391
5485	0.3937	-0.0413	-0.8259	-0.6138	-0.0327	-0.2493
5500	0.397	-0.1071	-0.8192	-0.6384	-0.0311	-0.2594
5510	0.3984	-0.1365	-0.8162	-0.6445	-0.0307	-0.2611
5520	0.3998	-0.1661	-0.8133	-0.6446	-0.0307	-0.2611
5530	0	0	0	0	0	0
5550	0	-0.0047	0	0	0.0004	0.0003
5560	0	-0.0095	0	0	0.0004	0.0003
5570	0	-0.0144	0	0	0.0005	0.0003
5600	-0.0002	-0.0246	-0.0001	-0.0022	0.0049	0.004

5609	0.0001	-0.0256	-0.0003	-0.0034	0.0058	0.0062
5610	0.0009	-0.026	-0.0006	-0.0039	0.0074	0.0081
5640	0.025	-0.0287	-0.0083	-0.031	0.0183	0.0285
5649	0.0261	-0.0284	-0.0084	-0.0325	0.0188	0.0292
5650	0.0268	-0.0276	-0.0081	-0.0348	0.0193	0.0302
5720	-0.0537	-0.0664	0.0162	0.0097	0.0023	-0.1545
5740	-0.0341	-0.0764	0.0186	0.0457	-0.0048	-0.21
5750	-0.0315	-0.0774	0.0192	0.0457	-0.0048	-0.2101
5760	-0.0009	-0.034	-0.0218	-0.0101	-0.0041	0.0003
5770	-0.0008	-0.0343	-0.0197	-0.0101	-0.0041	0.0003
5780	-0.0005	-0.0348	-0.015	-0.0101	-0.0041	0.0003
5830	-0.1337	0.0083	0.1289	-0.1047	-0.0971	-0.0467
5860	0.0004	0.0024	0.0922	0.0067	-0.0575	-0.0378
6188	0.1778	-0.0686	-0.2802	-0.6444	-0.0372	-0.2516
6189	0.1803	-0.0458	-0.2934	-0.6474	-0.0339	-0.2551
6190	0.1894	-0.0391	-0.3184	-0.6308	-0.0318	-0.2613
6200	0.19	-0.0393	-0.3198	-0.6305	-0.0317	-0.2614
6210	0.2048	-0.0442	-0.3556	-0.6304	-0.0317	-0.2615
6420	0.0317	-0.0158	0.1123	-0.035	-0.0557	-0.0574
6429	0.0314	-0.0158	0.1114	-0.035	-0.0557	-0.0574
6430	0.0317	-0.0165	0.1107	-0.035	-0.0557	-0.0574
6460	0.0359	-0.0227	0.1082	-0.035	-0.0557	-0.0574
6470	0.0371	-0.0246	0.1075	-0.035	-0.0557	-0.0574
6480	0.0384	-0.0265	0.1067	-0.035	-0.0557	-0.0574
6490	0.0415	-0.0313	0.1048	-0.035	-0.0557	-0.0574
6500	0.0439	-0.0349	0.1033	-0.035	-0.0557	-0.0574
6520	-0.0084	-0.0575	0.0219	0.0464	-0.0048	-0.2106
6540	0.0425	-0.0132	-0.0232	-0.0588	-0.0777	-0.0426
6550	0.0489	-0.018	-0.0178	-0.052	-0.0736	-0.0537
6560	0.0526	-0.0206	-0.0145	-0.0519	-0.0735	-0.0538
6670	0.0314	-0.0098	0.1111	0.0215	-0.0449	-0.1493
6680	0.0382	-0.0128	0.1121	0.0215	-0.0449	-0.1493
6690	0.0447	-0.0156	0.113	0.0215	-0.0449	-0.1493
6710	0.235	-0.0979	0.1404	0.0215	-0.0449	-0.1493
6720	-0.1261	0.0096	0.1156	-0.1016	-0.0982	-0.0383
6730	-0.1243	0.0065	0.1106	-0.1016	-0.0982	-0.0383
6740	-0.124	0.0061	0.11	-0.1016	-0.0982	-0.0383
6750	0.0506	-0.012	-0.001	-0.0344	-0.0606	-0.0666
6770	0.0587	-0.0235	-0.0066	-0.0516	-0.0733	-0.0541
6780	0.0601	-0.0258	-0.008	-0.0516	-0.0733	-0.0541
6920	-0.182	0.033	0.1061	-0.0218	-0.0471	-0.1402
6930	-0.1807	0.0324	0.1059	-0.0218	-0.0471	-0.1402
6940	-0.179	0.0316	0.1056	-0.0218	-0.0471	-0.1402
6960	-0.17	0.0274	0.1042	-0.0218	-0.0471	-0.1402
6970	-0.1641	0.0247	0.1033	-0.0218	-0.0471	-0.1402
7000	-0.1523	0.0003	0.1369	-0.1076	-0.0737	-0.0831
7010	-0.1514	-0.0003	0.1358	-0.1076	-0.0737	-0.0831

7020	-0.1505	-0.0011	0.1346	-0.1076	-0.0737	-0.0831
7040	-0.1459	-0.0046	0.1287	-0.1076	-0.0737	-0.0831
7050	-0.1425	-0.0073	0.1242	-0.1076	-0.0737	-0.0831
7080	-0.1297	-0.0017	0.0562	-0.1033	0.0266	-0.0038
7090	-0.1296	-0.0029	0.0548	-0.1033	0.0266	-0.0038
7100	-0.1296	-0.0044	0.0531	-0.1033	0.0266	-0.0038
7120	-0.1294	-0.0091	0.0474	-0.1033	0.0266	-0.0038
7130	-0.1292	-0.0127	0.0432	-0.1033	0.0266	-0.0038
7140	-0.0494	0.0166	0.0055	-0.0483	-0.0682	0.0134
7150	-0.05	0.0134	0.0032	-0.0483	-0.0682	0.0134
7160	0.0082	-0.0117	0.0502	0.0605	-0.0105	-0.1828
7170	0.0245	-0.0175	0.0556	0.0605	-0.0105	-0.1828
7180	0.0212	-0.0276	-0.0034	-0.0097	-0.048	-0.1048
7190	0.0242	-0.0282	0.0021	-0.0097	-0.048	-0.1048
7200	0.0255	-0.0284	0.0043	-0.0097	-0.048	-0.1048
7230	0.4157	0.0135	-0.8935	-0.5697	-0.0367	-0.2391
7240	0.4408	0.0068	-0.9532	-0.5697	-0.0367	-0.2391
7440	0.0398	0.0047	0.008	-0.0469	0.0197	0.0375
7450	0.0388	0.0025	0.0069	-0.0469	0.0197	0.0375
7480	0.0361	-0.0038	0.0035	-0.0465	0.0196	0.0365
7490	0.034	-0.0088	0.0008	-0.0465	0.0196	0.0365
7530	-0.119	0.0433	0.0416	-0.0554	0.0278	0.0148
7540	-0.1184	0.0469	0.0439	-0.0554	0.0278	0.0148
7580	0.2613	-0.063	-0.4917	-0.6302	-0.0317	-0.2615
7590	0.2653	-0.0643	-0.5013	-0.6302	-0.0317	-0.2615
7600	0.3851	-0.1042	-0.7901	-0.6309	-0.0316	-0.2614
7620	0.078	0.0221	-0.0115	0.0456	-0.0185	0.0013
7630	0.078	0.0222	-0.0115	0.0456	-0.0185	0.0013
7640	0.0781	0.0268	-0.0139	0.0456	-0.0185	0.0013
7650	0.0781	0.0269	-0.014	0.0456	-0.0185	0.0013
7660	0.0781	0.0305	-0.0159	0.0456	-0.0185	0.0013
7700	-0.0501	0.013	0.0029	-0.0483	-0.0682	0.0134
7710	-0.0043	0.0132	0.0914	0.0067	-0.0575	-0.0378
7720	-0.0065	0.0183	0.091	0.0067	-0.0575	-0.0378
7750	0.0306	-0.0199	-0.1026	0.0662	-0.1554	0.0418
7760	0.0306	-0.0198	-0.1027	0.0662	-0.1554	0.0418
7770	0.0323	-0.0162	-0.1054	0.0662	-0.1554	0.0418
7790	0.0463	-0.0092	-0.0921	0.0367	0.0363	0.0236
7800	0.0473	-0.0055	-0.0936	0.0367	0.0363	0.0236
7870	0.2573	-0.0617	-0.4821	-0.6302	-0.0317	-0.2615
7900	0.3178	-0.0818	-0.6278	-0.6303	-0.0316	-0.2615
7930	0.3702	-0.0993	-0.7543	-0.6307	-0.0316	-0.2614
7970	0.0757	0.0144	-0.0189	0.0485	-0.0273	-0.0057
7980	0	0	0	0	0	0
8000	0.4022	-0.2167	-0.8082	-0.6447	-0.0307	-0.2612
8030	0.0018	-0.0327	0.0086	0.0125	-0.0179	-0.0141
8050	-0.0008	-0.0994	-0.0017	-0.0162	-0.0061	0.0083

8500	-0.0113	-0.0671	0.0221	0.0462	-0.0048	-0.2106
8510	-0.0164	-0.0837	0.0225	0.0459	-0.0048	-0.2104

Job Name: 338716-FINAL

Licensed To: ENS CANADA STRUCTURAL ENGNG & PROJECT MGMT INC

DISPLACEMENTS REPORT: Nodal Movements

CASE 6 (EXP) L6=L3-L4

Node	DX in.	DY in.	DZ in.	RX deg.	RY deg.	RZ deg.
20	0.0578	0.0074	-0.0438	0.0282	-0.0081	0.0032
23	-0.0001	0.0198	0.0013	0.0053	0.0022	0.0004
30	-0.0003	0.0404	0.0043	0.0075	0.0044	-0.0002
31	0.0002	0.0528	0.0065	0.0085	0.0032	-0.0032
40	0.0006	0.0586	0.0075	0.0089	0.0026	-0.0047
50	0.0083	0.0951	0.0151	0.0106	-0.0009	-0.0157
60	0.0096	0.0992	0.016	0.0106	-0.0009	-0.0157
70	0.0119	0.1059	0.0175	0.0106	-0.0009	-0.0157
80	0	0	0	0	0	0
100	0.0149	-0.006	-0.0002	0.0149	0.0248	-0.0098
110	0.0113	-0.0046	0.0033	0.0148	0.0247	-0.0099
120	0.0102	-0.0042	0.0044	0.0148	0.0246	-0.0099
140	0.0092	-0.0038	0.0054	0.0133	0.0229	-0.0103
150	0.0082	-0.0033	0.0063	0.0118	0.0212	-0.0112
160	0.007	-0.0028	0.0073	0.0118	0.0212	-0.0113
170	0.0028	-0.0009	0.0108	0.0116	0.0211	-0.0113
189	0.0016	-0.0004	0.0111	0.009	0.0137	-0.0087
190	0.0008	0	0.0104	0.0034	0.0069	-0.0064
210	0	0	0.0011	0	0	0
220	0	0	0	0	0	0
230	0	0.0081	0.0003	0.0026	0.0009	0.0003
235	-0.0001	0.018	0.0011	0.005	0.002	0.0004
250	-0.0056	0.0391	0.006	-0.0021	0.0222	0.0192
260	-0.0086	0.0379	0.0074	-0.0022	0.0224	0.0194
270	-0.0091	0.0377	0.0076	-0.0022	0.0224	0.0194
290	0.016	-0.0065	-0.0014	0.0149	0.0248	-0.0098
310	0.0172	-0.0069	-0.0025	0.0165	0.0264	-0.0079
320	0.0181	-0.0072	-0.0035	0.0175	0.0279	-0.0067
330	0.0192	-0.0074	-0.0048	0.0185	0.0296	-0.0052
340	0.0214	-0.0078	-0.0076	0.0208	0.0327	-0.0016
350	0.0226	-0.0078	-0.0091	0.0214	0.034	-0.0019
360	0.0268	-0.0082	-0.0148	0.0214	0.0341	-0.0019
370	0.0279	-0.0082	-0.0164	0.0215	0.0341	-0.0019
400	0.0308	-0.0084	-0.0207	0.0285	0.0424	-0.0002
410	0.031	-0.0084	-0.0209	0.0285	0.0424	-0.0002
420	0	0	0	0	0	0
430	0	0	0.0026	0	-0.0001	0

435	-0.0097	0	0.0223	-0.0059	-0.0346	-0.0083
450	-0.0183	0.0036	0.0356	-0.0193	-0.0206	-0.0139
460	-0.0238	0.0089	0.0485	-0.0195	-0.0197	-0.014
470	-0.0316	0.0171	0.0684	-0.0197	-0.0174	-0.0142
480	-0.0326	0.0182	0.0711	-0.0197	-0.0169	-0.0142
510	-0.0296	0.0217	0.0791	-0.0207	0.0542	-0.0175
515	-0.0171	0	0.099	0.1464	0.0165	0.0592
538	-0.0135	-0.0392	0.1091	0.1972	0.0209	0.098
540	-0.018	-0.0464	0.1203	0.1411	0.0257	0.1229
541	-0.0142	-0.0456	0.1137	0.1758	0.0253	0.1059
550	-0.0183	-0.0463	0.1206	0.1407	0.0259	0.1231
560	-0.05	-0.0341	0.1567	0.1397	0.0264	0.1235
570	-0.0571	-0.0314	0.1646	0.1395	0.0265	0.1236
590	-0.1296	0.0049	0.2376	0.066	0.1024	0.0287
599	-0.1291	0.0066	0.2382	0.0588	0.1091	-0.0149
600	-0.1269	0.006	0.2348	0.0542	0.1207	-0.0462
610	-0.1211	0	0.2196	0.0505	0.1277	-0.0397
615	-0.0913	0	0.1367	0.0317	0.1251	0.0057
620	-0.0555	-0.0173	0.0699	0.0092	0.0361	-0.0479
630	-0.0529	-0.0199	0.0679	0.0091	0.0359	-0.0479
640	-0.0502	-0.0226	0.0659	0.0091	0.0357	-0.048
660	-0.048	-0.0249	0.0644	0.0077	0.0265	-0.0504
670	-0.0458	-0.027	0.0633	0.0099	0.0247	-0.0427
680	-0.0432	-0.0294	0.0619	0.0099	0.0247	-0.0425
690	-0.0406	-0.0318	0.0605	0.01	0.0246	-0.0424
695	0.0177	0	0.0342	0.0671	0.0339	0.068
710	0.026	0.0118	0.0275	0.0752	0.0427	0.062
720	0.0287	0.0153	0.0251	0.0753	0.0428	0.0619
730	0.0312	0.0187	0.0228	0.0753	0.0428	0.0617
749	0.0322	0.0216	0.0203	0.0704	0.0532	0.0346
750	0.0308	0.0245	0.0176	0.0643	0.0598	0.0198
770	0.0264	0.0291	0.0142	0.0625	0.0591	0.0003
779	0.0242	0.0306	0.0116	0.0512	0.0585	-0.0127
780	0.0223	0.0295	0.0092	0.037	0.0598	-0.0372
810	0	0.0036	0	0	0.0001	-0.0002
820	0	0	0	0	0	0
830	0.0565	-0.0001	-0.0647	0.0401	0.0423	0.0186
840	0.0576	0.0008	-0.0666	0.0401	0.0423	0.0186
859	0.0592	0.001	-0.0679	0.0394	0.0386	0.0266
860	0.0609	0	-0.0675	0.0406	0.0347	0.0299
880	0.0631	-0.0026	-0.0659	0.0403	0.0332	0.0342
900	0.0678	-0.008	-0.0621	0.0257	0.0292	0.0447
910	0.0692	-0.0091	-0.061	0.0223	0.0286	0.0457
930	0.0723	-0.011	-0.0581	0.0069	0.0256	0.0515
940	0.0757	-0.0119	-0.0548	0.0068	0.0255	0.0516
950	0.0758	-0.012	-0.0547	0.0068	0.0255	0.0516
980	0.0784	-0.0124	-0.052	0.0031	0.0234	0.0575

990	0.0797	-0.0125	-0.0506	0.0035	0.0231	0.0586
1010	0.0821	-0.013	-0.0479	0.0061	0.0226	0.0607
1020	0.0832	-0.0133	-0.0468	0.0061	0.0226	0.0607
1040	0.0857	-0.014	-0.044	0.0061	0.0226	0.0607
1050	0.086	-0.014	-0.0437	0.0061	0.0226	0.0607
1060	0.0566	0.0033	-0.0368	0.0282	-0.0081	0.0032
1090	0.0557	0	-0.0313	0.0282	-0.0081	0.0032
1100	0.0551	-0.0019	-0.0281	0.0269	-0.0081	0.0032
1120	0.054	-0.0051	-0.0217	0.0172	-0.0081	0.0032
1130	0.0537	-0.0057	-0.0198	0.0138	-0.0085	0.0012
1140	0.0533	-0.0063	-0.0176	0.0137	-0.0085	0.0011
1150	0.0529	-0.007	-0.0152	0.0136	-0.0085	0.0011
1170	0.0521	-0.0079	-0.0112	0.009	-0.0089	-0.0032
1180	0.0508	-0.0088	-0.004	0.0042	-0.009	-0.0112
1189	0.0497	-0.0087	-0.0024	0.0008	-0.0085	-0.0145
1190	0.0478	-0.0081	-0.0019	-0.0011	-0.0076	-0.02
1195	0.0294	0	-0.0041	-0.0039	-0.0026	-0.0161
1210	0.0128	0.0031	-0.0035	-0.0063	0.0066	-0.0032
1219	0.0082	0.0031	-0.0034	-0.0079	0.0147	0.0013
1230	0.0068	0.0028	-0.0049	-0.0091	0.0209	0.0028
1250	0.0054	0.0022	-0.0078	-0.0089	0.026	0.0063
1260	0.005	0.0021	-0.0086	-0.0089	0.026	0.0063
1270	0.0008	0.0007	-0.0162	-0.0088	0.0262	0.0064
1300	-0.0028	0	-0.0218	-0.0037	0.0334	0.013
1310	-0.0054	-0.0003	-0.0254	-0.0037	0.0334	0.013
1330	0.0464	-0.0064	-0.0475	0.036	0.0438	0.0071
1350	0.0475	-0.006	-0.0495	0.0366	0.0433	0.0081
1360	0.0498	-0.005	-0.0533	0.0388	0.0428	0.015
1370	0.0509	-0.0042	-0.0553	0.04	0.0424	0.0183
1390	-0.0274	0.0207	0.0759	-0.0356	0.0805	-0.0241
1400	-0.0247	0.0193	0.0714	-0.036	0.081	-0.0242
1410	-0.0145	0.0141	0.0537	-0.0374	0.082	-0.0242
1420	-0.0112	0.0124	0.048	-0.0378	0.0819	-0.0241
1430	-0.011	0.0124	0.0478	-0.0386	0.0817	-0.0239
1439	-0.0091	0.0125	0.0442	-0.0511	0.0707	-0.0038
1440	-0.0087	0.0143	0.0408	-0.0731	0.0647	0.0194
1450	-0.0087	0.0144	0.0406	-0.0734	0.0642	0.0197
1460	-0.0139	0.0267	0.0217	-0.073	0.0629	0.0204
1470	-0.0141	0.0271	0.0211	-0.0729	0.0628	0.0204
1480	-0.0152	0.0298	0.0169	-0.0725	0.0626	0.0206
1510	-0.0173	0.0335	0.0126	-0.0322	0.0426	0.0305
1540	-0.103	0.0769	0.1138	0.2609	0.0294	0.1406
1560	-0.1972	0.1067	0.2867	0.2834	0.0265	0.1547
1580	-0.2149	0.1121	0.3192	0.2835	0.0252	0.1532
1590	-0.2174	0.1129	0.3238	0.2835	0.0252	0.1532
1600	0.0009	0.0576	0.0129	0.0089	0.0026	-0.0047
1610	0.0011	0.0571	0.0158	0.0089	0.0026	-0.0047

1620	0.0012	0.0568	0.0172	0.0089	0.0026	-0.0047
1630	-0.0621	-0.059	0.2114	0.1527	0.0945	0.1794
1640	-0.0603	-0.046	0.2046	0.1527	0.0945	0.1794
1645	-0.0538	0	0.1784	0.1334	0.1046	0.1534
1660	-0.0112	0.0289	0.0148	0.0077	0.0534	-0.0133
1670	-0.01	0.0283	0.0124	0.0076	0.0533	-0.0132
1680	-0.0089	0.0277	0.01	0.0075	0.0533	-0.0132
1700	-0.0078	0.0272	0.0077	0.0041	0.0488	-0.008
1705	0.0053	0.0355	-0.01	-0.0157	0.0228	0.039
1720	0.0081	0.0404	-0.0124	-0.0199	0.0203	0.0477
1729	0.0087	0.042	-0.0134	-0.0196	0.0173	0.0566
1730	0.0085	0.0421	-0.0146	-0.0227	0.0148	0.0598
1760	0.0049	0.0339	-0.0215	-0.0396	0.0114	0.0808
1770	0.0044	0.0319	-0.0226	-0.0456	0.011	0.0801
1775	0.0027	0.0236	-0.0266	-0.0572	0.0106	0.0777
1780	0.001	0.0145	-0.0305	-0.0558	0.0112	0.0753
1790	0.0005	0.0121	-0.0316	-0.0534	0.0116	0.0746
1800	0	0.0097	-0.0327	-0.0498	0.012	0.0739
1810	-0.0018	0.0038	-0.0362	-0.0327	0.014	0.0718
1820	-0.0024	0.0025	-0.0373	-0.0255	0.0148	0.0711
1830	-0.0031	0.0014	-0.0384	-0.0201	0.0147	0.0727
1835	-0.0046	0	-0.041	-0.0057	0.0146	0.0764
1840	-0.0069	0.0006	-0.0448	0.0097	0.0151	0.0818
1850	-0.0076	0.001	-0.046	0.0097	0.0151	0.0818
1860	-0.0082	0.0015	-0.0471	0.0097	0.0151	0.0818
1870	-0.0083	0.0015	-0.0471	0.0097	0.0151	0.0819
1880	-0.0089	0.0019	-0.0482	0.0087	0.0155	0.0835
1890	-0.0097	0.0023	-0.0493	0.0071	0.016	0.0838
1900	-0.0104	0.0026	-0.0505	0.0046	0.0166	0.0842
1910	-0.0111	0.0028	-0.0516	0.0015	0.0172	0.0845
1920	-0.0119	0.0027	-0.0527	-0.0012	0.0183	0.0782
1930	-0.0135	0.0025	-0.0547	-0.0038	0.0205	0.0673
1940	-0.0144	0.0023	-0.0558	-0.0042	0.0219	0.0614
1948	-0.0155	0.0021	-0.057	-0.0038	0.0235	0.0551
1949	-0.0168	0.0013	-0.0574	0.0042	0.0303	0.0458
1950	-0.0182	0.0001	-0.0566	0.0115	0.037	0.0259
1970	0.0136	0.0908	0.0157	0.0158	-0.0101	-0.0571
1980	0.0166	0.0873	0.0163	0.0158	-0.0102	-0.0575
2020	-0.0233	-0.0022	-0.0509	-0.0034	0.0335	0.0133
2030	-0.0259	-0.0024	-0.0545	-0.0033	0.0335	0.0133
2049	-0.0274	-0.0018	-0.0564	0	0.0334	0.0141
2050	-0.0285	0	-0.0571	0.0035	0.0334	0.0154
2070	-0.0322	0.0106	-0.0555	0.0108	0.0323	0.0173
2080	-0.0427	0.0394	-0.0413	0.0377	0.0291	0.0156
2089	-0.0436	0.043	-0.0368	0.0469	0.0288	0.0136
2100	-0.0427	0.0419	-0.0343	0.0519	0.0288	0.0128
2110	-0.0421	0.0407	-0.0332	0.0519	0.0288	0.0128

2120	-0.0399	0.0368	-0.0297	0.0519	0.0288	0.0128
2125	-0.0307	0.0228	-0.0147	0.0301	0.0302	0.007
2150	-0.021	0.0183	-0.0002	0.0054	0.0342	0.0014
2170	-0.016	0.0177	0.007	0.0036	0.0315	0.0055
2179	-0.0141	0.0176	0.0083	0.0036	0.0306	0.0067
2180	-0.0119	0.0179	0.0079	0.0039	0.0296	0.0082
2210	-0.0049	0.0191	0.0038	0.0057	0.0263	0.0082
2218	-0.0028	0.0195	0.0026	0.0063	0.0247	0.0075
2219	-0.0009	0.019	0.0016	0.0059	0.0204	0.0049
2220	-0.0001	0.0173	0.0011	0.0055	0.0175	0.0021
2240	0	0.0036	0	0	0.0001	0
2250	0	0	0	0	0	0
2260	-0.0121	0.0365	0.009	-0.0023	0.0225	0.0195
2280	-0.0151	0.035	0.0108	-0.0146	0.0323	0.0262
2300	-0.0306	-0.0234	-0.0127	0.0113	-0.011	-0.0203
2309	-0.0311	-0.0238	-0.0129	0.0097	-0.0107	-0.02
2310	-0.0317	-0.0238	-0.013	0.0086	-0.0104	-0.0198
2340	-0.042	-0.0198	-0.0151	-0.0079	-0.0073	-0.0159
2349	-0.0425	-0.0196	-0.0149	-0.0088	-0.0064	-0.0154
2350	-0.0428	-0.0194	-0.0144	-0.0103	-0.0055	-0.0152
2390	-0.0432	-0.0186	-0.011	-0.0133	-0.0038	-0.0132
2400	-0.0432	-0.0184	-0.0104	-0.0133	-0.0038	-0.0132
2410	-0.0433	-0.0182	-0.0096	-0.0133	-0.0038	-0.0132
2415	-0.0434	-0.0152	-0.0013	-0.0205	0.0025	-0.0068
2440	-0.0424	-0.0113	0.0067	-0.0249	0.0095	-0.0006
2490	-0.0412	-0.0087	0.0116	-0.0265	0.0142	0.0032
2540	-0.0395	-0.0059	0.0165	-0.0271	0.0193	0.0069
2545	-0.0354	0	0.0264	-0.0289	0.0193	0.0069
2570	-0.0342	0.0018	0.0294	-0.0289	0.0193	0.0069
2579	-0.0338	0.0021	0.0298	-0.0289	0.0193	0.0069
2580	-0.0332	0.0023	0.0298	-0.0289	0.0193	0.0069
2610	-0.0301	0.0028	0.0286	-0.0289	0.0193	0.0069
2620	-0.0293	0.0029	0.0282	-0.0289	0.0193	0.0069
2640	-0.0194	0.0044	0.0242	-0.0289	0.0193	0.0069
2650	-0.0111	0.0056	0.0208	-0.0289	0.0193	0.0069
2660	-0.0083	0.006	0.0197	-0.0289	0.0193	0.0069
2690	-0.0032	0.0067	0.0177	-0.0289	0.0193	0.0069
2700	-0.0025	0.0068	0.0173	-0.0289	0.0193	0.0069
2710	-0.0018	0.0069	0.0171	-0.0289	0.0193	0.0069
2730	0.0077	0.0083	0.0132	-0.0289	0.0193	0.0069
2820	0.0472	-0.0049	-0.0478	0.0362	0.0429	0.0058
2830	0.0467	0.0005	-0.0402	0.0344	0.041	0.0012
2839	0.0463	0.0014	-0.0383	0.0329	0.0402	0.0025
2840	0.0453	0.0017	-0.0364	0.032	0.0388	0.0045
2845	0.0361	0	-0.0226	0.0282	0.0366	0.0025
2860	0.0273	0	-0.0099	0.0246	0.0346	-0.0009
2870	0.0261	0	-0.0083	0.0245	0.0346	-0.0009

2880	0.0219	0.0002	-0.0025	0.0245	0.0346	-0.0008
2899	0.021	-0.0003	-0.0015	0.0241	0.0342	0.0021
2900	0.0207	-0.0012	-0.0019	0.023	0.0342	0.0042
2920	0.0214	-0.0067	-0.0067	0.0212	0.033	0.0004
2930	-0.0078	0.0058	-0.0489	0.0078	0.0154	0.0842
2940	-0.005	0.0152	-0.0506	0.0057	0.0158	0.0839
2949	-0.0028	0.0178	-0.0513	0.0049	0.0162	0.0801
2950	0.0004	0.0181	-0.0517	0.0032	0.0163	0.0752
2960	0.0006	0.0181	-0.0517	0.0032	0.0163	0.0751
2970	0.0287	0.0079	-0.0526	0.0025	0.0207	0.0634
2980	0.0316	0.0068	-0.0527	0.0025	0.0207	0.0634
2990	0.0512	-0.001	-0.0535	0.0027	0.0208	0.0632
3000	0.0514	-0.001	-0.0535	0.0027	0.0208	0.0632
3010	0.06	-0.0045	-0.0542	0.007	0.0223	0.0591
3019	0.0618	-0.0053	-0.0549	0.0129	0.0241	0.0542
3020	0.0616	-0.0051	-0.0561	0.018	0.0266	0.0517
3030	0.0616	-0.0051	-0.0561	0.018	0.0266	0.0516
3040	0.0606	-0.0044	-0.057	0.0187	0.0269	0.0502
3050	0.0594	-0.0035	-0.0581	0.0191	0.0273	0.0486
3060	0.02	0.0831	0.0171	0.0159	-0.0104	-0.0579
3090	0.0231	0.0783	0.018	0.0227	-0.0209	-0.0977
3100	0.036	0.0509	0.0239	0.0239	-0.0224	-0.1025
3110	0.0463	0.0285	0.0289	0.0248	-0.0234	-0.1042
3120	0.049	0.0226	0.0302	0.025	-0.0236	-0.1044
3139	0.0502	0.0176	0.0325	0.0382	-0.0558	-0.1186
3140	0.0482	0.014	0.0353	0.0526	-0.0841	-0.1228
3145	0.0403	0.0092	0.0394	0.0503	-0.0954	-0.1216
3160	-0.0096	-0.0047	0.0627	0.0127	-0.088	-0.1145
3169	-0.0144	-0.0059	0.0645	0.006	-0.0643	-0.1075
3170	-0.0191	-0.0077	0.0651	0.0011	-0.0512	-0.0969
3200	0.0657	-0.0069	-0.061	0.0221	0.0283	0.0465
3210	0.0636	-0.0057	-0.06	0.022	0.0282	0.0466
3220	0.0616	-0.0047	-0.0591	0.022	0.0282	0.0466
3250	0.0103	0.0169	-0.0548	-0.0028	0.0195	0.0757
3270	0.0011	0.0197	-0.0551	-0.0004	0.0168	0.0909
3280	0.0006	0.0198	-0.0551	-0.0004	0.0168	0.0909
3290	-0.0059	0.0216	-0.0551	-0.0004	0.0168	0.091
3300	-0.0079	0.0145	-0.0538	-0.0004	0.0168	0.091
3310	-0.009	0.0103	-0.053	-0.0004	0.0168	0.091
3390	-0.0353	-0.0052	0.0146	-0.0254	0.0233	0.0094
3400	-0.0341	-0.005	0.014	-0.0254	0.0233	0.0094
3420	-0.0262	-0.003	0.0097	-0.0221	0.0278	0.014
3430	-0.0234	-0.0022	0.0081	-0.0221	0.0278	0.014
3470	-0.0193	-0.0009	0.0057	-0.0204	0.0282	0.0163
3475	-0.0168	0	0.0042	-0.0194	0.028	0.0177
3500	-0.0143	0.001	0.0027	-0.0183	0.0274	0.0189
3510	-0.0135	0.0013	0.0023	-0.0183	0.0274	0.0189

3520	-0.0036	0.0052	-0.0035	-0.0183	0.0274	0.0189
3550	-0.0002	0.0065	-0.0053	-0.0173	0.0249	0.0177
3559	0.0003	0.0069	-0.0057	-0.0167	0.0234	0.0169
3560	0.0003	0.0075	-0.006	-0.016	0.0224	0.016
3590	-0.0007	0.0106	-0.007	-0.0146	0.018	0.014
3600	-0.0015	0.0134	-0.0078	-0.0146	0.018	0.014
3630	-0.0022	0.016	-0.0086	-0.0131	0.0152	0.0126
3639	-0.0023	0.0166	-0.0085	-0.0118	0.0145	0.0118
3640	-0.0022	0.0169	-0.008	-0.0105	0.0132	0.0114
3670	-0.0013	0.0176	-0.0045	-0.0069	0.0094	0.008
3680	-0.0012	0.0177	-0.0037	-0.0068	0.0094	0.008
3720	0.0161	-0.0047	-0.0002	0.036	0.0082	0.0285
3730	0.0151	-0.0038	0.0011	0.036	0.0082	0.0285
3760	0.013	-0.0022	0.0036	0.0409	0.0018	0.034
3770	0.0122	-0.0016	0.0046	0.0409	0.0018	0.034
3818	0.0054	0.0038	0.0138	0.0431	-0.0069	0.025
3819	0.0051	0.0044	0.0147	0.0431	-0.0078	0.0212
3820	0.0054	0.005	0.0152	0.0431	-0.0089	0.0173
3827	0.0257	0	0.0211	0.0372	0.0072	-0.0136
3830	0.0318	-0.003	0.0171	0.0355	0.027	-0.0126
3840	0.0324	-0.0033	0.0165	0.0355	0.0271	-0.0126
3868	0.0339	-0.0041	0.0146	0.035	0.0333	-0.0138
3871	0.0341	-0.0041	0.0138	0.0347	0.0377	-0.0148
3890	0.0336	-0.0036	0.013	0.0343	0.0418	-0.0156
3900	0.013	0.0082	0.0027	0.0189	0.0448	-0.0303
3909	0.0124	0.0083	0.0024	0.0168	0.0425	-0.0304
3910	0.0119	0.0081	0.0021	0.0147	0.041	-0.0306
3940	0.0084	0.0053	0.0008	0.008	0.0278	-0.0301
3950	0.0077	0.0046	0.0006	0.008	0.0277	-0.0301
3970	0.0056	0.0028	0.0001	0.0048	0.0194	-0.0261
3980	0.0043	0.0016	-0.0001	0.0048	0.0193	-0.0261
3990	0.0027	-0.0002	-0.0004	0.0026	0.011	-0.0183
3999	0.0024	-0.0004	-0.0003	0.0023	0.0094	-0.0142
4000	0.0021	-0.0004	-0.0003	0.0023	0.0069	-0.01
4030	0.0003	0	0	0	0	0
4040	0	0	0	0	0	0
4070	0.0081	-0.0016	0.0066	0.0149	0.0177	0.0336
4080	0.0068	-0.0007	0.0072	0.0149	0.0177	0.0336
4110	0.0043	0.0009	0.0081	0.0142	0.0159	0.0436
4120	0.0032	0.0015	0.0084	0.0142	0.0159	0.0436
4140	-0.0095	0.0085	0.0117	0.008	0.0127	0.0428
4149	-0.0099	0.009	0.0117	0.0071	0.0127	0.0413
4150	-0.0098	0.0095	0.0116	0.0065	0.0126	0.0396
4190	0.0099	0.0278	-0.0026	-0.0288	0.0322	0.0113
4200	0.0105	0.0281	-0.0034	-0.0288	0.0322	0.0113
4220	0.0123	0.0289	-0.0059	-0.032	0.0366	0.01
4229	0.0124	0.0288	-0.0064	-0.0327	0.0387	0.0094

4230	0.0121	0.0285	-0.0069	-0.0338	0.0408	0.0089
4260	-0.0032	0.0154	-0.0153	-0.0429	0.0432	0.0024
4269	-0.0036	0.0149	-0.0154	-0.0435	0.0418	0.0024
4270	-0.0038	0.0144	-0.015	-0.0441	0.0409	0.0023
4300	-0.0036	0.0124	-0.0115	-0.0453	0.0355	0.0026
4310	-0.0035	0.0118	-0.0103	-0.0453	0.0355	0.0026
4330	-0.0033	0.01	-0.007	-0.0458	0.0307	0.0051
4340	-0.003	0.0088	-0.0048	-0.0458	0.0307	0.0051
4350	-0.0025	0.007	-0.0015	-0.0456	0.0258	0.0105
4359	-0.0025	0.0065	-0.0011	-0.0453	0.0244	0.0133
4360	-0.0026	0.0059	-0.0012	-0.0451	0.0223	0.0152
4400	-0.0043	0.002	-0.0034	-0.0442	0.0161	0.0255
4580	-0.0207	0.0033	0.0039	-0.0204	0.0282	0.0163
4590	-0.0211	0.0044	0.0034	-0.0204	0.0282	0.0163
4610	-0.0232	0.0104	0.0008	-0.0204	0.0282	0.0163
4619	-0.0231	0.0109	0.0005	-0.0204	0.0282	0.0163
4620	-0.0227	0.0113	0.0001	-0.0204	0.0282	0.0163
4650	-0.0043	0.0177	-0.0108	-0.0204	0.0282	0.0163
4659	-0.0038	0.018	-0.0112	-0.0204	0.0282	0.0163
4660	-0.0038	0.0186	-0.0116	-0.0204	0.0282	0.0163
4690	-0.0076	0.0296	-0.0163	-0.0204	0.0282	0.0163
4700	-0.0078	0.0304	-0.0166	-0.0204	0.0282	0.0163
4710	-0.0113	0.0403	-0.0209	-0.0204	0.0282	0.0163
4740	-0.0124	0.0438	-0.0223	-0.0204	0.0282	0.0163
4750	-0.0134	0.0465	-0.0235	-0.0204	0.0282	0.0163
4780	-0.0146	0.05	-0.025	-0.0204	0.0282	0.0163
4789	-0.0146	0.0506	-0.025	-0.0204	0.0282	0.0163
4790	-0.0144	0.051	-0.0246	-0.0204	0.0282	0.0163
4820	-0.0123	0.0526	-0.021	-0.0204	0.0282	0.0163
4830	-0.0118	0.0529	-0.0203	-0.0204	0.0282	0.0163
4840	-0.0114	0.0532	-0.0196	-0.0204	0.0282	0.0163
4850	-0.0183	0	-0.0565	0.0116	0.037	0.0256
4857	-0.0329	0	-0.0315	0.0393	0.0435	-0.0137
4860	-0.0373	0.0024	-0.0242	0.0475	0.0398	-0.0119
4869	-0.0388	0.0035	-0.0232	0.0488	0.0345	-0.0082
4870	-0.0403	0.0055	-0.0236	0.0519	0.0291	-0.0065
4890	-0.0479	0.021	-0.0309	0.0504	0.0234	0.0085
4900	-0.0489	0.0233	-0.0321	0.0504	0.0234	0.0085
4910	-0.0508	0.0273	-0.034	0.0503	0.0234	0.0086
4920	-0.0502	0.0255	-0.0376	0.0502	0.0234	0.0086
4980	-0.0025	-0.0002	-0.0002	-0.0278	0.0058	0.0171
4989	-0.0022	-0.0004	0.0001	-0.0219	0.0052	0.0138
4990	-0.0019	-0.0004	0.0001	-0.0182	0.0039	0.0102
5020	-0.0003	0	0	0	0	0
5030	0	0	0	0	0	0
5040	0	0	0	0	0	0
5050	0	0	-0.0001	0	0	0

5060	-0.0004	0	-0.0036	-0.0001	0.0127	0
5070	-0.0006	0	-0.004	-0.0001	0.0128	0
5080	-0.0078	-0.0001	-0.0081	-0.0004	0.075	-0.0001
5089	-0.009	-0.0001	-0.008	-0.0004	0.0882	-0.0001
5090	-0.0099	-0.0001	-0.0068	-0.0004	0.1006	-0.0001
5110	-0.0155	0	0.0205	-0.0006	0.1246	-0.0006
5119	-0.0165	0	0.0221	-0.0006	0.1196	-0.0007
5120	-0.0182	0	0.0224	-0.0006	0.1138	-0.0008
5140	-0.0292	0	0.0198	-0.0005	0.0962	-0.0014
5150	-0.031	-0.0001	0.0193	-0.0005	0.0962	-0.0014
5155	-0.0578	0	0.0089	0.0012	0.0335	-0.0034
5157	-0.0519	0	-0.0085	-0.0047	-0.0452	-0.0069
5160	-0.0111	0.0001	-0.0234	0.0172	-0.087	-0.0099
5169	-0.0099	0.0005	-0.0236	0.0204	-0.0886	-0.0102
5170	-0.0093	0.001	-0.0234	0.023	-0.0897	-0.0105
5190	-0.0089	0.0019	-0.0226	0.0238	-0.092	-0.0106
5199	-0.0086	0.0022	-0.0217	0.023	-0.0928	-0.0105
5200	-0.0082	0.0022	-0.0203	0.0219	-0.0933	-0.0104
5220	-0.0027	0.0003	-0.0032	0.0053	-0.0432	-0.0045
5230	-0.0017	0.0002	-0.0016	0.0053	-0.0431	-0.0045
5240	0.0452	-0.0067	-0.0455	0.036	0.0438	0.007
5250	0.0421	-0.0076	-0.04	0.0359	0.0438	0.007
5260	0.041	-0.0079	-0.0381	0.0359	0.0438	0.007
5290	0.0381	-0.0085	-0.033	0.0289	0.0426	0
5300	0.0379	-0.0085	-0.0327	0.0289	0.0426	0
5320	0.016	0.0121	-0.0385	-0.0016	0.0177	0.0688
5340	0.0081	0.0149	-0.0392	-0.0179	0.0163	0.0685
5350	0.0077	0.0151	-0.0393	-0.0179	0.0163	0.0685
5360	0.0028	0.0169	-0.0406	-0.018	0.0163	0.0685
5370	0.0008	0.0115	-0.0394	-0.0181	0.0163	0.0685
5380	-0.0003	0.0084	-0.0386	-0.0182	0.0163	0.0685
5410	-0.0684	-0.0449	0.2117	0.1552	0.0917	0.1757
5420	-0.0761	-0.0438	0.2184	0.1552	0.0917	0.1756
5440	-0.0842	-0.0427	0.2255	0.1553	0.0916	0.1755
5450	-0.2059	-0.0236	0.3544	0.1714	0.0443	0.1497
5459	-0.2121	-0.02	0.3604	0.1714	0.041	0.1487
5470	-0.2158	-0.0133	0.3621	0.178	0.0344	0.1476
5480	-0.2209	0.0178	0.358	0.2076	0.0288	0.1497
5485	-0.2238	0.0413	0.3554	0.2463	0.0266	0.151
5500	-0.2265	0.0689	0.3528	0.2756	0.0255	0.1522
5510	-0.2276	0.0818	0.3516	0.2833	0.0252	0.1531
5520	-0.2288	0.0947	0.3505	0.2834	0.0252	0.1531
5530	0	0	0	0	0	0
5550	0	0.0026	0	0	-0.0002	-0.0002
5560	0	0.0052	0	0	-0.0002	-0.0002
5570	0	0.0079	0	0	-0.0002	-0.0002
5600	0.0001	0.0134	0	0.0011	-0.0026	-0.0021

5609	-0.0001	0.0139	0.0001	0.0018	-0.0031	-0.0034
5610	-0.0005	0.0142	0.0003	0.002	-0.004	-0.0043
5640	-0.0136	0.0157	0.0046	0.0162	-0.0098	-0.0153
5649	-0.0142	0.0155	0.0046	0.017	-0.0101	-0.0157
5650	-0.0146	0.015	0.0045	0.0182	-0.0103	-0.0162
5720	0.025	0.0421	-0.0185	-0.0169	0.0066	0.0612
5740	0.0172	0.0475	-0.021	-0.0328	0.0109	0.084
5750	0.0162	0.0481	-0.0214	-0.0328	0.0109	0.084
5760	0.0003	0.0186	0.0118	0.0053	0.0022	0.0004
5770	0.0003	0.0187	0.0107	0.0053	0.0022	0.0004
5780	0.0002	0.019	0.0081	0.0053	0.0022	0.0004
5830	0.052	-0.0034	-0.0572	0.04	0.0424	0.0184
5860	-0.0143	-0.0013	-0.0382	-0.0035	0.0335	0.0131
6188	-0.0995	0.0445	0.1193	0.2803	0.0287	0.145
6189	-0.1008	0.0348	0.1254	0.281	0.027	0.1473
6190	-0.1059	0.0322	0.1364	0.2726	0.0257	0.1516
6200	-0.1062	0.0323	0.137	0.2725	0.0257	0.1517
6210	-0.1148	0.035	0.1525	0.2724	0.0257	0.1517
6420	-0.0288	0.0095	-0.0507	0.0108	0.0323	0.0173
6429	-0.0286	0.0096	-0.0502	0.0108	0.0323	0.0173
6430	-0.0286	0.01	-0.0499	0.0108	0.0323	0.0173
6460	-0.0299	0.0134	-0.0491	0.0108	0.0323	0.0173
6470	-0.0303	0.0144	-0.0489	0.0108	0.0323	0.0173
6480	-0.0306	0.0155	-0.0486	0.0108	0.0323	0.0173
6490	-0.0316	0.018	-0.0481	0.0108	0.0323	0.0173
6500	-0.0323	0.02	-0.0476	0.0108	0.0323	0.0173
6520	0.007	0.041	-0.0224	-0.0331	0.0109	0.0842
6540	-0.01	0.0274	0.0066	0.0031	0.0475	-0.0065
6550	-0.0139	0.0276	0.0044	0.0025	0.0444	-0.0038
6560	-0.0162	0.0277	0.0032	0.0025	0.0444	-0.0037
6670	-0.0172	0.0034	-0.056	-0.0042	0.0219	0.0614
6680	-0.02	0.0046	-0.0562	-0.0042	0.0219	0.0614
6690	-0.0227	0.0057	-0.0564	-0.0042	0.0219	0.0614
6710	-0.1009	0.0375	-0.0617	-0.0042	0.0219	0.0614
6720	0.0491	-0.0039	-0.0517	0.0388	0.0428	0.015
6730	0.0484	-0.0027	-0.0498	0.0388	0.0428	0.015
6740	0.0483	-0.0025	-0.0495	0.0388	0.0428	0.015
6750	-0.021	0.0204	0	0.0051	0.0367	-0.0002
6770	-0.0208	0.0267	0.0006	0.0025	0.0443	-0.0037
6780	-0.0207	0.028	0.0006	0.0025	0.0443	-0.0037
6920	0.0737	-0.01	-0.0502	0.0035	0.0231	0.0586
6930	0.0731	-0.0097	-0.0502	0.0035	0.0231	0.0586
6940	0.0724	-0.0094	-0.0502	0.0035	0.0231	0.0586
6960	0.0687	-0.0078	-0.0499	0.0035	0.0231	0.0586
6970	0.0662	-0.0068	-0.0498	0.0035	0.0231	0.0586
7000	0.0596	-0.0001	-0.0618	0.0403	0.0332	0.0342
7010	0.0592	0.0002	-0.0614	0.0403	0.0332	0.0342

7020	0.0588	0.0005	-0.0609	0.0403	0.0332	0.0342
7040	0.0569	0.0018	-0.0587	0.0403	0.0332	0.0342
7050	0.0555	0.0029	-0.057	0.0403	0.0332	0.0342
7080	0.0548	0.003	-0.0253	0.0269	-0.0081	0.0032
7090	0.0547	0.0036	-0.0249	0.0269	-0.0081	0.0032
7100	0.0547	0.0044	-0.0245	0.0269	-0.0081	0.0032
7120	0.0545	0.007	-0.023	0.0269	-0.0081	0.0032
7130	0.0544	0.009	-0.0219	0.0269	-0.0081	0.0032
7140	0.0194	-0.0064	-0.004	0.0185	0.0296	-0.0052
7150	0.0197	-0.0052	-0.0031	0.0185	0.0296	-0.0052
7160	-0.0029	0.0132	-0.034	-0.0534	0.0116	0.0746
7170	-0.0096	0.0155	-0.0388	-0.0534	0.0116	0.0746
7180	-0.0061	0.0194	0.0017	0.0057	0.0263	0.0082
7190	-0.0077	0.0197	-0.0013	0.0057	0.0263	0.0082
7200	-0.0084	0.0199	-0.0025	0.0057	0.0263	0.0082
7230	-0.2369	0.0204	0.3802	0.2076	0.0288	0.1497
7240	-0.2526	0.023	0.4019	0.2076	0.0288	0.1497
7440	-0.0216	-0.0026	-0.004	0.0246	-0.0106	-0.0201
7450	-0.0211	-0.0014	-0.0034	0.0246	-0.0106	-0.0201
7480	-0.0196	0.0021	-0.0016	0.0243	-0.0105	-0.0196
7490	-0.0185	0.0048	-0.0002	0.0243	-0.0105	-0.0196
7530	0.0518	-0.0128	-0.0122	0.009	-0.0089	-0.0032
7540	0.0517	-0.0148	-0.0125	0.009	-0.0089	-0.0032
7580	-0.1476	0.0453	0.2113	0.2723	0.0257	0.1518
7590	-0.1499	0.046	0.2155	0.2723	0.0257	0.1518
7600	-0.2195	0.0678	0.3402	0.2725	0.0256	0.152
7620	-0.0424	-0.0121	0.0071	-0.0249	0.0095	-0.0006
7630	-0.0424	-0.0121	0.0071	-0.0249	0.0095	-0.0006
7640	-0.0424	-0.0146	0.0085	-0.0249	0.0095	-0.0006
7650	-0.0424	-0.0146	0.0085	-0.0249	0.0095	-0.0006
7660	-0.0425	-0.0166	0.0095	-0.0249	0.0095	-0.0006
7700	0.0197	-0.005	-0.003	0.0185	0.0296	-0.0052
7710	-0.0127	-0.0072	-0.0377	-0.0035	0.0335	0.0131
7720	-0.0119	-0.01	-0.0375	-0.0035	0.0335	0.0131
7750	-0.0166	0.0099	0.057	-0.0374	0.082	-0.0242
7760	-0.0166	0.0098	0.0571	-0.0374	0.082	-0.0242
7770	-0.0176	0.0079	0.0586	-0.0374	0.082	-0.0242
7790	-0.025	0.0047	0.0502	-0.0195	-0.0197	-0.014
7800	-0.0256	0.0028	0.051	-0.0195	-0.0197	-0.014
7870	-0.1453	0.0446	0.2071	0.2723	0.0257	0.1518
7900	-0.1804	0.0556	0.2701	0.2723	0.0257	0.1519
7930	-0.2109	0.0651	0.3248	0.2725	0.0256	0.1519
7970	-0.0412	-0.0079	0.0111	-0.0265	0.0142	0.0032
7980	0	0	0	0	0	0
8000	-0.2308	0.117	0.3485	0.2835	0.0252	0.1532
8030	-0.0011	0.0178	-0.003	-0.0068	0.0094	0.008
8050	-0.0004	0.0542	0.0023	0.0085	0.0032	-0.0032

8500	0.0082	0.0449	-0.0229	-0.033	0.0109	0.0842
8510	0.0101	0.0515	-0.0238	-0.0329	0.0109	0.0841

Job Name: 338716-FINAL

Licensed To: ENS CANADA STRUCTURAL ENGNG & PROJECT MGMT INC

DISPLACEMENTS REPORT: Nodal Movements

CASE 5 (EXP) L5=L2-L4

Node	DX in.	DY in.	DZ in.	RX deg.	RY deg.	RZ deg.
20	-0.0811	-0.0207	0.0519	-0.0784	0.0185	-0.0006
23	-0.0001	-0.0165	-0.0012	-0.0048	-0.0019	0.0007
30	-0.0007	-0.0336	-0.0039	-0.0069	-0.0039	0.0023
31	-0.0017	-0.044	-0.0059	-0.0077	-0.0029	0.0051
40	-0.0024	-0.0488	-0.0068	-0.008	-0.0024	0.0065
50	-0.011	-0.0791	-0.0136	-0.0094	0.0004	0.0166
60	-0.0125	-0.0826	-0.0144	-0.0094	0.0004	0.0166
70	-0.0148	-0.0882	-0.0157	-0.0094	0.0004	0.0166
80	0	0	0	0	0	0
100	-0.0228	0.0097	-0.0031	-0.0239	-0.0322	0.0157
110	-0.0172	0.0074	-0.0077	-0.0237	-0.032	0.0158
120	-0.0155	0.0068	-0.0091	-0.0237	-0.032	0.0158
140	-0.0138	0.0061	-0.0104	-0.0214	-0.0296	0.0165
150	-0.0121	0.0053	-0.0116	-0.0189	-0.0273	0.018
160	-0.0103	0.0045	-0.0128	-0.0189	-0.0273	0.018
170	-0.0037	0.0015	-0.0174	-0.0187	-0.0271	0.0181
189	-0.0018	0.0006	-0.0177	-0.0144	-0.0171	0.0139
190	-0.0008	0	-0.0164	-0.0055	-0.0078	0.0103
210	0	0	-0.0017	0	0	0
220	0	0	0	0	0	0
230	0	-0.0067	-0.0002	-0.0023	-0.0008	0.0002
235	-0.0001	-0.015	-0.001	-0.0045	-0.0018	0.0006
250	0.0038	-0.0331	-0.0054	-0.0012	-0.0193	-0.0102
260	0.0062	-0.0324	-0.0066	-0.0011	-0.0194	-0.0103
270	0.0066	-0.0323	-0.0068	-0.0011	-0.0194	-0.0103
290	-0.0246	0.0104	-0.0017	-0.024	-0.0322	0.0156
310	-0.0264	0.0111	-0.0001	-0.0265	-0.0344	0.0125
320	-0.0279	0.0115	0.0012	-0.028	-0.0364	0.0106
330	-0.0296	0.0119	0.0028	-0.0298	-0.0387	0.0081
340	-0.0332	0.0124	0.0065	-0.0334	-0.043	0.0021
350	-0.035	0.0125	0.0085	-0.0345	-0.0449	0.0024
360	-0.0416	0.0129	0.016	-0.0345	-0.045	0.0025
370	-0.0434	0.013	0.0181	-0.0346	-0.045	0.0024
400	-0.0481	0.0132	0.0237	-0.046	-0.0561	-0.0006
410	-0.0483	0.0132	0.0241	-0.046	-0.0561	-0.0007
420	0	0	0	0	0	0
430	0	0	-0.0022	0	0.0001	0

435	0.0085	0	-0.0186	0.0054	0.0301	0.0057
450	0.0158	-0.0033	-0.0296	0.0171	0.0173	0.0095
460	0.0205	-0.0079	-0.0404	0.0172	0.0165	0.0096
470	0.027	-0.0152	-0.0569	0.0173	0.0144	0.0097
480	0.0278	-0.0161	-0.0592	0.0173	0.014	0.0097
510	0.025	-0.019	-0.0659	0.0156	-0.0492	0.012
515	0.013	0	-0.0824	-0.1236	-0.0173	-0.051
538	0.0093	0.033	-0.0908	-0.1653	-0.0205	-0.0829
540	0.013	0.039	-0.1002	-0.119	-0.024	-0.1035
541	0.0098	0.0383	-0.0946	-0.1476	-0.0238	-0.0895
550	0.0132	0.0389	-0.1005	-0.1186	-0.0242	-0.1037
560	0.0399	0.0287	-0.1309	-0.1178	-0.0246	-0.104
570	0.0458	0.0265	-0.1375	-0.1176	-0.0247	-0.104
590	0.1072	-0.0037	-0.1992	-0.0557	-0.0852	-0.0255
599	0.1068	-0.0052	-0.1998	-0.0493	-0.0907	0.0105
600	0.105	-0.0048	-0.197	-0.0455	-0.1001	0.0364
610	0.1002	0	-0.1844	-0.042	-0.1057	0.0312
615	0.0754	0	-0.1161	-0.0244	-0.1028	-0.0019
620	0.0456	0.018	-0.0612	-0.0033	-0.0297	0.0436
630	0.0434	0.0204	-0.0596	-0.0032	-0.0295	0.0437
640	0.0412	0.0228	-0.0579	-0.0032	-0.0293	0.0437
660	0.0394	0.0249	-0.0567	-0.0019	-0.0218	0.045
670	0.0376	0.0268	-0.0558	-0.0037	-0.0205	0.0377
680	0.0353	0.0289	-0.0546	-0.0038	-0.0205	0.0375
690	0.0332	0.0309	-0.0535	-0.0038	-0.0205	0.0373
695	-0.0153	0	-0.0289	-0.0523	-0.0314	-0.0596
710	-0.0222	-0.0102	-0.0228	-0.0591	-0.0387	-0.053
720	-0.0245	-0.0132	-0.0206	-0.0592	-0.0388	-0.0529
730	-0.0266	-0.0161	-0.0185	-0.0592	-0.0388	-0.0528
749	-0.0274	-0.0185	-0.0163	-0.055	-0.0473	-0.0296
750	-0.0261	-0.0208	-0.0141	-0.05	-0.0525	-0.0171
770	-0.0223	-0.0244	-0.0113	-0.0487	-0.0518	-0.0006
779	-0.0203	-0.0255	-0.0091	-0.04	-0.051	0.0104
780	-0.0187	-0.0246	-0.0072	-0.0289	-0.0519	0.0311
810	0	-0.003	0	0	-0.0001	0.0002
820	0	0	0	0	0	0
830	-0.0886	-0.0001	0.0813	-0.0648	-0.0546	-0.0287
840	-0.0904	-0.0014	0.0838	-0.0648	-0.0546	-0.0287
859	-0.0928	-0.0018	0.0852	-0.0644	-0.0489	-0.0391
860	-0.0951	0	0.0845	-0.0671	-0.0428	-0.0431
880	-0.0977	0.0043	0.082	-0.0673	-0.0405	-0.0488
900	-0.1034	0.0137	0.076	-0.0494	-0.0344	-0.0626
910	-0.105	0.0159	0.0742	-0.0455	-0.0335	-0.0639
930	-0.1086	0.0203	0.0696	-0.0263	-0.0286	-0.0719
940	-0.1124	0.0238	0.0644	-0.0261	-0.0286	-0.072
950	-0.1126	0.0239	0.0642	-0.0261	-0.0286	-0.072
980	-0.1154	0.0261	0.0599	-0.0186	-0.0246	-0.0801

990	-0.1167	0.0271	0.0577	-0.0183	-0.024	-0.0816
1010	-0.1192	0.0291	0.0535	-0.0194	-0.0229	-0.0845
1020	-0.1202	0.0299	0.0517	-0.0194	-0.0229	-0.0845
1040	-0.1228	0.0321	0.0472	-0.0194	-0.0229	-0.0845
1050	-0.1231	0.0324	0.0468	-0.0194	-0.0229	-0.0845
1060	-0.0784	-0.0092	0.046	-0.0784	0.0185	-0.0006
1090	-0.0762	0	0.0414	-0.0784	0.0185	-0.0006
1100	-0.075	0.0053	0.0387	-0.0763	0.0185	-0.0006
1120	-0.0725	0.0148	0.0334	-0.0597	0.0185	-0.0006
1130	-0.0717	0.017	0.0319	-0.0542	0.0187	0.0033
1140	-0.0708	0.0196	0.03	-0.0541	0.0187	0.0034
1150	-0.0699	0.0223	0.028	-0.054	0.0187	0.0035
1170	-0.0683	0.0264	0.0247	-0.0464	0.0188	0.0116
1180	-0.0655	0.0327	0.0187	-0.0379	0.0184	0.0265
1189	-0.0642	0.0335	0.0175	-0.0308	0.0172	0.033
1190	-0.0625	0.0325	0.0175	-0.0268	0.0157	0.0438
1195	-0.0471	0.0139	0.0226	-0.0188	0.0099	0.0438
1210	-0.0333	0.0021	0.0246	-0.0115	0.0009	0.0238
1219	-0.0296	0.0002	0.0251	-0.007	-0.0067	0.0118
1230	-0.0287	-0.0001	0.0264	-0.0025	-0.0125	0.0071
1250	-0.0278	-0.0002	0.0288	-0.0002	-0.0172	-0.0035
1260	-0.0275	-0.0002	0.0295	-0.0002	-0.0172	-0.0035
1270	-0.0247	-0.0003	0.0358	-0.0002	-0.0174	-0.0039
1300	-0.0222	0	0.0404	0.0032	-0.0239	-0.0242
1310	-0.0204	0.0002	0.0435	0.0032	-0.024	-0.0243
1330	-0.0727	0.0096	0.059	-0.0581	-0.0572	-0.0114
1350	-0.0745	0.009	0.0616	-0.0591	-0.0564	-0.0129
1360	-0.078	0.0074	0.0666	-0.0628	-0.0554	-0.0233
1370	-0.0798	0.0062	0.0691	-0.0646	-0.0547	-0.0283
1390	0.0232	-0.0183	-0.063	0.0274	-0.0721	0.0173
1400	0.021	-0.0173	-0.0589	0.0277	-0.0726	0.0174
1410	0.0124	-0.0135	-0.0431	0.0288	-0.0735	0.0175
1420	0.0096	-0.0123	-0.0379	0.0291	-0.0734	0.0174
1430	0.0096	-0.0122	-0.0378	0.0297	-0.0732	0.0173
1439	0.008	-0.0124	-0.0347	0.039	-0.0624	0.0031
1440	0.0076	-0.0139	-0.0319	0.0548	-0.0561	-0.0134
1450	0.0076	-0.014	-0.0318	0.0551	-0.0556	-0.0136
1460	0.0112	-0.0242	-0.0176	0.0546	-0.0544	-0.0141
1470	0.0113	-0.0245	-0.0172	0.0545	-0.0544	-0.0141
1480	0.0121	-0.0268	-0.0141	0.0541	-0.0541	-0.0142
1510	0.0135	-0.0299	-0.0111	0.0169	-0.0364	-0.0204
1540	0.0793	-0.0661	-0.1562	-0.3406	-0.0101	-0.1046
1560	0.1477	-0.0911	-0.3805	-0.3648	-0.007	-0.1103
1580	0.1603	-0.0956	-0.4222	-0.3613	-0.0056	-0.108
1590	0.162	-0.0962	-0.4281	-0.3613	-0.0056	-0.108
1600	-0.0026	-0.0479	-0.0113	-0.008	-0.0024	0.0065
1610	-0.0028	-0.0474	-0.0137	-0.008	-0.0024	0.0065

1620	-0.0029	-0.0472	-0.0149	-0.008	-0.0024	0.0065
1630	0.1171	0.1577	-0.1767	-0.2975	-0.0714	-0.0567
1640	0.1142	0.1536	-0.1716	-0.2975	-0.0714	-0.0567
1645	0.1039	0.1374	-0.1514	-0.2663	-0.0819	-0.0664
1660	0.0364	0.0231	-0.0231	-0.0631	-0.0349	-0.047
1670	0.0346	0.0209	-0.0215	-0.063	-0.0348	-0.047
1680	0.0329	0.0189	-0.02	-0.0629	-0.0347	-0.047
1700	0.0311	0.0168	-0.0185	-0.0574	-0.0304	-0.0446
1705	0.0104	0	-0.0125	-0.0132	0.0012	-0.0423
1720	0.0059	-0.0055	-0.0128	-0.0037	0.0032	-0.0556
1729	0.0044	-0.0079	-0.0123	-0.0035	0.0047	-0.0714
1730	0.0036	-0.0091	-0.0109	0.0022	0.0055	-0.0776
1760	0.002	-0.0059	-0.0001	0.0213	0.0059	-0.1191
1770	0.0018	-0.0047	0.0017	0.0267	0.0057	-0.1178
1775	0.0009	0	0.008	0.0262	0.0045	-0.1136
1780	0.0004	0.0029	0.0142	0.0112	0.002	-0.1093
1790	0.0003	0.0033	0.0159	0.0072	0.0011	-0.1082
1800	0.0003	0.0036	0.0177	0.003	0	-0.1069
1810	0.0006	0.0031	0.0232	-0.0095	-0.0038	-0.1031
1820	0.0008	0.0026	0.0249	-0.0132	-0.0052	-0.102
1830	0.001	0.0019	0.0268	-0.0158	-0.006	-0.1033
1835	0.0017	0	0.0309	-0.02	-0.008	-0.1063
1840	0.0032	-0.0032	0.0369	-0.0191	-0.0115	-0.1107
1850	0.0037	-0.004	0.0387	-0.019	-0.0115	-0.1107
1860	0.0042	-0.0049	0.0404	-0.019	-0.0115	-0.1107
1870	0.0042	-0.0049	0.0405	-0.0188	-0.0116	-0.1108
1880	0.0048	-0.0057	0.0422	-0.0148	-0.0129	-0.112
1890	0.0054	-0.0063	0.0441	-0.01	-0.0141	-0.1141
1900	0.0061	-0.0066	0.0459	-0.0043	-0.0155	-0.1162
1910	0.0068	-0.0067	0.0476	0.0018	-0.0168	-0.1182
1920	0.0076	-0.0064	0.0494	0.0084	-0.0182	-0.11
1930	0.0091	-0.0053	0.0526	0.0157	-0.0212	-0.0957
1940	0.0101	-0.0046	0.0543	0.0173	-0.023	-0.088
1948	0.0112	-0.0037	0.0561	0.0172	-0.0251	-0.0798
1949	0.0129	-0.0021	0.0571	0.0057	-0.034	-0.0672
1950	0.0149	-0.0001	0.0563	-0.0055	-0.0428	-0.0386
1970	-0.0155	-0.075	-0.0141	-0.0136	0.0082	0.054
1980	-0.0179	-0.0717	-0.0146	-0.0137	0.0082	0.0544
2020	-0.0075	0.0019	0.0647	0.0029	-0.024	-0.025
2030	-0.0056	0.0022	0.0677	0.0028	-0.024	-0.0251
2049	-0.0043	0.0016	0.0692	-0.0037	-0.0244	-0.0278
2050	-0.0028	0	0.0696	-0.0105	-0.0249	-0.0319
2070	0.0053	-0.0088	0.0657	-0.0242	-0.0234	-0.0401
2080	0.0348	-0.0328	0.0385	-0.067	-0.0193	-0.0555
2089	0.0397	-0.0352	0.0313	-0.0803	-0.0183	-0.058
2100	0.0399	-0.0326	0.0286	-0.0873	-0.0176	-0.0591
2110	0.0395	-0.0306	0.0276	-0.0874	-0.0176	-0.0591

2120	0.0382	-0.0241	0.0247	-0.0874	-0.0176	-0.0591
2125	0.0326	0	0.0122	-0.055	-0.0185	-0.0648
2150	0.0265	0.0102	0.0002	-0.022	-0.0221	-0.0704
2170	0.0232	0.0119	-0.0059	-0.0052	-0.0215	-0.0888
2179	0.0218	0.0105	-0.007	-0.0016	-0.0224	-0.0947
2180	0.02	0.0069	-0.0068	-0.0009	-0.0231	-0.1009
2210	0.0142	-0.008	-0.0034	-0.004	-0.0217	-0.0966
2218	0.0124	-0.0124	-0.0024	-0.0049	-0.0205	-0.091
2219	0.0097	-0.0148	-0.0016	-0.0052	-0.0172	-0.0716
2220	0.0069	-0.0144	-0.0012	-0.0054	-0.0149	-0.0495
2240	0	-0.003	0	0	0	-0.0001
2250	0	0	0	0	0	0
2260	0.0091	-0.0317	-0.008	-0.001	-0.0195	-0.0104
2280	0.0116	-0.0308	-0.0095	0.0064	-0.0278	-0.0158
2300	0.026	0.0195	0.0121	-0.011	0.0093	0.0175
2309	0.0264	0.0198	0.0123	-0.0095	0.0091	0.0173
2310	0.0269	0.0198	0.0124	-0.0086	0.0088	0.0171
2340	0.0355	0.0164	0.0141	0.0058	0.0059	0.0138
2349	0.036	0.0162	0.014	0.0066	0.0051	0.0134
2350	0.0362	0.0161	0.0136	0.0079	0.0043	0.0132
2390	0.0364	0.0154	0.0107	0.0105	0.0028	0.0115
2400	0.0365	0.0152	0.0102	0.0105	0.0028	0.0115
2410	0.0365	0.0151	0.0095	0.0105	0.0028	0.0115
2415	0.0365	0.0127	0.0026	0.0168	-0.0028	0.006
2440	0.0356	0.0095	-0.004	0.0207	-0.009	0.0007
2490	0.0344	0.0073	-0.0081	0.0221	-0.0131	-0.0025
2540	0.0329	0.005	-0.0122	0.0227	-0.0175	-0.0057
2545	0.0292	0	-0.0204	0.0242	-0.0175	-0.0057
2570	0.0281	-0.0015	-0.0229	0.0242	-0.0175	-0.0057
2579	0.0277	-0.0018	-0.0233	0.0242	-0.0175	-0.0057
2580	0.0272	-0.002	-0.0232	0.0242	-0.0175	-0.0057
2610	0.0246	-0.0023	-0.0221	0.0242	-0.0175	-0.0057
2620	0.024	-0.0024	-0.0218	0.0242	-0.0175	-0.0057
2640	0.0157	-0.0036	-0.0181	0.0242	-0.0175	-0.0057
2650	0.0088	-0.0046	-0.0151	0.0242	-0.0175	-0.0057
2660	0.0065	-0.005	-0.0141	0.0242	-0.0175	-0.0057
2690	0.0023	-0.0056	-0.0122	0.0242	-0.0175	-0.0057
2700	0.0016	-0.0057	-0.0119	0.0242	-0.0175	-0.0057
2710	0.0011	-0.0057	-0.0117	0.0242	-0.0175	-0.0057
2730	-0.0069	-0.0069	-0.0081	0.0242	-0.0175	-0.0057
2820	-0.074	0.0072	0.0589	-0.0585	-0.0558	-0.0093
2830	-0.0731	-0.0013	0.0466	-0.0555	-0.0531	-0.0024
2839	-0.0724	-0.0027	0.0438	-0.0531	-0.0519	-0.0049
2840	-0.0708	-0.0031	0.0411	-0.0517	-0.0499	-0.0083
2845	-0.0563	0	0.0234	-0.0457	-0.0468	-0.0048
2860	-0.0423	0.0002	0.0072	-0.0398	-0.0445	0.0014
2870	-0.0405	0.0001	0.0051	-0.0398	-0.0445	0.0014

2880	-0.0338	-0.0001	-0.0024	-0.0397	-0.0445	0.0014
2899	-0.0323	0.0005	-0.0035	-0.0389	-0.0443	-0.0034
2900	-0.0319	0.002	-0.0028	-0.037	-0.0445	-0.0069
2920	-0.0332	0.0107	0.005	-0.0341	-0.0433	-0.0011
2930	0.003	-0.0108	0.0428	-0.0146	-0.013	-0.1114
2940	-0.0014	-0.023	0.0443	-0.0141	-0.0137	-0.1093
2949	-0.0045	-0.0264	0.0451	-0.0142	-0.0152	-0.1052
2950	-0.0089	-0.0265	0.0458	-0.0143	-0.0159	-0.1007
2960	-0.0092	-0.0265	0.0459	-0.0143	-0.016	-0.1007
2970	-0.0477	-0.0104	0.052	-0.0174	-0.022	-0.0888
2980	-0.0518	-0.0086	0.0528	-0.0174	-0.022	-0.0888
2990	-0.0793	0.0037	0.0583	-0.0176	-0.0221	-0.0886
3000	-0.0795	0.0037	0.0583	-0.0177	-0.0221	-0.0885
3010	-0.0916	0.0094	0.0611	-0.0227	-0.0243	-0.0828
3019	-0.0942	0.0104	0.0627	-0.0298	-0.0268	-0.0758
3020	-0.0942	0.0098	0.0647	-0.0369	-0.0304	-0.0721
3030	-0.0942	0.0097	0.0648	-0.037	-0.0304	-0.072
3040	-0.093	0.0083	0.0662	-0.0383	-0.0309	-0.07
3050	-0.0917	0.0066	0.0679	-0.0399	-0.0315	-0.0676
3060	-0.0208	-0.0677	-0.0152	-0.0137	0.0083	0.0548
3090	-0.0234	-0.0632	-0.016	-0.0193	0.0171	0.0908
3100	-0.0342	-0.0378	-0.0208	-0.0202	0.0184	0.0951
3110	-0.0427	-0.017	-0.0249	-0.0209	0.0193	0.0967
3120	-0.045	-0.0115	-0.026	-0.0211	0.0194	0.0969
3139	-0.0459	-0.007	-0.0279	-0.0318	0.0472	0.1088
3140	-0.0443	-0.0038	-0.0302	-0.0425	0.0717	0.1118
3145	-0.0375	0	-0.0337	-0.0391	0.0815	0.1103
3160	0.0053	0.0085	-0.053	-0.0029	0.0758	0.102
3169	0.0095	0.0091	-0.0546	0.002	0.0556	0.0958
3170	0.0137	0.0105	-0.0554	0.0051	0.0442	0.0863
3200	-0.1005	0.0119	0.0738	-0.0444	-0.033	-0.0649
3210	-0.0975	0.0101	0.0718	-0.0444	-0.033	-0.0649
3220	-0.0947	0.0084	0.0699	-0.0443	-0.0329	-0.065
3250	-0.0243	-0.0257	0.0515	-0.0054	-0.0208	-0.1049
3270	-0.0114	-0.0302	0.0511	0.0002	-0.017	-0.1281
3280	-0.0107	-0.0304	0.0511	0.0002	-0.017	-0.1281
3290	-0.0015	-0.0333	0.0511	0.0002	-0.017	-0.1283
3300	0.0016	-0.0232	0.0498	0.0002	-0.017	-0.1283
3310	0.0034	-0.0173	0.049	0.0002	-0.017	-0.1283
3390	0.0294	0.0044	-0.0105	0.0213	-0.021	-0.0078
3400	0.0284	0.0042	-0.0099	0.0213	-0.021	-0.0078
3420	0.0218	0.0025	-0.0061	0.0186	-0.0249	-0.0117
3430	0.0195	0.0019	-0.0046	0.0186	-0.0249	-0.0117
3470	0.0161	0.0007	-0.0024	0.0172	-0.0252	-0.0137
3475	0.014	0	-0.0011	0.0163	-0.025	-0.0148
3500	0.0119	-0.0008	0.0002	0.0155	-0.0245	-0.0158
3510	0.0113	-0.0011	0.0006	0.0155	-0.0245	-0.0158

3520	0.003	-0.0044	0.0057	0.0155	-0.0245	-0.0158
3550	0.0002	-0.0055	0.0074	0.0146	-0.0223	-0.0148
3559	-0.0002	-0.0058	0.0077	0.0141	-0.0209	-0.014
3560	-0.0002	-0.0063	0.008	0.0135	-0.02	-0.0132
3590	0.0006	-0.0089	0.0088	0.0124	-0.0162	-0.0114
3600	0.0012	-0.0112	0.0095	0.0124	-0.0161	-0.0114
3630	0.0018	-0.0134	0.0102	0.0111	-0.0137	-0.0101
3639	0.0019	-0.0139	0.0101	0.01	-0.013	-0.0095
3640	0.0018	-0.0141	0.0097	0.0088	-0.0118	-0.0091
3670	0.001	-0.0147	0.0068	0.0057	-0.0085	-0.0061
3680	0.0009	-0.0148	0.0061	0.0057	-0.0085	-0.0061
3720	-0.0249	0.0076	-0.0037	-0.0554	-0.01	-0.0438
3730	-0.0232	0.0062	-0.0058	-0.0555	-0.01	-0.0438
3760	-0.02	0.0037	-0.0096	-0.0627	-0.0015	-0.0524
3770	-0.0187	0.0027	-0.0112	-0.0627	-0.0015	-0.0524
3818	-0.0083	-0.0059	-0.0253	-0.0661	0.0102	-0.0385
3819	-0.0079	-0.0069	-0.0266	-0.0661	0.0113	-0.0327
3820	-0.0084	-0.0078	-0.0274	-0.0661	0.0128	-0.0266
3827	-0.0405	0	-0.0345	-0.0578	-0.0145	0.0209
3830	-0.0501	0.0046	-0.0275	-0.0553	-0.045	0.0193
3840	-0.0511	0.0051	-0.0263	-0.0553	-0.045	0.0193
3868	-0.0535	0.0063	-0.0233	-0.0547	-0.0545	0.0212
3871	-0.0538	0.0063	-0.0219	-0.0542	-0.0611	0.0227
3890	-0.0529	0.0055	-0.0207	-0.0536	-0.0674	0.024
3900	-0.0203	-0.013	-0.0044	-0.03	-0.0708	0.0469
3909	-0.0193	-0.0132	-0.0038	-0.0267	-0.0671	0.0469
3910	-0.0185	-0.0128	-0.0034	-0.0235	-0.0647	0.0472
3940	-0.0131	-0.0084	-0.0013	-0.0131	-0.0438	0.0466
3950	-0.0119	-0.0074	-0.001	-0.0131	-0.0438	0.0466
3970	-0.0088	-0.0045	-0.0003	-0.0079	-0.0306	0.0404
3980	-0.0068	-0.0026	0.0001	-0.0079	-0.0305	0.0403
3990	-0.0043	0.0003	0.0006	-0.0043	-0.0173	0.0282
3999	-0.0038	0.0006	0.0005	-0.0038	-0.0149	0.0219
4000	-0.0033	0.0006	0.0004	-0.0038	-0.0109	0.0154
4030	-0.0005	0	0	0	0	0
4040	0	0	0	0	0	0
4070	-0.0123	0.0027	-0.0124	-0.0252	-0.0231	-0.0485
4080	-0.0104	0.0012	-0.0134	-0.0252	-0.0231	-0.0486
4110	-0.0067	-0.0013	-0.0149	-0.0245	-0.0208	-0.0633
4120	-0.0051	-0.0023	-0.0156	-0.0245	-0.0208	-0.0633
4140	0.0132	-0.0134	-0.0215	-0.0163	-0.0168	-0.0614
4149	0.0137	-0.0141	-0.0216	-0.0149	-0.0169	-0.059
4150	0.0136	-0.0149	-0.0215	-0.0141	-0.0168	-0.0564
4190	-0.0176	-0.039	-0.0012	0.0351	-0.0474	-0.0112
4200	-0.0186	-0.0393	0	0.0351	-0.0474	-0.0112
4220	-0.0214	-0.04	0.0037	0.0396	-0.0542	-0.0091
4229	-0.0216	-0.0399	0.0044	0.0407	-0.0574	-0.0081

4230	-0.0211	-0.0395	0.0051	0.0422	-0.0605	-0.0073
4260	0.0015	-0.0229	0.0185	0.0547	-0.0642	0.0041
4269	0.0022	-0.0222	0.0187	0.0556	-0.0622	0.0042
4270	0.0025	-0.0215	0.0182	0.0563	-0.0609	0.0044
4300	0.0029	-0.0183	0.0137	0.0579	-0.0528	0.0044
4310	0.003	-0.0174	0.0122	0.0579	-0.0528	0.0044
4330	0.0032	-0.0145	0.008	0.0584	-0.0455	0.0008
4340	0.0033	-0.0126	0.0052	0.0584	-0.0455	0.0008
4350	0.0031	-0.0097	0.001	0.0578	-0.0382	-0.007
4359	0.0032	-0.009	0.0006	0.0574	-0.036	-0.0112
4360	0.0035	-0.0082	0.0007	0.0569	-0.0329	-0.014
4400	0.006	-0.0033	0.0042	0.0553	-0.0236	-0.0291
4580	0.0173	-0.0027	-0.0009	0.0172	-0.0252	-0.0137
4590	0.0176	-0.0037	-0.0005	0.0172	-0.0252	-0.0137
4610	0.0193	-0.0086	0.0016	0.0172	-0.0252	-0.0137
4619	0.0193	-0.0091	0.0019	0.0172	-0.0252	-0.0137
4620	0.0189	-0.0094	0.0023	0.0172	-0.0252	-0.0137
4650	0.0036	-0.0147	0.0121	0.0172	-0.0252	-0.0137
4659	0.0032	-0.0151	0.0124	0.0172	-0.0252	-0.0137
4660	0.0032	-0.0155	0.0127	0.0172	-0.0252	-0.0137
4690	0.0064	-0.0247	0.0167	0.0172	-0.0252	-0.0137
4700	0.0066	-0.0253	0.017	0.0172	-0.0252	-0.0137
4710	0.0095	-0.0336	0.0205	0.0172	-0.0252	-0.0137
4740	0.0104	-0.0365	0.0218	0.0172	-0.0252	-0.0137
4750	0.0112	-0.0388	0.0228	0.0172	-0.0252	-0.0137
4780	0.0122	-0.0417	0.024	0.0172	-0.0252	-0.0137
4789	0.0123	-0.0422	0.024	0.0172	-0.0252	-0.0137
4790	0.0121	-0.0425	0.0237	0.0172	-0.0252	-0.0137
4820	0.0102	-0.0438	0.0207	0.0172	-0.0252	-0.0137
4830	0.0097	-0.0441	0.0201	0.0172	-0.0252	-0.0137
4840	0.0094	-0.0443	0.0195	0.0172	-0.0252	-0.0137
4850	0.015	0	0.0562	-0.0057	-0.0429	-0.0382
4857	0.0381	0	0.0266	-0.0556	-0.0517	0.0216
4860	0.045	-0.0038	0.0179	-0.0705	-0.0471	0.0203
4869	0.0472	-0.0056	0.0169	-0.0737	-0.0403	0.0164
4870	0.0491	-0.0087	0.0178	-0.0804	-0.0335	0.0149
4890	0.0577	-0.0333	0.0294	-0.0813	-0.0264	-0.0047
4900	0.0589	-0.037	0.0312	-0.0813	-0.0264	-0.0047
4910	0.061	-0.0434	0.0343	-0.0812	-0.0264	-0.0048
4920	0.0607	-0.0405	0.0402	-0.0811	-0.0264	-0.0049
4980	0.0038	0.0001	0.0002	0.0348	-0.0089	-0.02
4989	0.0035	0.0004	-0.0001	0.0275	-0.0079	-0.0165
4990	0.003	0.0005	-0.0002	0.023	-0.0058	-0.0124
5020	0.0005	0	0	0	0	0
5030	0	0	0	0	0	0
5040	0	0	0	0	0	0
5050	0	0	0.0001	0	0	0

5060	0.0006	0	0.0056	0.0002	-0.0201	0
5070	0.001	0	0.0064	0.0002	-0.0202	0
5080	0.0123	0.0001	0.0128	0.0007	-0.1188	0.0002
5089	0.0143	0.0001	0.0126	0.0007	-0.1396	0.0002
5090	0.0156	0.0001	0.0108	0.0007	-0.1593	0.0002
5110	0.0245	0	-0.0325	0.0009	-0.1973	0.001
5119	0.0261	0	-0.0349	0.0009	-0.1893	0.0012
5120	0.0288	0	-0.0354	0.0009	-0.1801	0.0013
5140	0.0462	0.0001	-0.0313	0.0008	-0.1523	0.0021
5150	0.0492	0.0001	-0.0305	0.0008	-0.1522	0.0021
5155	0.0915	0	-0.014	-0.0018	-0.0531	0.0054
5157	0.0821	0	0.0135	0.0074	0.0715	0.0109
5160	0.0176	-0.0002	0.037	-0.0272	0.1378	0.0156
5169	0.0157	-0.0008	0.0374	-0.0324	0.1403	0.0161
5170	0.0147	-0.0016	0.0371	-0.0364	0.1421	0.0167
5190	0.0141	-0.003	0.0357	-0.0377	0.1457	0.0167
5199	0.0136	-0.0034	0.0344	-0.0364	0.147	0.0167
5200	0.013	-0.0034	0.0322	-0.0347	0.1477	0.0165
5220	0.0043	-0.0005	0.0051	-0.0084	0.0685	0.0071
5230	0.0028	-0.0003	0.0025	-0.0083	0.0683	0.0071
5240	-0.0708	0.0101	0.0564	-0.0581	-0.0572	-0.0114
5250	-0.0659	0.0115	0.0493	-0.058	-0.0572	-0.0113
5260	-0.0642	0.012	0.0468	-0.058	-0.0572	-0.0113
5290	-0.0596	0.013	0.0401	-0.0466	-0.0564	-0.001
5300	-0.0593	0.013	0.0397	-0.0466	-0.0564	-0.001
5320	-0.0264	-0.0106	0.0298	-0.0216	-0.0103	-0.0979
5340	-0.0152	-0.0151	0.0275	-0.0159	-0.0066	-0.099
5350	-0.0146	-0.0154	0.0274	-0.0159	-0.0066	-0.099
5360	-0.0075	-0.0182	0.0263	-0.0159	-0.0066	-0.099
5370	-0.0044	-0.0104	0.0258	-0.0159	-0.0066	-0.099
5380	-0.0026	-0.0059	0.0255	-0.0158	-0.0066	-0.099
5410	0.1168	0.1518	-0.1853	-0.3017	-0.0684	-0.0546
5420	0.1191	0.1501	-0.1985	-0.3017	-0.0684	-0.0545
5440	0.1216	0.1483	-0.2123	-0.3018	-0.0683	-0.0545
5450	0.163	0.1177	-0.465	-0.3452	-0.0191	-0.0647
5459	0.1658	0.1109	-0.4772	-0.3504	-0.0179	-0.0724
5470	0.1675	0.0972	-0.4812	-0.3557	-0.0134	-0.0755
5480	0.1692	0.0382	-0.4746	-0.362	-0.0079	-0.0894
5485	0.1699	0	-0.4705	-0.3674	-0.0061	-0.0983
5500	0.1705	-0.0382	-0.4664	-0.3628	-0.0057	-0.1071
5510	0.1708	-0.0548	-0.4646	-0.3612	-0.0055	-0.1079
5520	0.171	-0.0713	-0.4628	-0.3612	-0.0055	-0.108
5530	0	0	0	0	0	0
5550	0	-0.0022	0	0	0.0002	0.0001
5560	0	-0.0043	0	0	0.0002	0.0001
5570	0	-0.0066	0	0	0.0002	0.0001
5600	-0.0001	-0.0112	0	-0.0011	0.0023	0.0018

5609	0	-0.0116	-0.0001	-0.0017	0.0027	0.0029
5610	0.0004	-0.0118	-0.0003	-0.0019	0.0035	0.0037
5640	0.0114	-0.013	-0.0037	-0.0147	0.0085	0.0132
5649	0.0119	-0.0129	-0.0038	-0.0155	0.0087	0.0135
5650	0.0122	-0.0125	-0.0036	-0.0166	0.009	0.014
5720	-0.0287	-0.0244	-0.0023	-0.0072	0.0089	-0.0934
5740	-0.0168	-0.0289	-0.0024	0.0129	0.0061	-0.1261
5750	-0.0153	-0.0293	-0.0023	0.0129	0.0061	-0.1261
5760	-0.0005	-0.0154	-0.01	-0.0048	-0.0019	0.0007
5770	-0.0005	-0.0155	-0.009	-0.0048	-0.0019	0.0007
5780	-0.0004	-0.0158	-0.0068	-0.0048	-0.0019	0.0007
5830	-0.0816	0.0049	0.0717	-0.0647	-0.0547	-0.0283
5860	-0.0139	0.0011	0.0541	0.0032	-0.024	-0.0246
6188	0.0782	-0.024	-0.1608	-0.3641	-0.0085	-0.1066
6189	0.0796	-0.011	-0.1679	-0.3664	-0.0069	-0.1079
6190	0.0835	-0.0068	-0.182	-0.3582	-0.0061	-0.1097
6200	0.0838	-0.0069	-0.1828	-0.3581	-0.006	-0.1097
6210	0.09	-0.0092	-0.2031	-0.358	-0.006	-0.1097
6420	0.0029	-0.0063	0.0617	-0.0242	-0.0234	-0.0401
6429	0.0028	-0.0062	0.0612	-0.0242	-0.0234	-0.0401
6430	0.0031	-0.0065	0.0608	-0.0242	-0.0234	-0.0401
6460	0.006	-0.0094	0.0591	-0.0242	-0.0234	-0.0401
6470	0.0068	-0.0102	0.0586	-0.0242	-0.0234	-0.0401
6480	0.0077	-0.0111	0.058	-0.0242	-0.0234	-0.0401
6490	0.0099	-0.0133	0.0567	-0.0242	-0.0234	-0.0401
6500	0.0116	-0.0149	0.0557	-0.0242	-0.0234	-0.0401
6520	-0.0013	-0.0165	-0.0006	0.0133	0.0061	-0.1264
6540	0.0325	0.0142	-0.0167	-0.0557	-0.0302	-0.0491
6550	0.035	0.0096	-0.0133	-0.0495	-0.0291	-0.0575
6560	0.0365	0.0072	-0.0113	-0.0494	-0.0291	-0.0576
6670	0.0141	-0.0064	0.0551	0.0173	-0.023	-0.088
6680	0.0182	-0.0082	0.0559	0.0173	-0.023	-0.088
6690	0.022	-0.0099	0.0566	0.0173	-0.023	-0.088
6710	0.1341	-0.0603	0.0787	0.0173	-0.023	-0.088
6720	-0.077	0.0057	0.0639	-0.0628	-0.0554	-0.0233
6730	-0.0759	0.0038	0.0609	-0.0628	-0.0554	-0.0233
6740	-0.0757	0.0035	0.0605	-0.0628	-0.0554	-0.0233
6750	0.0296	0.0084	-0.001	-0.0293	-0.0238	-0.0668
6770	0.0379	0.0032	-0.006	-0.0491	-0.029	-0.0578
6780	0.0394	0.0022	-0.0073	-0.0491	-0.029	-0.0578
6920	-0.1083	0.023	0.0558	-0.0183	-0.024	-0.0816
6930	-0.1075	0.0226	0.0557	-0.0183	-0.024	-0.0816
6940	-0.1066	0.0222	0.0554	-0.0183	-0.024	-0.0816
6960	-0.1013	0.0196	0.0543	-0.0183	-0.024	-0.0816
6970	-0.0979	0.018	0.0535	-0.0183	-0.024	-0.0816
7000	-0.0927	0.0003	0.0751	-0.0673	-0.0405	-0.0488
7010	-0.0922	-0.0001	0.0744	-0.0673	-0.0405	-0.0488

7020	-0.0916	-0.0006	0.0736	-0.0673	-0.0405	-0.0488
7040	-0.089	-0.0027	0.07	-0.0673	-0.0405	-0.0488
7050	-0.0869	-0.0044	0.0672	-0.0673	-0.0405	-0.0488
7080	-0.0749	0.0013	0.0309	-0.0763	0.0185	-0.0006
7090	-0.0749	0.0007	0.0298	-0.0763	0.0185	-0.0006
7100	-0.0749	0	0.0286	-0.0763	0.0185	-0.0006
7120	-0.0749	-0.0021	0.0244	-0.0763	0.0185	-0.0006
7130	-0.0748	-0.0037	0.0213	-0.0763	0.0185	-0.0006
7140	-0.03	0.0102	0.0015	-0.0298	-0.0387	0.0081
7150	-0.0304	0.0083	0.0001	-0.0298	-0.0387	0.0081
7160	0.0053	0.0015	0.0162	0.0072	0.0011	-0.1082
7170	0.015	-0.002	0.0169	0.0072	0.0011	-0.1082
7180	0.0151	-0.0082	-0.0017	-0.004	-0.0217	-0.0966
7190	0.0165	-0.0084	0.0008	-0.004	-0.0217	-0.0966
7200	0.017	-0.0085	0.0018	-0.004	-0.0217	-0.0966
7230	0.1788	0.0339	-0.5134	-0.362	-0.0079	-0.0894
7240	0.1882	0.0298	-0.5513	-0.362	-0.0079	-0.0894
7440	0.0182	0.0021	0.0041	-0.0223	0.0091	0.0174
7450	0.0178	0.0011	0.0035	-0.0223	0.0091	0.0174
7480	0.0165	-0.0017	0.0019	-0.0221	0.0091	0.0169
7490	0.0155	-0.004	0.0006	-0.0221	0.0091	0.0169
7530	-0.0672	0.0305	0.0295	-0.0464	0.0188	0.0116
7540	-0.0667	0.0321	0.0314	-0.0464	0.0188	0.0116
7580	0.1137	-0.0177	-0.2804	-0.3579	-0.006	-0.1097
7590	0.1154	-0.0183	-0.2859	-0.3579	-0.006	-0.1097
7600	0.1656	-0.0364	-0.4499	-0.3583	-0.0059	-0.1094
7620	0.0356	0.0101	-0.0044	0.0207	-0.009	0.0007
7630	0.0356	0.0101	-0.0044	0.0207	-0.009	0.0007
7640	0.0356	0.0122	-0.0055	0.0207	-0.009	0.0007
7650	0.0356	0.0122	-0.0055	0.0207	-0.009	0.0007
7660	0.0356	0.0139	-0.0064	0.0207	-0.009	0.0007
7700	-0.0304	0.008	-0.0001	-0.0298	-0.0387	0.0081
7710	-0.017	0.006	0.0537	0.0032	-0.024	-0.0246
7720	-0.0184	0.0084	0.0535	0.0032	-0.024	-0.0246
7750	0.014	-0.01	-0.0456	0.0288	-0.0735	0.0175
7760	0.014	-0.0099	-0.0456	0.0288	-0.0735	0.0175
7770	0.0147	-0.0083	-0.0468	0.0288	-0.0735	0.0175
7790	0.0213	-0.0044	-0.0419	0.0172	0.0165	0.0096
7800	0.0217	-0.0028	-0.0426	0.0172	0.0165	0.0096
7870	0.112	-0.0171	-0.2749	-0.3579	-0.006	-0.1097
7900	0.1374	-0.0263	-0.3577	-0.358	-0.006	-0.1096
7930	0.1594	-0.0342	-0.4296	-0.3582	-0.006	-0.1095
7970	0.0345	0.0066	-0.0077	0.0221	-0.0131	-0.0025
7980	0	0	0	0	0	0
8000	0.1715	-0.0997	-0.4597	-0.3612	-0.0055	-0.108
8030	0.0008	-0.0149	0.0055	0.0057	-0.0085	-0.0061
8050	-0.0012	-0.0452	0.0006	-0.0077	-0.0029	0.0051

8500	-0.0031	-0.0223	-0.0008	0.0132	0.0061	-0.1264
8510	-0.0063	-0.0322	-0.0013	0.013	0.0061	-0.1263

Job Name: 338716-FINAL

Licensed To: ENS CANADA STRUCTURAL ENGNG & PROJECT MGMT INC

DISPLACEMENTS REPORT: Nodal Movements

CASE 4 (SUS) W+P1

Node	DX in.	DY in.	DZ in.	RX deg.	RY deg.	RZ deg.
20	0.0258	-0.0191	0.0351	-0.0844	-0.0366	0.0109
23	-0.0007	-0.0001	-0.0001	-0.0006	-0.0006	0.0036
30	-0.0031	-0.0002	-0.0004	-0.0005	-0.0012	0.0074
31	-0.0049	-0.0003	-0.0005	-0.0003	-0.0012	0.0064
40	-0.0057	-0.0003	-0.0006	-0.0002	-0.0013	0.0059
50	-0.0091	-0.0004	-0.0008	-0.0004	-0.0014	0.003
60	-0.0093	-0.0004	-0.0008	-0.0004	-0.0014	0.003
70	-0.0098	-0.0004	-0.0008	-0.0004	-0.0014	0.003
80	0	0	0	0	0	0
100	-0.0009	-0.0866	-0.0015	0.05	0.0035	-0.1385
110	-0.0009	-0.0668	-0.001	0.05	0.0034	-0.14
120	-0.0009	-0.0607	-0.0008	0.05	0.0034	-0.1404
140	-0.0009	-0.0544	-0.0007	0.0504	0.003	-0.1569
150	-0.0009	-0.0474	-0.0006	0.0502	0.0025	-0.1724
160	-0.0009	-0.0395	-0.0005	0.0502	0.0025	-0.1727
170	-0.0009	-0.0105	0	0.0502	0.0025	-0.173
189	-0.0009	-0.0033	0	0.0413	-0.0001	-0.1468
190	-0.0008	0	0	0.0154	-0.0022	-0.125
210	0	0	0	-0.0001	0	-0.0003
220	0	0	0	0	0	0
230	-0.0001	-0.0001	0	-0.0003	-0.0002	0.0015
235	-0.0006	-0.0001	-0.0001	-0.0006	-0.0005	0.0033
250	-0.0031	-0.0031	-0.0007	-0.0018	-0.0035	0.0361
260	-0.0031	-0.0053	-0.0009	-0.0018	-0.0035	0.0363
270	-0.0031	-0.0057	-0.0009	-0.0018	-0.0035	0.0363
290	-0.0009	-0.0929	-0.0016	0.05	0.0035	-0.138
310	-0.0009	-0.0987	-0.0018	0.0495	0.0036	-0.1129
320	-0.0009	-0.1025	-0.0019	0.0496	0.0036	-0.0942
330	-0.0009	-0.1061	-0.0021	0.0496	0.0036	-0.0726
340	-0.0009	-0.1107	-0.0024	0.0497	0.0035	-0.0302
350	-0.0009	-0.112	-0.0026	0.0497	0.0035	-0.0261
360	-0.0009	-0.1163	-0.0032	0.0497	0.0035	-0.0256
370	-0.0009	-0.1175	-0.0033	0.0497	0.0035	-0.0254
400	-0.0009	-0.1171	-0.0037	0.0502	0.0009	0.0919
410	-0.0009	-0.1165	-0.0037	0.0502	0.0009	0.092
420	0	0	0	0	0	0
430	0	0	0	-0.0001	0	0

435	0.0027	0	0	0.0298	0.0107	0.0149
450	0.0059	-0.0123	0	0.0283	0.011	0.0249
460	0.0089	-0.0197	0	0.0257	0.0109	0.0251
470	0.0134	-0.0294	0	0.0206	0.0106	0.0254
480	0.014	-0.0305	0	0.02	0.0105	0.0254
510	0.0148	-0.0281	0	-0.0409	-0.0009	0.0315
515	0.0155	0	0	-0.0326	0.0041	0.026
538	0.0166	-0.0003	0	0.0196	0.0066	0.0232
540	0.0159	-0.0017	0.0013	0.0223	0.01	0.02
541	0.0166	-0.0013	0.0004	0.025	0.0087	0.022
550	0.0159	-0.0017	0.0014	0.0222	0.01	0.02
560	0.0108	-0.0017	0.0071	0.0221	0.0101	0.02
570	0.0096	-0.0017	0.0083	0.0221	0.0101	0.02
590	-0.0029	-0.0017	0.0225	0.0171	0.0215	0.0127
599	-0.0034	-0.0015	0.0228	0.0173	0.0222	0.0111
600	-0.0035	-0.0011	0.0222	0.0172	0.0237	0.0096
610	-0.0035	0	0.0193	0.0179	0.0247	0.0085
615	-0.0035	0	0.0033	0.0215	0.0243	-0.0163
620	-0.0035	-0.0184	-0.0108	0.0259	0.0108	-0.0123
630	-0.0035	-0.019	-0.0114	0.0259	0.0107	-0.0122
640	-0.0035	-0.0197	-0.012	0.0259	0.0107	-0.0121
660	-0.0035	-0.0202	-0.0125	0.0262	0.0093	-0.0086
670	-0.0035	-0.0205	-0.0129	0.0253	0.0077	-0.0063
680	-0.0035	-0.0209	-0.0133	0.0253	0.0077	-0.0062
690	-0.0035	-0.0212	-0.0137	0.0253	0.0076	-0.0061
695	-0.0035	0	-0.0065	0.0014	-0.0135	0.0096
710	-0.0035	0.0007	-0.0041	-0.0019	-0.0137	0.0005
720	-0.0035	0.0007	-0.0033	-0.002	-0.0137	0.0005
730	-0.0035	0.0007	-0.0026	-0.002	-0.0137	0.0005
749	-0.0033	0.0007	-0.0021	-0.0028	-0.0129	0.0009
750	-0.0029	0.0006	-0.0019	-0.0042	-0.0118	0.001
770	-0.002	0.0003	-0.0019	-0.0047	-0.0111	0.0019
779	-0.0016	0.0001	-0.0018	-0.0049	-0.0097	0.0021
780	-0.0014	0	-0.0016	-0.0047	-0.0091	0.0028
810	0	0	0	0	0	0
820	0	0	0	0	0	0
830	-0.0009	-0.0056	0.0014	0.0508	-0.0102	0.0941
840	-0.0009	-0.0013	0.0019	0.0508	-0.0102	0.0941
859	-0.0011	0.0012	0.0024	0.0568	-0.0164	0.0734
860	-0.0018	0	0.0027	0.068	-0.0225	0.0606
880	-0.0033	-0.0044	0.0027	0.0685	-0.0244	0.0476
900	-0.0074	-0.0139	0.0027	0.0491	-0.0284	0.0161
910	-0.0087	-0.016	0.0027	0.0427	-0.0298	0.0151
930	-0.0124	-0.0196	0.0027	0.0089	-0.0362	0.0084
940	-0.0172	-0.0207	0.0027	0.0086	-0.0363	0.0083
950	-0.0173	-0.0208	0.0027	0.0086	-0.0363	0.0083
980	-0.0215	-0.0204	0.0027	-0.0054	-0.0381	0.0015

990	-0.0236	-0.0201	0.0027	-0.0053	-0.038	0.0003
1010	-0.0276	-0.0197	0.0027	-0.0003	-0.0372	-0.0022
1020	-0.0293	-0.0197	0.0027	-0.0001	-0.0372	-0.0022
1040	-0.0335	-0.0197	0.0027	0.0003	-0.0372	-0.0022
1050	-0.0339	-0.0197	0.0027	0.0003	-0.0372	-0.0022
1060	0.0204	-0.0067	0.0351	-0.0842	-0.0366	0.0109
1090	0.0161	0	0.0351	-0.0376	-0.0366	0.0109
1100	0.0136	0.0019	0.0351	-0.022	-0.0366	0.0109
1120	0.0087	0.0035	0.0351	-0.0072	-0.0366	0.0109
1130	0.0073	0.0037	0.0351	-0.0063	-0.0368	0.0107
1140	0.0055	0.004	0.0351	-0.0063	-0.0368	0.0107
1150	0.0037	0.0044	0.0351	-0.0063	-0.0368	0.0106
1170	0.0006	0.0049	0.0351	-0.0056	-0.0373	0.0101
1180	-0.0052	0.0056	0.0351	-0.0035	-0.0385	0.0092
1189	-0.0066	0.0055	0.0345	-0.0004	-0.0401	0.0097
1190	-0.0073	0.0051	0.033	0.0013	-0.0416	0.0104
1195	-0.0073	0	0.0163	0.0135	-0.044	0.0196
1210	-0.0073	-0.009	0.0008	0.0245	-0.0444	0.0291
1219	-0.0066	-0.0113	-0.0033	0.0281	-0.0439	0.0283
1230	-0.005	-0.0106	-0.0039	0.0325	-0.0434	0.0271
1250	-0.0023	-0.0085	-0.0039	0.0373	-0.0428	0.0265
1260	-0.0016	-0.0079	-0.0039	0.0373	-0.0428	0.0265
1270	0.0053	-0.0019	-0.0039	0.0373	-0.0428	0.0264
1300	0.0101	0	-0.0039	-0.0006	-0.0409	0.0253
1310	0.0132	-0.0001	-0.0039	-0.0008	-0.0409	0.0253
1330	-0.0009	-0.0458	-0.0022	0.0506	-0.0057	0.1329
1350	-0.0009	-0.0401	-0.002	0.0507	-0.0065	0.1102
1360	-0.0009	-0.0309	-0.0013	0.0508	-0.0088	0.0982
1370	-0.0009	-0.0266	-0.0008	0.0508	-0.0101	0.0943
1390	0.0148	-0.0267	0.0002	-0.0336	-0.0045	0.034
1400	0.0148	-0.0247	0.0004	-0.0334	-0.0046	0.0341
1410	0.0148	-0.0173	0.0014	-0.0328	-0.0047	0.0347
1420	0.0148	-0.0149	0.0018	-0.0325	-0.0047	0.0348
1430	0.0148	-0.0148	0.0018	-0.0322	-0.0047	0.0349
1439	0.0142	-0.0134	0.0016	-0.0239	-0.0063	0.0392
1440	0.0128	-0.0128	0.0011	-0.0076	-0.0088	0.0392
1450	0.0127	-0.0128	0.0011	-0.0073	-0.0087	0.0392
1460	0.0026	-0.0128	-0.0008	-0.007	-0.0085	0.0392
1470	0.0023	-0.0128	-0.0008	-0.0069	-0.0085	0.0392
1480	0	-0.0128	-0.0012	-0.0069	-0.0085	0.0392
1510	-0.0031	-0.0127	-0.0017	-0.0056	-0.0056	0.041
1540	-0.0117	-0.0131	-0.022	-0.0399	0.0083	-0.0155
1560	0.0012	-0.0134	-0.0508	-0.0471	0.0111	-0.0232
1580	0.0039	-0.0134	-0.0561	-0.0427	0.0124	-0.0226
1590	0.0043	-0.0134	-0.0568	-0.0427	0.0124	-0.0226
1600	-0.0058	-0.0004	-0.0006	0.0009	-0.0013	0.0059
1610	-0.0059	-0.0004	-0.0006	0.0009	-0.0013	0.0059

1620	-0.0059	-0.0005	-0.0006	0.0009	-0.0013	0.0059
1630	-0.0141	0.0142	-0.0425	-0.0147	-0.0114	-0.0392
1640	-0.0141	0.0114	-0.0416	-0.0147	-0.0114	-0.0392
1645	-0.0141	0	-0.0381	-0.0092	-0.0155	-0.0462
1660	-0.0141	-0.0195	0.0004	0.0265	-0.0244	0.0324
1670	-0.0141	-0.018	0.0015	0.0265	-0.0244	0.0324
1680	-0.0141	-0.0166	0.0026	0.0265	-0.0244	0.0324
1700	-0.0141	-0.0151	0.0037	0.0275	-0.0242	0.0324
1705	-0.0141	0	0.0178	0.0099	-0.0289	0.023
1720	-0.0141	0.0024	0.021	0.0062	-0.0294	0.0195
1729	-0.0136	0.0031	0.0221	0.0031	-0.03	0.0141
1730	-0.0125	0.0033	0.0226	-0.0018	-0.0303	0.0111
1760	-0.0043	0.0019	0.0226	-0.0077	-0.0293	0.0017
1770	-0.0029	0.0016	0.0226	-0.0088	-0.0288	-0.0044
1775	0.0014	0	0.0226	-0.0099	-0.0266	-0.0253
1780	0.0054	-0.0014	0.0226	-0.0062	-0.0239	-0.0462
1790	0.0064	-0.0016	0.0226	-0.0043	-0.023	-0.052
1800	0.0075	-0.0018	0.0226	-0.0019	-0.0221	-0.0581
1810	0.0104	-0.0015	0.0226	0.0063	-0.0188	-0.0767
1820	0.0111	-0.0011	0.0226	0.0091	-0.0177	-0.0825
1830	0.0119	-0.0007	0.0226	0.0089	-0.017	-0.0817
1835	0.0136	0	0.0226	-0.0003	-0.0157	-0.0797
1840	0.0159	-0.0013	0.0226	-0.012	-0.0149	-0.0769
1850	0.0166	-0.0019	0.0226	-0.012	-0.0149	-0.0768
1860	0.0173	-0.0024	0.0226	-0.0119	-0.0149	-0.0768
1870	0.0173	-0.0024	0.0226	-0.0118	-0.0149	-0.0768
1880	0.018	-0.0029	0.0226	-0.008	-0.0151	-0.076
1890	0.0186	-0.0032	0.0226	-0.0046	-0.0148	-0.0687
1900	0.0193	-0.0033	0.0226	-0.0016	-0.0147	-0.0615
1910	0.0199	-0.0033	0.0226	0.0008	-0.0148	-0.0546
1920	0.0206	-0.0032	0.0226	0.0033	-0.0138	-0.0505
1930	0.0216	-0.0028	0.0226	0.0071	-0.0122	-0.0435
1940	0.0222	-0.0024	0.0226	0.0089	-0.0114	-0.0397
1948	0.0227	-0.002	0.0226	0.0102	-0.0106	-0.0357
1949	0.023	-0.0011	0.0225	0.0092	-0.0076	-0.0306
1950	0.0231	0	0.0223	0.0059	-0.0048	-0.0175
1970	-0.0091	-0.0006	-0.0006	-0.0014	-0.0018	-0.004
1980	-0.0091	-0.0009	-0.0005	-0.0014	-0.0018	-0.004
2020	0.0352	-0.0003	-0.0039	0.0006	-0.0408	0.0253
2030	0.0383	-0.0002	-0.0039	0.0007	-0.0408	0.0253
2049	0.0395	-0.0001	-0.0039	0.0041	-0.0395	0.0254
2050	0.0391	0	-0.0037	0.0046	-0.0388	0.0254
2070	0.0335	0	-0.0027	0.005	-0.0352	0.0252
2080	0.0178	0	-0.0017	-0.0013	-0.0256	0.027
2089	0.0149	0	-0.0019	-0.0025	-0.0241	0.0277
2100	0.0136	0.0001	-0.0019	-0.0036	-0.0229	0.0279
2110	0.0131	0.0002	-0.0019	-0.0036	-0.0229	0.0279

2120	0.0114	0.0005	-0.0019	-0.0036	-0.0229	0.0279
2125	0.0047	0	-0.0019	0.0121	-0.0199	0.0306
2150	-0.001	-0.0065	-0.0019	0.024	-0.0178	0.0332
2170	-0.0035	-0.0096	-0.0019	0.0168	-0.0147	0.0346
2179	-0.004	-0.0096	-0.0017	0.013	-0.0126	0.0357
2180	-0.0042	-0.0084	-0.0013	0.0109	-0.0105	0.0366
2210	-0.0042	-0.0031	0.0001	0.0052	-0.0081	0.0348
2218	-0.0042	-0.0015	0.0004	0.0047	-0.0074	0.0332
2219	-0.0038	-0.0004	0.0006	0.0043	-0.006	0.0271
2220	-0.0029	0	0.0005	0.0035	-0.0053	0.0197
2240	0	0	0	0	0	0.0001
2250	0	0	0	0	0	0
2260	-0.0031	-0.008	-0.0012	-0.0018	-0.0035	0.0365
2280	-0.0031	-0.0106	-0.0014	-0.0034	-0.0046	0.0417
2300	-0.0384	-0.0043	0.0225	-0.0485	0.0376	-0.1117
2309	-0.0397	-0.0038	0.0232	-0.0505	0.0384	-0.118
2310	-0.0402	-0.0025	0.0238	-0.0519	0.0395	-0.1241
2340	-0.0402	0.0282	0.033	-0.0704	0.045	-0.1539
2349	-0.04	0.0302	0.0335	-0.072	0.0458	-0.1565
2350	-0.0395	0.0317	0.0337	-0.0742	0.0466	-0.1581
2390	-0.0361	0.0372	0.0337	-0.0761	0.0477	-0.1631
2400	-0.0354	0.0382	0.0337	-0.0761	0.0477	-0.1631
2410	-0.0346	0.0395	0.0337	-0.0761	0.0477	-0.1631
2415	-0.0262	0.0515	0.0337	-0.0553	0.0488	-0.1791
2440	-0.0181	0.0567	0.0337	0.001	0.0469	-0.1946
2490	-0.0134	0.054	0.0337	0.0558	0.0445	-0.204
2540	-0.009	0.0447	0.0337	0.1292	0.041	-0.2134
2545	-0.0004	0	0.0337	0.2731	0.041	-0.5959
2570	0.0022	-0.0176	0.0337	0.2865	0.041	-0.7095
2579	0.0026	-0.024	0.0335	0.2951	0.041	-0.7356
2580	0.0028	-0.0335	0.0331	0.3025	0.041	-0.7752
2610	0.0028	-0.087	0.0304	0.3025	0.041	-0.8532
2620	0.0028	-0.1009	0.0297	0.3025	0.041	-0.8533
2640	0.0028	-0.2795	0.0211	0.3025	0.041	-0.854
2650	0.0028	-0.4332	0.014	0.3025	0.041	-0.8996
2660	0.0028	-0.4855	0.0116	0.3025	0.041	-0.8996
2690	0.0028	-0.582	0.0072	0.3025	0.041	-0.9043
2700	0.0028	-0.5968	0.0065	0.3025	0.041	-0.9043
2710	0.0028	-0.6096	0.006	0.3025	0.041	-0.9043
2730	0.0028	-0.7913	-0.0023	0.3025	0.041	-0.9052
2820	-0.0055	-0.0401	0.0004	0.0507	-0.0061	0.0921
2830	-0.016	-0.04	0.0113	0.0506	-0.0045	0.0034
2839	-0.0148	-0.0392	0.0131	0.0507	-0.004	-0.07
2840	-0.0133	-0.0353	0.0138	0.0509	-0.0031	-0.1266
2845	-0.0133	0	0.013	0.0506	-0.001	0.0199
2860	-0.0133	-0.054	0.013	0.0503	0.0008	0.2208
2870	-0.0133	-0.0642	0.013	0.0503	0.0008	0.2208

2880	-0.0133	-0.1012	0.0132	0.0503	0.0008	0.2201
2899	-0.0107	-0.1087	0.0124	0.0501	0.0016	0.1499
2900	-0.0065	-0.1106	0.0106	0.0498	0.002	0.0753
2920	0.0001	-0.1107	-0.0002	0.0497	0.0032	-0.0132
2930	0.018	-0.0065	0.0233	-0.0064	-0.0157	-0.0799
2940	0.018	-0.0157	0.0251	-0.0027	-0.0169	-0.0812
2949	0.0168	-0.0185	0.0258	-0.001	-0.0171	-0.0706
2950	0.0145	-0.0196	0.026	0.003	-0.0165	-0.0556
2960	0.0143	-0.0196	0.026	0.0031	-0.0166	-0.0554
2970	-0.0014	-0.0196	0.0221	0.0174	-0.0202	-0.0232
2980	-0.0024	-0.0196	0.0213	0.0174	-0.0202	-0.0231
2990	-0.0095	-0.0196	0.0158	0.0177	-0.0202	-0.0227
3000	-0.0096	-0.0196	0.0158	0.0178	-0.0203	-0.0226
3010	-0.0122	-0.0196	0.0127	0.0259	-0.0215	-0.0147
3019	-0.0122	-0.0191	0.0116	0.0362	-0.0241	-0.0063
3020	-0.0113	-0.0176	0.011	0.0432	-0.027	-0.0022
3030	-0.0113	-0.0175	0.011	0.0433	-0.027	-0.0021
3040	-0.0103	-0.0159	0.011	0.0437	-0.0272	0.0003
3050	-0.0091	-0.0139	0.011	0.0431	-0.0273	0.0032
3060	-0.0091	-0.0011	-0.0003	-0.0015	-0.0018	-0.004
3090	-0.0091	-0.0014	-0.0002	-0.0029	-0.002	-0.0005
3100	-0.0091	-0.0014	0.0003	-0.0031	-0.002	0.0009
3110	-0.0091	-0.001	0.0008	-0.0033	-0.0019	0.0021
3120	-0.0091	-0.0009	0.0009	-0.0034	-0.0019	0.0022
3139	-0.0091	-0.0005	0.0009	-0.0065	0.0023	0.0099
3140	-0.0089	-0.0001	0.0008	-0.0034	0.0065	0.0095
3145	-0.0082	0	0.0008	0.0071	0.0083	0.0083
3160	-0.0027	-0.0177	0.0008	0.0475	0.0127	0.0017
3169	-0.0021	-0.0195	0.0001	0.0427	0.0119	0.0008
3170	-0.002	-0.0202	-0.0013	0.0365	0.0112	-0.0012
3200	-0.0079	-0.0139	0.0048	0.0458	-0.0279	0.0097
3210	-0.0084	-0.0139	0.0069	0.0457	-0.0279	0.0096
3220	-0.0088	-0.0139	0.0089	0.0457	-0.0278	0.0094
3250	0.0108	-0.014	0.0258	0.0028	-0.0194	-0.0437
3270	0.016	-0.014	0.026	0.0006	-0.0166	-0.0503
3280	0.0163	-0.014	0.026	0.0006	-0.0166	-0.0503
3290	0.0199	-0.014	0.026	0.0006	-0.0166	-0.0504
3300	0.0199	-0.0101	0.0247	0.0006	-0.0166	-0.0504
3310	0.0199	-0.0078	0.024	0.0006	-0.0166	-0.0504
3390	-0.009	0.0307	0.0303	0.1055	0.0376	-0.1155
3400	-0.009	0.0278	0.0293	0.1055	0.0376	-0.1154
3420	-0.009	0.0155	0.0236	0.0603	0.031	-0.0592
3430	-0.009	0.0121	0.0218	0.0602	0.031	-0.0593
3470	-0.009	0.0048	0.0193	0.0365	0.0275	-0.1174
3475	-0.009	0	0.0179	0.0187	0.0254	-0.0765
3500	-0.009	-0.0033	0.0166	0.0008	0.0232	-0.0495
3510	-0.009	-0.0041	0.0162	0.0008	0.0232	-0.0494

3520	-0.009	-0.0144	0.0114	0.0004	0.0232	-0.0489
3550	-0.009	-0.0175	0.0098	-0.018	0.021	-0.0381
3559	-0.0088	-0.0178	0.0094	-0.0227	0.0211	-0.0354
3560	-0.0084	-0.018	0.0091	-0.0301	0.0218	-0.0333
3590	-0.0064	-0.018	0.0065	-0.0472	0.0183	-0.0291
3600	-0.0047	-0.018	0.0038	-0.0473	0.0182	-0.0291
3630	-0.0032	-0.018	0.0009	-0.0583	0.016	-0.0259
3639	-0.0028	-0.0177	0.0002	-0.0666	0.0148	-0.0234
3640	-0.0026	-0.0169	-0.0001	-0.0739	0.0132	-0.0217
3670	-0.0017	-0.0109	-0.0001	-0.0803	0.0097	-0.0139
3680	-0.0016	-0.0096	-0.0001	-0.0803	0.0097	-0.0139
3720	0.0049	-0.0987	0.0015	0.0262	0.0088	-0.0199
3730	0.0056	-0.0987	0.0024	0.0262	0.0088	-0.0198
3760	0.0055	-0.0987	0.0038	0.0185	0.0106	0.0135
3770	0.0052	-0.0987	0.0042	0.0185	0.0106	0.0135
3818	-0.0029	-0.0987	0.0072	0.0089	0.0131	0.0612
3819	-0.0041	-0.0981	0.0072	0.0074	0.0136	0.0704
3820	-0.0046	-0.0967	0.007	0.0061	0.0141	0.0795
3827	-0.0046	0	-0.0047	-0.036	0.0117	0.0953
3830	-0.0046	0.0174	-0.007	-0.0487	0.0075	0.0543
3840	-0.0046	0.0187	-0.0072	-0.0487	0.0075	0.0542
3868	-0.0046	0.0219	-0.0076	-0.0518	0.0062	0.0501
3871	-0.0047	0.0224	-0.0077	-0.0532	0.0052	0.048
3890	-0.0048	0.0218	-0.0078	-0.0547	0.0043	0.0465
3900	-0.0053	0.0008	-0.0078	-0.0389	-0.0003	0.0234
3909	-0.0052	0.0004	-0.0076	-0.0361	0	0.0226
3910	-0.0049	0.0002	-0.0072	-0.0332	0.0002	0.0213
3940	-0.0028	0.0002	-0.004	-0.0233	0.0004	0.0159
3950	-0.0024	0.0002	-0.0034	-0.0232	0.0004	0.0159
3970	-0.0014	0.0002	-0.002	-0.0171	0.0005	0.0121
3980	-0.0008	0.0002	-0.0012	-0.0171	0.0005	0.0121
3990	-0.0001	0.0002	-0.0001	-0.0113	0.0006	0.0077
3999	0	0.0002	0	-0.0089	0.0002	0.0057
4000	0	0.0001	0	-0.0075	-0.0002	0.0038
4030	0	0	0	0	0	0
4040	0	0	0	0	0	0
4070	0.009	-0.0544	0.005	0.0808	0.0031	-0.0733
4080	0.0117	-0.0544	0.008	0.0808	0.0031	-0.0732
4110	0.0153	-0.0544	0.0135	0.0902	0.0031	-0.0493
4120	0.0166	-0.0544	0.0158	0.0902	0.0031	-0.0493
4140	0.0264	-0.0544	0.0429	0.1022	0.0032	-0.0252
4149	0.0267	-0.0545	0.044	0.1032	0.003	-0.0239
4150	0.0268	-0.0548	0.0444	0.1037	0.0029	-0.0226
4190	0.0267	-0.0559	0.0354	0.1354	0.0279	0.0126
4200	0.0267	-0.0556	0.0347	0.1355	0.0279	0.0126
4220	0.0267	-0.0548	0.0326	0.1383	0.0327	0.0098
4229	0.0266	-0.0541	0.0322	0.1386	0.0349	0.0083

4230	0.0262	-0.0525	0.032	0.1391	0.0371	0.0074
4260	0.0119	-0.0074	0.032	0.1174	0.0412	-0.0191
4269	0.0114	-0.0061	0.0315	0.112	0.0403	-0.0199
4270	0.011	-0.0056	0.0304	0.1064	0.0397	-0.0214
4300	0.0091	-0.0056	0.0224	0.0928	0.035	-0.0248
4310	0.0085	-0.0056	0.0201	0.0928	0.035	-0.0248
4330	0.0067	-0.0056	0.0138	0.081	0.0307	-0.0256
4340	0.0054	-0.0056	0.0099	0.081	0.0307	-0.0256
4350	0.0037	-0.0056	0.0045	0.0699	0.0264	-0.0236
4359	0.0033	-0.0053	0.0037	0.0651	0.0253	-0.0222
4360	0.0029	-0.0047	0.0034	0.06	0.0236	-0.0211
4400	0.0011	-0.0001	0.0034	0.0417	0.018	-0.0162
4580	0.0088	0.0048	0.0226	0.0412	0.0275	-0.2899
4590	0.0161	0.0048	0.0237	0.0412	0.0275	-0.2902
4610	0.0675	0.0047	0.0292	0.0479	0.0275	-0.536
4619	0.0736	0.0022	0.0296	0.0495	0.0272	-0.5988
4620	0.0764	-0.0047	0.0296	0.0505	0.0269	-0.6604
4650	0.0764	-0.3569	0.0191	0.0775	0.0269	-1.0391
4659	0.081	-0.3681	0.0192	0.0785	0.0266	-1.0406
4660	0.0923	-0.3728	0.0199	0.08	0.0264	-1.0408
4690	0.3329	-0.3729	0.0399	0.0925	0.0264	-1.0408
4700	0.3499	-0.3729	0.0414	0.0925	0.0264	-1.0408
4710	0.5676	-0.3729	0.0608	0.0926	0.0264	-1.0408
4740	0.6426	-0.3729	0.0675	0.0955	0.0264	-1.0408
4750	0.7031	-0.3729	0.0731	0.0955	0.0264	-1.0408
4780	0.7792	-0.3729	0.0802	0.0985	0.0264	-1.0408
4789	0.7905	-0.3733	0.0812	0.1002	0.0264	-1.0408
4790	0.7955	-0.3744	0.0817	0.1017	0.0264	-1.0408
4820	0.7974	-0.3822	0.0817	0.1037	0.0264	-1.0408
4830	0.7979	-0.3839	0.0817	0.1037	0.0264	-1.0408
4840	0.7982	-0.3853	0.0817	0.1037	0.0264	-1.0408
4850	0.0231	0	0.0222	0.0058	-0.0048	-0.0173
4857	0.0231	0	0.0219	0.0029	0.0034	0.0086
4860	0.0231	-0.0015	0.0227	0.002	0.0054	0.008
4869	0.023	-0.0017	0.0229	0.0023	0.0074	0.0063
4870	0.0227	-0.0017	0.0231	0.0026	0.0092	0.0053
4890	0.0196	-0.0008	0.0231	0.0045	0.0112	-0.0001
4900	0.0191	-0.0006	0.0231	0.0045	0.0112	-0.0001
4910	0.0182	-0.0002	0.0231	0.0045	0.0112	-0.0001
4920	0.0182	-0.0002	0.0227	0.0046	0.0112	-0.0002
4980	0.0001	-0.0001	0.0005	0.0248	0.0097	-0.0066
4989	0	-0.0001	0.0003	0.019	0.0074	-0.0026
4990	0	-0.0001	0.0001	0.0152	0.0043	0.0008
5020	0	0	0	0	0	0
5030	0	0	0	0	0	0
5040	0	0	0	0	0	0
5050	0	0	0	0	0	0

5060	0	-0.0001	0	-0.002	0	0.002
5070	0	-0.0001	0	-0.002	0	0.002
5080	0	-0.0007	0	-0.0033	0	0.0114
5089	0	-0.0008	0	-0.003	0	0.0123
5090	0	-0.001	0	-0.0027	0.0001	0.0135
5110	0	-0.0046	0	0.0034	0	0.0174
5119	0	-0.0048	0	0.0039	-0.0001	0.0173
5120	0	-0.0049	0	0.0046	-0.0001	0.0172
5140	0	-0.0043	0	0.0074	-0.0002	0.0169
5150	0	-0.0041	0	0.0074	-0.0002	0.0169
5155	0.0002	0	0	0.0067	-0.0005	0.016
5157	0.0006	0	0	-0.0046	-0.0007	0.0145
5160	0.001	-0.003	0	-0.0016	-0.0005	0.0132
5169	0.0009	-0.0031	0	-0.0015	-0.0005	0.0132
5170	0.0007	-0.0031	0	-0.0013	-0.0005	0.0131
5190	0.0002	-0.0031	-0.0001	-0.0012	-0.0004	0.0131
5199	0.0001	-0.003	-0.0001	-0.0011	-0.0004	0.013
5200	0	-0.0028	-0.0001	-0.0011	-0.0004	0.0129
5220	0	-0.0005	0	-0.0003	-0.0002	0.0062
5230	0	-0.0002	0	-0.0003	-0.0002	0.0062
5240	-0.0009	-0.052	-0.0025	0.0506	-0.0056	0.1333
5250	-0.0009	-0.0686	-0.0032	0.0506	-0.0056	0.1337
5260	-0.0009	-0.0744	-0.0034	0.0506	-0.0056	0.1338
5290	-0.0009	-0.0895	-0.0039	0.0502	0.0007	0.0973
5300	-0.0009	-0.0902	-0.0039	0.0502	0.0007	0.0972
5320	-0.0035	-0.0196	0.0227	0.0237	-0.0218	-0.059
5340	0.0043	-0.0195	0.0251	0.0142	-0.0174	-0.0881
5350	0.0048	-0.0195	0.0252	0.0141	-0.0174	-0.0881
5360	0.0112	-0.0195	0.0262	0.0141	-0.0174	-0.0883
5370	0.0112	-0.0126	0.0249	0.014	-0.0173	-0.0884
5380	0.0112	-0.0085	0.0241	0.014	-0.0173	-0.0884
5410	-0.0124	0.0114	-0.0423	-0.0154	-0.0104	-0.0372
5420	-0.0107	0.0114	-0.043	-0.0154	-0.0104	-0.0372
5440	-0.009	0.0114	-0.0437	-0.0154	-0.0104	-0.0372
5450	0.0121	0.0115	-0.0592	-0.0237	0.0066	-0.0224
5459	0.0128	0.0111	-0.0601	-0.0252	0.0079	-0.0218
5470	0.0128	0.0101	-0.0605	-0.0288	0.0102	-0.0212
5480	0.0109	0.0047	-0.0605	-0.0394	0.012	-0.0217
5485	0.0096	0	-0.0605	-0.0533	0.0124	-0.0219
5500	0.0083	-0.0061	-0.0605	-0.0493	0.0123	-0.0222
5510	0.0078	-0.0081	-0.0605	-0.0428	0.0124	-0.0226
5520	0.0072	-0.0101	-0.0605	-0.0427	0.0124	-0.0226
5530	0	0	0	0	0	0
5550	0	0	0	0.0002	0.0002	0.0003
5560	0	0	0	0.0002	0.0002	0.0003
5570	0	0	0	0.0002	0.0002	0.0003
5600	-0.0002	0	0.0001	0.0023	0.0025	0.0046

5609	-0.0003	0	0.0002	0.0039	0.0032	0.0075
5610	-0.0003	-0.0002	0.0002	0.0054	0.0043	0.0102
5640	0.0009	-0.0042	0.0026	0.0015	0.0134	0.0064
5649	0.001	-0.0043	0.0027	-0.0004	0.0141	0.0029
5650	0.001	-0.0043	0.0028	-0.0026	0.0146	-0.0007
5720	-0.0026	0.0033	0.03	-0.0052	-0.0311	0.0098
5740	-0.0036	0.0033	0.0293	-0.0069	-0.0295	0.0076
5750	-0.0037	0.0033	0.0293	-0.0069	-0.0295	0.0076
5760	-0.0009	-0.0006	-0.0001	0.003	-0.0006	0.0036
5770	-0.0009	-0.0006	-0.0001	0.003	-0.0006	0.0036
5780	-0.0008	-0.0004	-0.0001	0.003	-0.0006	0.0036
5830	-0.0009	-0.0222	-0.0004	0.0508	-0.0101	0.0942
5860	0.0242	-0.0003	-0.0039	-0.0004	-0.0409	0.0253
6188	-0.0106	-0.0084	-0.022	-0.0411	0.0092	-0.0179
6189	-0.01	-0.0068	-0.0227	-0.043	0.0108	-0.0193
6190	-0.0091	-0.0061	-0.0243	-0.0452	0.0118	-0.0218
6200	-0.009	-0.0061	-0.0244	-0.0452	0.0118	-0.0218
6210	-0.0078	-0.0061	-0.027	-0.0452	0.0118	-0.0218
6420	0.0299	-0.0014	-0.0027	0.0187	-0.0352	0.0252
6429	0.0295	-0.0016	-0.0026	0.0192	-0.0352	0.0252
6430	0.0291	-0.0017	-0.0024	0.0193	-0.0352	0.0252
6460	0.0273	-0.0017	-0.001	0.0193	-0.0352	0.0252
6470	0.0268	-0.0017	-0.0006	0.0193	-0.0352	0.0252
6480	0.0262	-0.0017	-0.0002	0.0193	-0.0352	0.0252
6490	0.0248	-0.0017	0.0009	0.0193	-0.0352	0.0252
6500	0.0238	-0.0017	0.0017	0.0193	-0.0352	0.0252
6520	-0.0043	0.0024	0.0251	-0.0069	-0.0294	0.0075
6540	-0.013	-0.0138	0.0037	0.0292	-0.0234	0.0326
6550	-0.0111	-0.0112	0.0037	0.0309	-0.0217	0.0329
6560	-0.01	-0.0097	0.0037	0.0309	-0.0217	0.033
6670	0.024	-0.0024	0.023	0.0089	-0.0114	-0.0397
6680	0.0258	-0.0025	0.0234	0.0089	-0.0114	-0.0397
6690	0.0275	-0.0025	0.0238	0.0089	-0.0114	-0.0397
6710	0.0781	-0.0025	0.0351	0.0089	-0.0114	-0.0397
6720	-0.0051	-0.0309	0.0009	0.0508	-0.0088	0.0982
6730	-0.0099	-0.0309	0.0034	0.0508	-0.0088	0.0982
6740	-0.0105	-0.0309	0.0037	0.0508	-0.0088	0.0982
6750	-0.0026	-0.0065	-0.0008	0.0257	-0.0188	0.0332
6770	-0.0069	-0.0065	0.0029	0.0308	-0.0217	0.033
6780	-0.0078	-0.0065	0.0037	0.0308	-0.0217	0.033
6920	-0.0236	-0.0201	0.0021	-0.0053	-0.038	0.0003
6930	-0.0236	-0.0201	0.0021	-0.0053	-0.038	0.0003
6940	-0.0236	-0.0201	0.002	-0.0053	-0.038	0.0003
6960	-0.0236	-0.0201	0.0017	-0.0053	-0.038	0.0003
6970	-0.0236	-0.0201	0.0015	-0.0053	-0.038	0.0003
7000	-0.0082	-0.0044	0.0097	0.0685	-0.0244	0.0476
7010	-0.0087	-0.0044	0.0104	0.0685	-0.0244	0.0476

7020	-0.0092	-0.0044	0.0112	0.0685	-0.0244	0.0476
7040	-0.0118	-0.0044	0.0149	0.0685	-0.0244	0.0476
7050	-0.0138	-0.0044	0.0178	0.0685	-0.0244	0.0476
7080	0.0125	0.0019	0.0328	-0.022	-0.0366	0.0109
7090	0.0124	0.0019	0.0325	-0.022	-0.0366	0.0109
7100	0.0122	0.0019	0.0321	-0.022	-0.0366	0.0109
7120	0.0116	0.0019	0.0309	-0.022	-0.0366	0.0109
7130	0.0111	0.0019	0.03	-0.022	-0.0366	0.0109
7140	0.0022	-0.1061	0	0.0496	0.0036	-0.0726
7150	0.0058	-0.1061	0.0025	0.0496	0.0036	-0.0726
7160	0.0088	-0.0016	0.0224	-0.0043	-0.023	-0.052
7170	0.0135	-0.0016	0.022	-0.0043	-0.023	-0.052
7180	-0.0039	-0.0029	0.0001	0.0042	-0.0081	0.0348
7190	-0.0034	-0.0027	0.0001	0.0042	-0.0081	0.0348
7200	-0.0031	-0.0026	0.0001	0.0042	-0.0081	0.0348
7230	0.0132	0.0047	-0.0647	-0.0394	0.012	-0.0217
7240	0.0155	0.0047	-0.0688	-0.0394	0.012	-0.0217
7440	-0.0068	-0.0043	0.0075	-0.0198	0.0234	-0.0359
7450	-0.0059	-0.0043	0.007	-0.0198	0.0234	-0.0358
7480	-0.0036	-0.0043	0.0057	-0.0163	0.0216	-0.0279
7490	-0.002	-0.0043	0.0048	-0.0163	0.0216	-0.0279
7530	0.0016	0.0049	0.0357	-0.0056	-0.0373	0.0101
7540	0.0021	0.0049	0.0359	-0.0056	-0.0373	0.0101
7580	-0.003	-0.0061	-0.0368	-0.0453	0.0119	-0.0219
7590	-0.0027	-0.0061	-0.0374	-0.0454	0.0119	-0.0219
7600	0.0073	-0.0061	-0.0583	-0.0459	0.0119	-0.022
7620	-0.021	0.0567	0.0337	0.001	0.0469	-0.1946
7630	-0.0212	0.0567	0.0337	0.001	0.0469	-0.1946
7640	-0.0314	0.0567	0.0336	0.001	0.0469	-0.1946
7650	-0.0316	0.0567	0.0336	0.001	0.0469	-0.1946
7660	-0.0397	0.0567	0.0336	0.001	0.0469	-0.1946
7700	0.0062	-0.1061	0.0028	0.0496	0.0036	-0.0726
7710	0.0274	-0.0003	-0.0039	-0.0004	-0.0409	0.0253
7720	0.0288	-0.0003	-0.0039	-0.0004	-0.0409	0.0253
7750	0.0179	-0.0173	0.0043	-0.0328	-0.0047	0.0347
7760	0.0179	-0.0173	0.0044	-0.0328	-0.0047	0.0347
7770	0.0194	-0.0173	0.0057	-0.0328	-0.0047	0.0347
7790	0.0111	-0.0197	-0.0022	0.0257	0.0109	0.0251
7800	0.0121	-0.0197	-0.0033	0.0257	0.0109	0.0251
7870	-0.0034	-0.0061	-0.0361	-0.0453	0.0119	-0.0219
7900	0.0017	-0.0061	-0.0466	-0.0455	0.0119	-0.0219
7930	0.0061	-0.0061	-0.0557	-0.0458	0.0119	-0.022
7970	-0.0098	0.054	0.0347	0.0558	0.0445	-0.204
7980	0	0	0	0	0	0
8000	0.0062	-0.0134	-0.0605	-0.0426	0.0124	-0.0226
8030	-0.0014	-0.0085	-0.0001	-0.0803	0.0097	-0.0139
8050	-0.0047	-0.0004	-0.0005	-0.0008	-0.0012	0.0064

8500	-0.0043	0.0027	0.0264	-0.0069	-0.0294	0.0075
8510	-0.0043	0.0033	0.0288	-0.0069	-0.0295	0.0076

Job Name: 338716-FINAL

Licensed To: ENS CANADA STRUCTURAL ENGNG & PROJECT MGMT INC

DISPLACEMENTS REPORT: Nodal Movements

CASE 3 (OPE) W+T2+P1

Node	DX in.	DY in.	DZ in.	RX deg.	RY deg.	RZ deg.
20	0.0836	-0.0117	-0.0088	-0.0562	-0.0447	0.0141
23	-0.0009	0.0197	0.0012	0.0048	0.0016	0.004
30	-0.0034	0.0401	0.0039	0.007	0.0032	0.0072
31	-0.0048	0.0525	0.0059	0.0081	0.0019	0.0032
40	-0.005	0.0583	0.007	0.0086	0.0014	0.0012
50	-0.0008	0.0947	0.0143	0.0102	-0.0023	-0.0127
60	0.0003	0.0988	0.0152	0.0102	-0.0023	-0.0127
70	0.0021	0.1055	0.0167	0.0102	-0.0023	-0.0127
80	0	0	0	0	0	0
100	0.014	-0.0926	-0.0017	0.0649	0.0282	-0.1483
110	0.0105	-0.0715	0.0023	0.0648	0.0281	-0.1499
120	0.0094	-0.0649	0.0035	0.0648	0.0281	-0.1503
140	0.0083	-0.0582	0.0047	0.0637	0.0259	-0.1672
150	0.0073	-0.0508	0.0057	0.062	0.0238	-0.1836
160	0.0061	-0.0423	0.0068	0.062	0.0237	-0.1839
170	0.0019	-0.0114	0.0108	0.0618	0.0236	-0.1843
189	0.0007	-0.0036	0.0111	0.0503	0.0136	-0.1554
190	0	0	0.0104	0.0188	0.0046	-0.1314
210	0	0	0.0011	-0.0001	0	-0.0003
220	0	0	0	0	0	0
230	-0.0002	0.008	0.0002	0.0023	0.0007	0.0017
235	-0.0007	0.0179	0.001	0.0044	0.0015	0.0037
250	-0.0088	0.036	0.0053	-0.0038	0.0188	0.0553
260	-0.0117	0.0326	0.0065	-0.004	0.0189	0.0557
270	-0.0122	0.032	0.0067	-0.004	0.0189	0.0557
290	0.0152	-0.0994	-0.003	0.0649	0.0283	-0.1477
310	0.0163	-0.1056	-0.0043	0.0661	0.03	-0.1208
320	0.0172	-0.1097	-0.0055	0.067	0.0315	-0.101
330	0.0183	-0.1136	-0.0069	0.0681	0.0332	-0.0779
340	0.0206	-0.1184	-0.01	0.0705	0.0362	-0.0318
350	0.0217	-0.1198	-0.0117	0.0711	0.0376	-0.028
360	0.0259	-0.1245	-0.018	0.0712	0.0377	-0.0275
370	0.027	-0.1258	-0.0197	0.0712	0.0377	-0.0273
400	0.03	-0.1256	-0.0243	0.0787	0.0433	0.0917
410	0.0301	-0.125	-0.0246	0.0787	0.0433	0.0918
420	0	0	0	0	0	0
430	0	0	0.0026	-0.0001	-0.0001	0

435	-0.007	0	0.0224	0.0239	-0.0239	0.0066
450	-0.0124	-0.0087	0.0356	0.009	-0.0096	0.011
460	-0.0149	-0.0108	0.0485	0.0062	-0.0088	0.0111
470	-0.0182	-0.0123	0.0684	0.0009	-0.0068	0.0112
480	-0.0186	-0.0123	0.0711	0.0004	-0.0064	0.0112
510	-0.0148	-0.0064	0.0792	-0.0616	0.0534	0.0139
515	-0.0016	0	0.0991	0.1138	0.0207	0.0852
538	0.0032	-0.0396	0.1091	0.2168	0.0275	0.1212
540	-0.0021	-0.0481	0.1216	0.1634	0.0357	0.1429
541	0.0024	-0.0469	0.1141	0.2007	0.034	0.1279
550	-0.0024	-0.048	0.122	0.1629	0.0359	0.1432
560	-0.0393	-0.0357	0.1638	0.1618	0.0365	0.1435
570	-0.0474	-0.033	0.1729	0.1616	0.0366	0.1435
590	-0.1325	0.0032	0.2601	0.0832	0.1239	0.0414
599	-0.1325	0.0051	0.2611	0.076	0.1313	-0.0038
600	-0.1305	0.0049	0.2571	0.0714	0.1444	-0.0366
610	-0.1247	0	0.2389	0.0684	0.1525	-0.0312
615	-0.0948	0	0.14	0.0533	0.1494	-0.0106
620	-0.059	-0.0357	0.059	0.0351	0.0469	-0.0602
630	-0.0564	-0.039	0.0565	0.0351	0.0467	-0.0602
640	-0.0537	-0.0424	0.0539	0.035	0.0464	-0.0601
660	-0.0516	-0.0451	0.052	0.0339	0.0358	-0.059
670	-0.0494	-0.0476	0.0504	0.0352	0.0324	-0.049
680	-0.0467	-0.0504	0.0486	0.0352	0.0323	-0.0487
690	-0.0441	-0.053	0.0468	0.0352	0.0323	-0.0485
695	0.0142	0	0.0277	0.0686	0.0203	0.0776
710	0.0224	0.0124	0.0234	0.0733	0.029	0.0625
720	0.0251	0.016	0.0218	0.0733	0.0291	0.0624
730	0.0277	0.0194	0.0202	0.0734	0.0292	0.0622
749	0.0289	0.0223	0.0182	0.0675	0.0403	0.0354
750	0.0279	0.0251	0.0158	0.0601	0.048	0.0208
770	0.0244	0.0294	0.0123	0.0578	0.048	0.0022
779	0.0225	0.0306	0.0098	0.0463	0.0488	-0.0106
780	0.0209	0.0295	0.0076	0.0323	0.0507	-0.0344
810	0	0.0036	0	0	0.0001	-0.0002
820	0	0	0	0	0	0
830	0.0556	-0.0057	-0.0633	0.0909	0.0321	0.1127
840	0.0567	-0.0005	-0.0648	0.0909	0.0321	0.1127
859	0.0581	0.0023	-0.0655	0.0962	0.0222	0.1001
860	0.0591	0	-0.0648	0.1086	0.0122	0.0905
880	0.0598	-0.007	-0.0632	0.1088	0.0088	0.0818
900	0.0605	-0.0219	-0.0594	0.0748	0.0008	0.0609
910	0.0605	-0.0251	-0.0583	0.0651	-0.0012	0.0608
930	0.06	-0.0306	-0.0554	0.0158	-0.0106	0.0599
940	0.0585	-0.0327	-0.0521	0.0153	-0.0107	0.0599
950	0.0585	-0.0328	-0.052	0.0153	-0.0107	0.0599
980	0.057	-0.0328	-0.0493	-0.0024	-0.0147	0.059

990	0.0562	-0.0326	-0.0479	-0.0018	-0.015	0.0589
1010	0.0546	-0.0327	-0.0453	0.0058	-0.0146	0.0585
1020	0.0539	-0.033	-0.0441	0.006	-0.0146	0.0585
1040	0.0522	-0.0337	-0.0413	0.0064	-0.0146	0.0585
1050	0.0521	-0.0337	-0.041	0.0064	-0.0146	0.0585
1060	0.077	-0.0034	-0.0018	-0.0561	-0.0447	0.0141
1090	0.0718	0	0.0038	-0.0095	-0.0447	0.0141
1100	0.0688	0	0.007	0.0049	-0.0447	0.0141
1120	0.0628	-0.0016	0.0134	0.0101	-0.0447	0.0141
1130	0.061	-0.0019	0.0152	0.0074	-0.0453	0.0118
1140	0.0588	-0.0023	0.0175	0.0074	-0.0453	0.0118
1150	0.0565	-0.0026	0.0199	0.0073	-0.0453	0.0117
1170	0.0527	-0.0031	0.0238	0.0034	-0.0463	0.0069
1180	0.0456	-0.0033	0.0311	0.0007	-0.0476	-0.002
1189	0.0431	-0.0032	0.0321	0.0004	-0.0486	-0.0048
1190	0.0406	-0.0029	0.031	0.0002	-0.0493	-0.0095
1195	0.0221	0	0.0122	0.0097	-0.0466	0.0035
1210	0.0055	-0.0059	-0.0027	0.0182	-0.0378	0.0259
1219	0.0016	-0.0081	-0.0067	0.0203	-0.0292	0.0296
1230	0.0019	-0.0078	-0.0089	0.0234	-0.0225	0.0299
1250	0.0031	-0.0063	-0.0118	0.0284	-0.0169	0.0327
1260	0.0034	-0.0058	-0.0126	0.0284	-0.0168	0.0328
1270	0.0061	-0.0012	-0.0202	0.0285	-0.0167	0.0328
1300	0.0073	0	-0.0257	-0.0043	-0.0076	0.0383
1310	0.0079	-0.0003	-0.0294	-0.0045	-0.0075	0.0383
1330	0.0455	-0.0522	-0.0497	0.0866	0.0381	0.14
1350	0.0466	-0.0462	-0.0514	0.0873	0.0368	0.1183
1360	0.0489	-0.0359	-0.0546	0.0896	0.0339	0.1132
1370	0.05	-0.0308	-0.0561	0.0908	0.0323	0.1126
1390	-0.0126	-0.006	0.0761	-0.0692	0.076	0.01
1400	-0.0099	-0.0054	0.0718	-0.0694	0.0764	0.01
1410	0.0004	-0.0032	0.0552	-0.0702	0.0773	0.0105
1420	0.0037	-0.0025	0.0498	-0.0704	0.0772	0.0107
1430	0.0038	-0.0024	0.0496	-0.0708	0.077	0.011
1439	0.0051	-0.0009	0.0458	-0.075	0.0644	0.0354
1440	0.0041	0.0016	0.0419	-0.0807	0.0559	0.0586
1450	0.004	0.0017	0.0417	-0.0808	0.0555	0.0589
1460	-0.0113	0.0139	0.021	-0.0799	0.0544	0.0596
1470	-0.0118	0.0143	0.0203	-0.0799	0.0543	0.0596
1480	-0.0152	0.017	0.0157	-0.0794	0.0541	0.0598
1510	-0.0204	0.0208	0.0109	-0.0378	0.037	0.0715
1540	-0.1146	0.0638	0.0917	0.221	0.0377	0.125
1560	-0.196	0.0933	0.2358	0.2363	0.0376	0.1315
1580	-0.211	0.0987	0.2631	0.2408	0.0376	0.1306
1590	-0.2131	0.0994	0.267	0.2408	0.0376	0.1306
1600	-0.0049	0.0572	0.0123	0.0097	0.0014	0.0012
1610	-0.0048	0.0566	0.0153	0.0097	0.0014	0.0012

1620	-0.0048	0.0563	0.0166	0.0097	0.0014	0.0012
1630	-0.0762	-0.0447	0.169	0.138	0.0831	0.1402
1640	-0.0744	-0.0346	0.163	0.138	0.0831	0.1402
1645	-0.0679	0	0.1403	0.1242	0.089	0.1072
1660	-0.0253	0.0094	0.0152	0.0341	0.029	0.0191
1670	-0.0241	0.0103	0.0139	0.0341	0.0289	0.0192
1680	-0.023	0.0111	0.0126	0.0341	0.0288	0.0193
1700	-0.0219	0.0121	0.0114	0.0316	0.0246	0.0244
1705	-0.0088	0.0355	0.0078	-0.0057	-0.0061	0.062
1720	-0.006	0.0427	0.0087	-0.0137	-0.0091	0.0672
1729	-0.0049	0.0451	0.0087	-0.0165	-0.0127	0.0707
1730	-0.004	0.0454	0.008	-0.0245	-0.0155	0.0709
1760	0.0007	0.0359	0.0011	-0.0473	-0.0179	0.0825
1770	0.0015	0.0335	0	-0.0545	-0.0177	0.0757
1775	0.0042	0.0236	-0.0039	-0.0671	-0.016	0.0524
1780	0.0065	0.0131	-0.0079	-0.0621	-0.0127	0.0291
1790	0.007	0.0105	-0.009	-0.0576	-0.0115	0.0226
1800	0.0075	0.0079	-0.0101	-0.0517	-0.01	0.0158
1810	0.0085	0.0023	-0.0136	-0.0264	-0.0049	-0.0049
1820	0.0087	0.0013	-0.0147	-0.0163	-0.003	-0.0114
1830	0.0088	0.0007	-0.0158	-0.0112	-0.0023	-0.0089
1835	0.009	0	-0.0184	-0.006	-0.0011	-0.0033
1840	0.0091	-0.0007	-0.0222	-0.0023	0.0002	0.0049
1850	0.0091	-0.0008	-0.0233	-0.0022	0.0002	0.005
1860	0.009	-0.0009	-0.0244	-0.0022	0.0002	0.005
1870	0.009	-0.0009	-0.0245	-0.002	0.0002	0.0051
1880	0.009	-0.001	-0.0256	0.0007	0.0004	0.0075
1890	0.009	-0.0009	-0.0267	0.0025	0.0012	0.0151
1900	0.0089	-0.0007	-0.0279	0.003	0.0019	0.0227
1910	0.0088	-0.0006	-0.029	0.0023	0.0024	0.0299
1920	0.0087	-0.0005	-0.0301	0.0021	0.0045	0.0277
1930	0.0082	-0.0003	-0.0321	0.0033	0.0083	0.0238
1940	0.0077	-0.0001	-0.0332	0.0047	0.0105	0.0217
1948	0.0072	0.0001	-0.0343	0.0064	0.0129	0.0195
1949	0.0062	0.0002	-0.035	0.0134	0.0227	0.0152
1950	0.0049	0	-0.0343	0.0174	0.0322	0.0083
1970	0.0046	0.0902	0.0152	0.0143	-0.012	-0.0611
1980	0.0075	0.0864	0.0159	0.0144	-0.0121	-0.0615
2020	0.0118	-0.0024	-0.0549	-0.0028	-0.0073	0.0385
2030	0.0124	-0.0026	-0.0585	-0.0026	-0.0073	0.0386
2049	0.0121	-0.0019	-0.0603	0.0041	-0.0061	0.0395
2050	0.0107	0	-0.0608	0.0081	-0.0053	0.0408
2070	0.0013	0.0106	-0.0582	0.0158	-0.003	0.0425
2080	-0.0249	0.0394	-0.043	0.0365	0.0035	0.0426
2089	-0.0287	0.043	-0.0387	0.0444	0.0048	0.0414
2100	-0.0291	0.042	-0.0362	0.0483	0.0058	0.0407
2110	-0.029	0.0409	-0.0351	0.0483	0.0059	0.0407

2120	-0.0285	0.0373	-0.0316	0.0483	0.0059	0.0407
2125	-0.026	0.0228	-0.0167	0.0422	0.0103	0.0376
2150	-0.022	0.0117	-0.0021	0.0294	0.0163	0.0346
2170	-0.0195	0.0081	0.0051	0.0204	0.0168	0.0402
2179	-0.0182	0.008	0.0066	0.0166	0.0181	0.0425
2180	-0.0161	0.0094	0.0066	0.0148	0.0191	0.0448
2210	-0.0091	0.016	0.0038	0.0109	0.0183	0.043
2218	-0.007	0.0179	0.003	0.0109	0.0173	0.0407
2219	-0.0047	0.0186	0.0022	0.0103	0.0144	0.032
2220	-0.0029	0.0173	0.0017	0.0091	0.0122	0.0218
2240	0	0.0036	0	0.0001	0	0.0001
2250	0	0	0	0	0	0
2260	-0.0152	0.0285	0.0079	-0.0041	0.019	0.056
2280	-0.0182	0.0243	0.0094	-0.018	0.0277	0.0679
2300	-0.0691	-0.0277	0.0098	-0.0371	0.0266	-0.132
2309	-0.0707	-0.0276	0.0103	-0.0408	0.0276	-0.138
2310	-0.0719	-0.0262	0.0108	-0.0433	0.029	-0.1439
2340	-0.0822	0.0084	0.0179	-0.0783	0.0377	-0.1698
2349	-0.0826	0.0106	0.0186	-0.0809	0.0394	-0.1719
2350	-0.0823	0.0123	0.0193	-0.0845	0.0412	-0.1733
2390	-0.0793	0.0186	0.0227	-0.0894	0.044	-0.1763
2400	-0.0786	0.0198	0.0234	-0.0894	0.044	-0.1763
2410	-0.0779	0.0213	0.0241	-0.0894	0.044	-0.1763
2415	-0.0696	0.0363	0.0324	-0.0758	0.0513	-0.1859
2440	-0.0605	0.0454	0.0404	-0.0239	0.0565	-0.1952
2490	-0.0545	0.0453	0.0453	0.0294	0.0587	-0.2009
2540	-0.0484	0.0388	0.0502	0.1021	0.0603	-0.2065
2545	-0.0358	0	0.0601	0.2442	0.0603	-0.589
2570	-0.0321	-0.0158	0.0631	0.2576	0.0603	-0.7025
2579	-0.0312	-0.0218	0.0633	0.2663	0.0603	-0.7287
2580	-0.0304	-0.0311	0.0629	0.2736	0.0603	-0.7683
2610	-0.0273	-0.0842	0.059	0.2736	0.0603	-0.8463
2620	-0.0265	-0.098	0.058	0.2736	0.0603	-0.8464
2640	-0.0166	-0.2752	0.0454	0.2736	0.0603	-0.847
2650	-0.0083	-0.4276	0.0348	0.2736	0.0603	-0.8927
2660	-0.0055	-0.4795	0.0313	0.2736	0.0603	-0.8927
2690	-0.0004	-0.5753	0.0249	0.2736	0.0603	-0.8974
2700	0.0003	-0.59	0.0239	0.2736	0.0603	-0.8974
2710	0.001	-0.6027	0.023	0.2736	0.0603	-0.8974
2730	0.0106	-0.7829	0.0109	0.2736	0.0603	-0.8983
2820	0.0417	-0.045	-0.0474	0.0869	0.0368	0.0979
2830	0.0307	-0.0394	-0.0289	0.085	0.0366	0.0046
2839	0.0315	-0.0378	-0.0252	0.0836	0.0362	-0.0675
2840	0.032	-0.0337	-0.0226	0.0829	0.0357	-0.1221
2845	0.0228	0	-0.0095	0.0788	0.0355	0.0224
2860	0.0139	-0.0541	0.0031	0.0749	0.0355	0.2199
2870	0.0128	-0.0642	0.0047	0.0749	0.0355	0.22

2880	0.0086	-0.1011	0.0107	0.0748	0.0355	0.2193
2899	0.0103	-0.1089	0.0109	0.0741	0.0358	0.152
2900	0.0141	-0.1118	0.0088	0.0728	0.0362	0.0794
2920	0.0215	-0.1173	-0.0069	0.0709	0.0362	-0.0128
2930	0.0102	-0.0007	-0.0256	0.0014	-0.0003	0.0043
2940	0.0129	-0.0005	-0.0255	0.003	-0.0011	0.0027
2949	0.014	-0.0007	-0.0255	0.0039	-0.0009	0.0095
2950	0.0149	-0.0015	-0.0257	0.0063	-0.0002	0.0195
2960	0.0149	-0.0015	-0.0257	0.0063	-0.0002	0.0197
2970	0.0273	-0.0117	-0.0305	0.0199	0.0005	0.0403
2980	0.0292	-0.0128	-0.0314	0.02	0.0005	0.0403
2990	0.0417	-0.0206	-0.0376	0.0204	0.0005	0.0405
3000	0.0418	-0.0206	-0.0377	0.0205	0.0005	0.0406
3010	0.0478	-0.0242	-0.0414	0.0329	0.0008	0.0443
3019	0.0495	-0.0244	-0.0433	0.0491	0	0.0479
3020	0.0503	-0.0227	-0.0451	0.0612	-0.0004	0.0495
3030	0.0503	-0.0225	-0.0452	0.0613	-0.0004	0.0495
3040	0.0503	-0.0202	-0.0461	0.0625	-0.0003	0.0506
3050	0.0503	-0.0175	-0.0472	0.0622	0	0.0518
3060	0.0109	0.082	0.0168	0.0144	-0.0122	-0.062
3090	0.014	0.0769	0.0178	0.0198	-0.0229	-0.0982
3100	0.027	0.0495	0.0243	0.0207	-0.0244	-0.1016
3110	0.0372	0.0275	0.0297	0.0214	-0.0253	-0.1022
3120	0.0399	0.0217	0.0311	0.0216	-0.0255	-0.1022
3139	0.0411	0.0171	0.0334	0.0316	-0.0535	-0.1087
3140	0.0393	0.0139	0.0361	0.0492	-0.0776	-0.1133
3145	0.0321	0.0092	0.0402	0.0573	-0.087	-0.1132
3160	-0.0123	-0.0224	0.0635	0.0602	-0.0753	-0.1128
3169	-0.0166	-0.0254	0.0646	0.0487	-0.0524	-0.1067
3170	-0.0211	-0.0278	0.0637	0.0376	-0.04	-0.0981
3200	0.0578	-0.0208	-0.0562	0.0679	0.0004	0.0562
3210	0.0552	-0.0197	-0.0531	0.0677	0.0004	0.0561
3220	0.0528	-0.0186	-0.0501	0.0676	0.0004	0.056
3250	0.0211	0.0028	-0.029	0	0.0001	0.032
3270	0.0172	0.0057	-0.0291	0.0002	0.0002	0.0406
3280	0.017	0.0058	-0.0291	0.0002	0.0002	0.0406
3290	0.014	0.0076	-0.0291	0.0002	0.0002	0.0407
3300	0.0121	0.0044	-0.0291	0.0002	0.0002	0.0407
3310	0.0109	0.0025	-0.029	0.0003	0.0002	0.0406
3390	-0.0443	0.0255	0.0449	0.0801	0.0608	-0.1062
3400	-0.0431	0.0229	0.0434	0.0801	0.0608	-0.106
3420	-0.0352	0.0125	0.0333	0.0381	0.0588	-0.0452
3430	-0.0324	0.0099	0.0299	0.0381	0.0588	-0.0453
3470	-0.0282	0.0039	0.0249	0.0161	0.0557	-0.101
3475	-0.0258	0	0.0221	-0.0007	0.0533	-0.0587
3500	-0.0233	-0.0024	0.0193	-0.0175	0.0507	-0.0306
3510	-0.0225	-0.0029	0.0185	-0.0175	0.0507	-0.0306

3520	-0.0125	-0.0092	0.0079	-0.0179	0.0506	-0.0301
3550	-0.0091	-0.0109	0.0044	-0.0353	0.0459	-0.0204
3559	-0.0085	-0.0109	0.0038	-0.0394	0.0446	-0.0185
3560	-0.0081	-0.0105	0.0031	-0.046	0.0441	-0.0174
3590	-0.0071	-0.0074	-0.0004	-0.0618	0.0363	-0.0151
3600	-0.0062	-0.0046	-0.004	-0.0619	0.0363	-0.0151
3630	-0.0054	-0.0019	-0.0077	-0.0715	0.0312	-0.0134
3639	-0.0051	-0.0011	-0.0083	-0.0784	0.0293	-0.0116
3640	-0.0048	0	-0.0082	-0.0844	0.0263	-0.0103
3670	-0.0031	0.0067	-0.0046	-0.0871	0.0191	-0.0059
3680	-0.0027	0.0081	-0.0038	-0.0871	0.0191	-0.0059
3720	0.021	-0.1034	0.0012	0.0622	0.017	0.0085
3730	0.0207	-0.1025	0.0036	0.0622	0.017	0.0087
3760	0.0185	-0.1009	0.0074	0.0593	0.0125	0.0475
3770	0.0173	-0.1003	0.0089	0.0593	0.0124	0.0475
3818	0.0025	-0.0949	0.021	0.052	0.0062	0.0862
3819	0.0011	-0.0937	0.0219	0.0505	0.0058	0.0916
3820	0.0008	-0.0918	0.0222	0.0492	0.0052	0.0967
3827	0.0211	0	0.0165	0.0012	0.0189	0.0818
3830	0.0271	0.0144	0.0101	-0.0132	0.0346	0.0417
3840	0.0278	0.0154	0.0093	-0.0132	0.0346	0.0417
3868	0.0293	0.0178	0.007	-0.0168	0.0395	0.0363
3871	0.0294	0.0183	0.006	-0.0185	0.0429	0.0332
3890	0.0288	0.0182	0.0052	-0.0204	0.0461	0.0309
3900	0.0078	0.009	-0.0051	-0.02	0.0446	-0.0069
3909	0.0073	0.0087	-0.0053	-0.0193	0.0425	-0.0078
3910	0.007	0.0083	-0.0052	-0.0185	0.0412	-0.0093
3940	0.0056	0.0055	-0.0032	-0.0152	0.0282	-0.0142
3950	0.0052	0.0048	-0.0029	-0.0152	0.0281	-0.0142
3970	0.0042	0.003	-0.0019	-0.0123	0.0199	-0.014
3980	0.0035	0.0018	-0.0013	-0.0123	0.0198	-0.014
3990	0.0026	0	-0.0005	-0.0087	0.0116	-0.0105
3999	0.0024	-0.0002	-0.0004	-0.0066	0.0096	-0.0085
4000	0.0021	-0.0002	-0.0002	-0.0052	0.0067	-0.0062
4030	0.0003	0	0	0	0	0
4040	0	0	0	0	0	0
4070	0.0171	-0.0561	0.0116	0.0957	0.0208	-0.0398
4080	0.0185	-0.0551	0.0152	0.0958	0.0208	-0.0396
4110	0.0196	-0.0535	0.0216	0.1043	0.019	-0.0056
4120	0.0198	-0.0529	0.0242	0.1043	0.019	-0.0056
4140	0.0169	-0.0459	0.0546	0.1103	0.0158	0.0177
4149	0.0168	-0.0456	0.0557	0.1103	0.0157	0.0174
4150	0.017	-0.0453	0.056	0.1102	0.0155	0.017
4190	0.0366	-0.0281	0.0328	0.1067	0.06	0.0238
4200	0.0372	-0.0275	0.0313	0.1067	0.06	0.0238
4220	0.039	-0.0259	0.0266	0.1064	0.0693	0.0198
4229	0.039	-0.0252	0.0258	0.1059	0.0736	0.0177

4230	0.0383	-0.024	0.0252	0.1053	0.0778	0.0163
4260	0.0088	0.0081	0.0167	0.0744	0.0844	-0.0167
4269	0.0078	0.0087	0.0161	0.0684	0.0821	-0.0175
4270	0.0072	0.0088	0.0153	0.0623	0.0807	-0.019
4300	0.0056	0.0068	0.011	0.0475	0.0705	-0.0223
4310	0.005	0.0061	0.0098	0.0475	0.0705	-0.0223
4330	0.0034	0.0043	0.0068	0.0352	0.0614	-0.0205
4340	0.0024	0.0031	0.0051	0.0352	0.0613	-0.0205
4350	0.0012	0.0013	0.0029	0.0244	0.0522	-0.0132
4359	0.0008	0.0012	0.0026	0.0197	0.0496	-0.0089
4360	0.0003	0.0012	0.0022	0.0149	0.0459	-0.0059
4400	-0.0033	0.0018	0.0001	-0.0025	0.034	0.0093
4580	-0.0119	0.008	0.0265	0.0208	0.0557	-0.2736
4590	-0.005	0.0092	0.027	0.0208	0.0557	-0.2738
4610	0.0443	0.0151	0.0301	0.0276	0.0557	-0.5197
4619	0.0505	0.0131	0.0301	0.0291	0.0554	-0.5825
4620	0.0537	0.0067	0.0297	0.0301	0.0551	-0.644
4650	0.0721	-0.3393	0.0083	0.0571	0.0551	-1.0228
4659	0.0772	-0.3501	0.008	0.0581	0.0548	-1.0242
4660	0.0884	-0.3542	0.0084	0.0596	0.0545	-1.0244
4690	0.3253	-0.3432	0.0236	0.0721	0.0545	-1.0244
4700	0.3421	-0.3425	0.0248	0.0721	0.0545	-1.0244
4710	0.5564	-0.3325	0.0399	0.0722	0.0545	-1.0244
4740	0.6302	-0.3291	0.0452	0.0751	0.0545	-1.0244
4750	0.6897	-0.3263	0.0496	0.0751	0.0545	-1.0244
4780	0.7646	-0.3229	0.0552	0.0781	0.0545	-1.0244
4789	0.7759	-0.3227	0.0562	0.0798	0.0545	-1.0244
4790	0.7811	-0.3234	0.0571	0.0813	0.0545	-1.0244
4820	0.7852	-0.3296	0.0607	0.0833	0.0545	-1.0244
4830	0.7861	-0.331	0.0614	0.0833	0.0545	-1.0244
4840	0.7868	-0.3321	0.0621	0.0833	0.0545	-1.0244
4850	0.0048	0	-0.0342	0.0174	0.0323	0.0083
4857	-0.0098	0	-0.0095	0.0422	0.0468	-0.0051
4860	-0.0142	0.0008	-0.0015	0.0495	0.0452	-0.0038
4869	-0.0158	0.0017	-0.0002	0.0511	0.0419	-0.0019
4870	-0.0176	0.0037	-0.0005	0.0545	0.0383	-0.0012
4890	-0.0282	0.0202	-0.0079	0.055	0.0346	0.0084
4900	-0.0298	0.0227	-0.009	0.0549	0.0346	0.0084
4910	-0.0325	0.027	-0.011	0.0549	0.0346	0.0084
4920	-0.0319	0.0252	-0.0149	0.0548	0.0346	0.0085
4980	-0.0024	-0.0003	0.0004	-0.0029	0.0155	0.0105
4989	-0.0022	-0.0005	0.0003	-0.0029	0.0126	0.0113
4990	-0.0019	-0.0005	0.0002	-0.0031	0.0082	0.011
5020	-0.0003	0	0	0	0	0
5030	0	0	0	0	0	0
5040	0	0	0	0	0	0
5050	0	0	-0.0001	0	0	0

5060	-0.0004	-0.0001	-0.0036	-0.0021	0.0127	0.002
5070	-0.0006	-0.0001	-0.004	-0.0021	0.0128	0.002
5080	-0.0078	-0.0007	-0.0081	-0.0037	0.0751	0.0113
5089	-0.009	-0.0009	-0.008	-0.0034	0.0882	0.0122
5090	-0.0099	-0.001	-0.0068	-0.0031	0.1007	0.0134
5110	-0.0155	-0.0046	0.0205	0.0028	0.1246	0.0168
5119	-0.0165	-0.0048	0.0221	0.0033	0.1195	0.0165
5120	-0.0182	-0.0049	0.0224	0.0041	0.1137	0.0163
5140	-0.0292	-0.0043	0.0198	0.0069	0.096	0.0156
5150	-0.031	-0.0042	0.0193	0.0069	0.096	0.0156
5155	-0.0576	0	0.0089	0.0078	0.033	0.0126
5157	-0.0512	0	-0.0085	-0.0093	-0.0458	0.0076
5160	-0.0102	-0.0029	-0.0234	0.0156	-0.0875	0.0033
5169	-0.009	-0.0025	-0.0236	0.019	-0.0891	0.003
5170	-0.0085	-0.0021	-0.0235	0.0217	-0.0902	0.0026
5190	-0.0086	-0.0012	-0.0226	0.0225	-0.0925	0.0025
5199	-0.0085	-0.0008	-0.0218	0.0218	-0.0933	0.0024
5200	-0.0082	-0.0006	-0.0204	0.0208	-0.0937	0.0024
5220	-0.0027	-0.0001	-0.0033	0.005	-0.0434	0.0017
5230	-0.0017	-0.0001	-0.0016	0.005	-0.0433	0.0017
5240	0.0443	-0.0586	-0.048	0.0866	0.0382	0.1403
5250	0.0412	-0.0761	-0.0432	0.0866	0.0382	0.1407
5260	0.0401	-0.0823	-0.0416	0.0866	0.0382	0.1408
5290	0.0372	-0.098	-0.0369	0.0791	0.0433	0.0973
5300	0.0371	-0.0986	-0.0366	0.0791	0.0433	0.0972
5320	0.0125	-0.0075	-0.0158	0.0221	-0.0041	0.0098
5340	0.0124	-0.0046	-0.0141	-0.0038	-0.0011	-0.0196
5350	0.0125	-0.0045	-0.0141	-0.0038	-0.0011	-0.0196
5360	0.0139	-0.0027	-0.0144	-0.0039	-0.0011	-0.0198
5370	0.012	-0.0011	-0.0145	-0.0041	-0.0011	-0.0199
5380	0.0108	-0.0002	-0.0145	-0.0042	-0.0011	-0.0199
5410	-0.0808	-0.0335	0.1693	0.1398	0.0813	0.1384
5420	-0.0869	-0.0324	0.1754	0.1398	0.0813	0.1384
5440	-0.0932	-0.0313	0.1819	0.1399	0.0812	0.1384
5450	-0.1938	-0.0121	0.2952	0.1477	0.0509	0.1273
5459	-0.1993	-0.0089	0.3003	0.1462	0.0489	0.127
5470	-0.203	-0.0031	0.3016	0.1492	0.0447	0.1264
5480	-0.21	0.0225	0.2975	0.1683	0.0408	0.128
5485	-0.2142	0.0413	0.2949	0.1931	0.039	0.129
5500	-0.2181	0.0628	0.2923	0.2263	0.0378	0.13
5510	-0.2199	0.0736	0.2911	0.2405	0.0376	0.1305
5520	-0.2216	0.0847	0.29	0.2407	0.0376	0.1305
5530	0	0	0	0	0	0
5550	0	0.0026	0	0.0002	0	0.0002
5560	0	0.0052	0	0.0002	0	0.0002
5570	0	0.0079	0	0.0002	0	0.0002
5600	-0.0001	0.0134	0.0002	0.0034	-0.0001	0.0025

5609	-0.0003	0.0139	0.0003	0.0056	0.0001	0.0041
5610	-0.0008	0.014	0.0006	0.0074	0.0003	0.0059
5640	-0.0128	0.0114	0.0071	0.0178	0.0036	-0.0089
5649	-0.0132	0.0112	0.0073	0.0166	0.0041	-0.0127
5650	-0.0136	0.0108	0.0073	0.0157	0.0043	-0.0169
5720	0.0225	0.0454	0.0115	-0.0222	-0.0245	0.071
5740	0.0136	0.0508	0.0083	-0.0397	-0.0186	0.0916
5750	0.0125	0.0514	0.0078	-0.0397	-0.0186	0.0916
5760	-0.0005	0.018	0.0117	0.0083	0.0016	0.004
5770	-0.0006	0.0182	0.0106	0.0083	0.0016	0.004
5780	-0.0007	0.0186	0.008	0.0083	0.0016	0.004
5830	0.0512	-0.0256	-0.0576	0.0908	0.0322	0.1126
5860	0.0099	-0.0015	-0.0421	-0.004	-0.0074	0.0384
6188	-0.1102	0.0362	0.0973	0.2391	0.0379	0.1271
6189	-0.1107	0.028	0.1028	0.238	0.0378	0.128
6190	-0.1149	0.0261	0.1121	0.2274	0.0375	0.1299
6200	-0.1152	0.0262	0.1126	0.2273	0.0375	0.1299
6210	-0.1226	0.0289	0.1255	0.2272	0.0375	0.1299
6420	0.001	0.008	-0.0533	0.0295	-0.003	0.0425
6429	0.0009	0.0079	-0.0528	0.03	-0.003	0.0425
6430	0.0004	0.0083	-0.0523	0.0301	-0.003	0.0425
6460	-0.0026	0.0117	-0.0501	0.0301	-0.003	0.0425
6470	-0.0035	0.0127	-0.0495	0.0301	-0.003	0.0425
6480	-0.0045	0.0138	-0.0488	0.0301	-0.003	0.0425
6490	-0.0068	0.0163	-0.0472	0.0301	-0.003	0.0425
6500	-0.0086	0.0183	-0.0459	0.0301	-0.003	0.0425
6520	0.0028	0.0434	0.0027	-0.04	-0.0185	0.0917
6540	-0.023	0.0136	0.0103	0.0323	0.0241	0.0261
6550	-0.025	0.0164	0.0081	0.0334	0.0227	0.0292
6560	-0.0262	0.018	0.0069	0.0334	0.0227	0.0292
6670	0.0067	0.001	-0.033	0.0047	0.0105	0.0217
6680	0.0058	0.0021	-0.0328	0.0047	0.0105	0.0217
6690	0.0048	0.0032	-0.0326	0.0047	0.0105	0.0217
6710	-0.0228	0.0351	-0.0266	0.0047	0.0105	0.0217
6720	0.0441	-0.0348	-0.0508	0.0896	0.0339	0.1132
6730	0.0385	-0.0336	-0.0464	0.0896	0.0339	0.1132
6740	0.0378	-0.0335	-0.0459	0.0896	0.0339	0.1132
6750	-0.0236	0.0139	-0.0008	0.0308	0.0179	0.033
6770	-0.0277	0.0202	0.0035	0.0334	0.0226	0.0293
6780	-0.0285	0.0214	0.0044	0.0334	0.0226	0.0293
6920	0.0501	-0.0301	-0.0481	-0.0018	-0.015	0.0589
6930	0.0495	-0.0298	-0.0481	-0.0018	-0.015	0.0589
6940	0.0488	-0.0295	-0.0481	-0.0018	-0.015	0.0589
6960	0.045	-0.0279	-0.0482	-0.0018	-0.015	0.0589
6970	0.0426	-0.0269	-0.0483	-0.0018	-0.015	0.0589
7000	0.0514	-0.0045	-0.0521	0.1088	0.0088	0.0818
7010	0.0506	-0.0042	-0.051	0.1088	0.0088	0.0818

7020	0.0496	-0.0039	-0.0497	0.1088	0.0088	0.0818
7040	0.0451	-0.0026	-0.0438	0.1088	0.0088	0.0818
7050	0.0417	-0.0015	-0.0393	0.1088	0.0088	0.0818
7080	0.0673	0.0049	0.0075	0.0049	-0.0447	0.0141
7090	0.0671	0.0055	0.0076	0.0049	-0.0447	0.0141
7100	0.0669	0.0063	0.0076	0.0049	-0.0447	0.0141
7120	0.0661	0.0089	0.0079	0.0049	-0.0447	0.0141
7130	0.0655	0.0109	0.0081	0.0049	-0.0447	0.0141
7140	0.0216	-0.1125	-0.004	0.0681	0.0332	-0.0779
7150	0.0255	-0.1113	-0.0006	0.0681	0.0332	-0.0779
7160	0.0059	0.0116	-0.0116	-0.0576	-0.0115	0.0226
7170	0.0039	0.0138	-0.0167	-0.0576	-0.0115	0.0226
7180	-0.0099	0.0164	0.0018	0.0099	0.0183	0.043
7190	-0.0111	0.0171	-0.0012	0.0099	0.0183	0.043
7200	-0.0116	0.0173	-0.0024	0.0099	0.0183	0.043
7230	-0.2237	0.0252	0.3155	0.1683	0.0408	0.128
7240	-0.2371	0.0278	0.3331	0.1683	0.0408	0.128
7440	-0.0284	-0.0068	0.0035	0.0047	0.0128	-0.056
7450	-0.0269	-0.0057	0.0037	0.0047	0.0128	-0.056
7480	-0.0232	-0.0022	0.0041	0.008	0.0111	-0.0476
7490	-0.0205	0.0005	0.0046	0.008	0.0111	-0.0475
7530	0.0535	-0.0079	0.0235	0.0034	-0.0463	0.0069
7540	0.0537	-0.0099	0.0234	0.0034	-0.0463	0.0069
7580	-0.1507	0.0392	0.1746	0.2269	0.0375	0.1299
7590	-0.1526	0.0399	0.178	0.2269	0.0375	0.13
7600	-0.2122	0.0617	0.2819	0.2267	0.0376	0.13
7620	-0.0634	0.0446	0.0408	-0.0239	0.0565	-0.1952
7630	-0.0636	0.0446	0.0408	-0.0239	0.0565	-0.1952
7640	-0.0739	0.0421	0.0421	-0.0239	0.0565	-0.1952
7650	-0.0741	0.042	0.0421	-0.0239	0.0565	-0.1952
7660	-0.0822	0.0401	0.0431	-0.0239	0.0565	-0.1952
7700	0.0259	-0.1111	-0.0002	0.0681	0.0332	-0.0779
7710	0.0146	-0.0075	-0.0416	-0.004	-0.0074	0.0384
7720	0.0169	-0.0103	-0.0414	-0.004	-0.0074	0.0384
7750	0.0013	-0.0074	0.0613	-0.0702	0.0773	0.0105
7760	0.0013	-0.0075	0.0614	-0.0702	0.0773	0.0105
7770	0.0017	-0.0094	0.0643	-0.0702	0.0773	0.0105
7790	-0.0139	-0.015	0.048	0.0062	-0.0088	0.0111
7800	-0.0134	-0.017	0.0477	0.0062	-0.0088	0.0111
7870	-0.1487	0.0384	0.1711	0.2269	0.0375	0.1299
7900	-0.1787	0.0494	0.2235	0.2268	0.0376	0.13
7930	-0.2048	0.059	0.2691	0.2267	0.0376	0.13
7970	-0.051	0.0461	0.0458	0.0294	0.0587	-0.2009
7980	0	0	0	0	0	0
8000	-0.2245	0.1036	0.288	0.2408	0.0376	0.1305
8030	-0.0025	0.0093	-0.0031	-0.0871	0.0191	-0.0059
8050	-0.0051	0.0538	0.0018	0.0077	0.0019	0.0032

8500	0.0039	0.0476	0.0035	-0.0399	-0.0185	0.0917
8510	0.0059	0.0548	0.005	-0.0398	-0.0186	0.0917

Job Name: 338716-FINAL

Licensed To: ENS CANADA STRUCTURAL ENGNG & PROJECT MGMT INC

DISPLACEMENTS REPORT: Nodal Movements

CASE 2 (OPE) W+T1+P1

Node	DX in.	DY in.	DZ in.	RX deg.	RY deg.	RZ deg.
20	-0.0553	-0.0398	0.0869	-0.1628	-0.0181	0.0103
23	-0.0008	-0.0166	-0.0013	-0.0054	-0.0025	0.0043
30	-0.0038	-0.0339	-0.0044	-0.0075	-0.0051	0.0097
31	-0.0066	-0.0442	-0.0064	-0.008	-0.0042	0.0115
40	-0.008	-0.0491	-0.0074	-0.0083	-0.0037	0.0124
50	-0.0201	-0.0795	-0.0144	-0.0098	-0.001	0.0196
60	-0.0218	-0.083	-0.0152	-0.0098	-0.001	0.0196
70	-0.0246	-0.0886	-0.0166	-0.0098	-0.001	0.0196
80	0	0	0	0	0	0
100	-0.0237	-0.0769	-0.0046	0.0261	-0.0287	-0.1228
110	-0.0181	-0.0594	-0.0087	0.0263	-0.0286	-0.1242
120	-0.0163	-0.054	-0.0099	0.0263	-0.0285	-0.1245
140	-0.0147	-0.0484	-0.0111	0.029	-0.0266	-0.1404
150	-0.013	-0.0421	-0.0122	0.0313	-0.0248	-0.1544
160	-0.0112	-0.035	-0.0133	0.0313	-0.0248	-0.1546
170	-0.0046	-0.009	-0.0174	0.0315	-0.0246	-0.155
189	-0.0027	-0.0027	-0.0177	0.0269	-0.0171	-0.1329
190	-0.0016	0	-0.0164	0.0099	-0.0101	-0.1147
210	0	0	-0.0017	0	0	-0.0003
220	0	0	0	0	0	0
230	-0.0001	-0.0068	-0.0003	-0.0026	-0.001	0.0017
235	-0.0007	-0.0151	-0.0011	-0.0051	-0.0023	0.0039
250	0.0007	-0.0361	-0.0061	-0.0029	-0.0227	0.0259
260	0.0031	-0.0377	-0.0075	-0.0029	-0.0229	0.026
270	0.0035	-0.038	-0.0077	-0.0029	-0.0229	0.026
290	-0.0255	-0.0825	-0.0033	0.026	-0.0287	-0.1223
310	-0.0273	-0.0876	-0.0019	0.023	-0.0308	-0.1004
320	-0.0288	-0.091	-0.0008	0.0215	-0.0328	-0.0836
330	-0.0305	-0.0942	0.0007	0.0198	-0.0351	-0.0645
340	-0.034	-0.0983	0.0041	0.0163	-0.0395	-0.0281
350	-0.0358	-0.0995	0.0059	0.0153	-0.0413	-0.0237
360	-0.0425	-0.1034	0.0129	0.0152	-0.0414	-0.0231
370	-0.0443	-0.1045	0.0148	0.0152	-0.0415	-0.0229
400	-0.0489	-0.1039	0.02	0.0042	-0.0552	0.0912
410	-0.0492	-0.1033	0.0204	0.0042	-0.0553	0.0914
420	0	0	0	0	0	0
430	0	0	-0.0022	-0.0001	0.0001	0

435	0.0112	0	-0.0186	0.0352	0.0408	0.0206
450	0.0217	-0.0156	-0.0296	0.0454	0.0283	0.0344
460	0.0293	-0.0277	-0.0403	0.0429	0.0274	0.0347
470	0.0404	-0.0445	-0.0569	0.0379	0.025	0.0351
480	0.0418	-0.0467	-0.0591	0.0373	0.0245	0.0351
510	0.0398	-0.0471	-0.0658	-0.0253	-0.0501	0.0435
515	0.0285	0	-0.0824	-0.1562	-0.0132	-0.025
538	0.0259	0.0326	-0.0907	-0.1457	-0.0139	-0.0597
540	0.0289	0.0373	-0.0989	-0.0967	-0.0141	-0.0834
541	0.0263	0.037	-0.0942	-0.1226	-0.0151	-0.0674
550	0.0291	0.0372	-0.0991	-0.0964	-0.0142	-0.0837
560	0.0507	0.0271	-0.1238	-0.0957	-0.0145	-0.084
570	0.0555	0.0248	-0.1292	-0.0955	-0.0146	-0.0841
590	0.1042	-0.0054	-0.1767	-0.0385	-0.0637	-0.0128
599	0.1035	-0.0067	-0.177	-0.0321	-0.0685	0.0217
600	0.1015	-0.0059	-0.1748	-0.0283	-0.0764	0.046
610	0.0967	0	-0.1651	-0.0242	-0.0809	0.0398
615	0.0718	0	-0.1128	-0.0029	-0.0785	-0.0182
620	0.042	-0.0004	-0.072	0.0227	-0.0189	0.0313
630	0.0399	0.0013	-0.071	0.0227	-0.0187	0.0315
640	0.0376	0.0031	-0.0699	0.0227	-0.0186	0.0316
660	0.0358	0.0047	-0.0692	0.0243	-0.0124	0.0364
670	0.034	0.0062	-0.0687	0.0216	-0.0128	0.0314
680	0.0318	0.008	-0.0679	0.0215	-0.0128	0.0313
690	0.0296	0.0097	-0.0672	0.0215	-0.0128	0.0312
695	-0.0189	0	-0.0354	-0.0508	-0.0449	-0.05
710	-0.0258	-0.0095	-0.0269	-0.0611	-0.0524	-0.0525
720	-0.028	-0.0125	-0.024	-0.0611	-0.0524	-0.0524
730	-0.0302	-0.0153	-0.0211	-0.0612	-0.0525	-0.0523
749	-0.0307	-0.0178	-0.0184	-0.0578	-0.0601	-0.0288
750	-0.029	-0.0202	-0.016	-0.0543	-0.0642	-0.0161
770	-0.0243	-0.0241	-0.0131	-0.0534	-0.0629	0.0013
779	-0.0219	-0.0254	-0.0109	-0.045	-0.0607	0.0125
780	-0.0201	-0.0246	-0.0089	-0.0336	-0.061	0.0339
810	0	-0.003	0	0	-0.0001	0.0002
820	0	0	0	0	0	0
830	-0.0895	-0.0057	0.0827	-0.014	-0.0649	0.0654
840	-0.0913	-0.0027	0.0857	-0.014	-0.0649	0.0654
859	-0.0939	-0.0005	0.0876	-0.0077	-0.0653	0.0343
860	-0.0969	0	0.0872	0.0009	-0.0653	0.0175
880	-0.101	-0.0001	0.0847	0.0012	-0.0649	-0.0012
900	-0.1108	-0.0002	0.0787	-0.0003	-0.0628	-0.0465
910	-0.1137	-0.0001	0.0769	-0.0027	-0.0633	-0.0488
930	-0.121	0.0007	0.0723	-0.0174	-0.0648	-0.0635
940	-0.1296	0.003	0.0671	-0.0176	-0.0648	-0.0638
950	-0.1299	0.0031	0.0669	-0.0176	-0.0648	-0.0638
980	-0.1369	0.0057	0.0626	-0.024	-0.0628	-0.0785

990	-0.1403	0.007	0.0604	-0.0236	-0.062	-0.0813
1010	-0.1467	0.0093	0.0562	-0.0198	-0.0601	-0.0867
1020	-0.1495	0.0102	0.0544	-0.0195	-0.0601	-0.0867
1040	-0.1563	0.0124	0.0499	-0.0191	-0.0601	-0.0867
1050	-0.157	0.0127	0.0495	-0.0191	-0.0601	-0.0867
1060	-0.058	-0.0158	0.0811	-0.1626	-0.0181	0.0103
1090	-0.0601	0	0.0765	-0.116	-0.0181	0.0103
1100	-0.0613	0.0072	0.0738	-0.0983	-0.0181	0.0103
1120	-0.0638	0.0182	0.0685	-0.0669	-0.0181	0.0103
1130	-0.0645	0.0207	0.0669	-0.0606	-0.018	0.0139
1140	-0.0653	0.0236	0.065	-0.0604	-0.018	0.014
1150	-0.0662	0.0267	0.0631	-0.0603	-0.018	0.0141
1170	-0.0677	0.0313	0.0598	-0.052	-0.0185	0.0217
1180	-0.0707	0.0383	0.0537	-0.0414	-0.0201	0.0357
1189	-0.0709	0.039	0.0519	-0.0312	-0.0229	0.0428
1190	-0.0698	0.0377	0.0504	-0.0255	-0.0259	0.0543
1195	-0.0544	0.0139	0.0389	-0.0052	-0.0341	0.0634
1210	-0.0406	-0.0068	0.0254	0.013	-0.0435	0.0529
1219	-0.0362	-0.0111	0.0218	0.0211	-0.0506	0.0401
1230	-0.0336	-0.0107	0.0225	0.03	-0.0559	0.0342
1250	-0.0301	-0.0087	0.0249	0.0371	-0.0601	0.023
1260	-0.0291	-0.0081	0.0255	0.0371	-0.0601	0.0229
1270	-0.0195	-0.0021	0.0319	0.0371	-0.0602	0.0225
1300	-0.0121	0	0.0365	0.0027	-0.0649	0.0012
1310	-0.0071	0.0002	0.0395	0.0024	-0.0649	0.001
1330	-0.0735	-0.0363	0.0568	-0.0074	-0.0628	0.1216
1350	-0.0754	-0.0311	0.0597	-0.0084	-0.0629	0.0973
1360	-0.0789	-0.0235	0.0653	-0.012	-0.0642	0.0749
1370	-0.0807	-0.0203	0.0683	-0.0138	-0.0648	0.066
1390	0.038	-0.0449	-0.0628	-0.0062	-0.0766	0.0514
1400	0.0358	-0.042	-0.0584	-0.0058	-0.0772	0.0516
1410	0.0272	-0.0308	-0.0416	-0.004	-0.0782	0.0522
1420	0.0245	-0.0271	-0.0361	-0.0034	-0.0781	0.0523
1430	0.0244	-0.027	-0.036	-0.0025	-0.0779	0.0522
1439	0.0222	-0.0258	-0.0331	0.0151	-0.0687	0.0422
1440	0.0203	-0.0267	-0.0308	0.0472	-0.0649	0.0258
1450	0.0203	-0.0268	-0.0307	0.0477	-0.0643	0.0256
1460	0.0138	-0.0369	-0.0184	0.0476	-0.063	0.0252
1470	0.0135	-0.0373	-0.018	0.0476	-0.0629	0.0251
1480	0.0121	-0.0395	-0.0153	0.0472	-0.0626	0.0251
1510	0.0103	-0.0426	-0.0127	0.0113	-0.0419	0.0205
1540	0.0676	-0.0793	-0.1782	-0.3806	-0.0018	-0.1201
1560	0.149	-0.1044	-0.4313	-0.4118	0.0041	-0.1334
1580	0.1642	-0.109	-0.4783	-0.404	0.0068	-0.1306
1590	0.1663	-0.1097	-0.4849	-0.4039	0.0068	-0.1306
1600	-0.0085	-0.0483	-0.0119	-0.0071	-0.0037	0.0124
1610	-0.0087	-0.0478	-0.0143	-0.0071	-0.0037	0.0124

1620	-0.0088	-0.0476	-0.0154	-0.0071	-0.0037	0.0124
1630	0.103	0.1719	-0.2192	-0.3122	-0.0828	-0.0959
1640	0.1001	0.165	-0.2132	-0.3122	-0.0828	-0.0959
1645	0.0898	0.1374	-0.1895	-0.2755	-0.0974	-0.1125
1660	0.0223	0.0036	-0.0227	-0.0366	-0.0593	-0.0146
1670	0.0205	0.0029	-0.02	-0.0365	-0.0592	-0.0146
1680	0.0188	0.0023	-0.0174	-0.0364	-0.0591	-0.0145
1700	0.017	0.0017	-0.0148	-0.03	-0.0546	-0.0122
1705	-0.0037	0	0.0053	-0.0032	-0.0277	-0.0193
1720	-0.0082	-0.0031	0.0083	0.0025	-0.0262	-0.0361
1729	-0.0092	-0.0048	0.0098	-0.0003	-0.0253	-0.0573
1730	-0.0089	-0.0058	0.0117	0.0004	-0.0249	-0.0665
1760	-0.0022	-0.004	0.0225	0.0136	-0.0234	-0.1174
1770	-0.0012	-0.0032	0.0244	0.0179	-0.023	-0.1222
1775	0.0024	0	0.0306	0.0163	-0.0222	-0.1389
1780	0.0058	0.0015	0.0368	0.005	-0.0219	-0.1556
1790	0.0068	0.0017	0.0385	0.0029	-0.022	-0.1602
1800	0.0078	0.0018	0.0403	0.0011	-0.0221	-0.165
1810	0.0109	0.0016	0.0458	-0.0031	-0.0227	-0.1799
1820	0.0119	0.0015	0.0476	-0.0041	-0.023	-0.1845
1830	0.013	0.0012	0.0494	-0.0069	-0.023	-0.1849
1835	0.0154	0	0.0535	-0.0203	-0.0237	-0.186
1840	0.0191	-0.0045	0.0595	-0.0311	-0.0264	-0.1875
1850	0.0203	-0.0059	0.0613	-0.031	-0.0264	-0.1875
1860	0.0215	-0.0073	0.063	-0.0309	-0.0264	-0.1875
1870	0.0215	-0.0073	0.0631	-0.0306	-0.0265	-0.1876
1880	0.0227	-0.0086	0.0649	-0.0228	-0.0279	-0.188
1890	0.024	-0.0094	0.0667	-0.0146	-0.0289	-0.1828
1900	0.0254	-0.0099	0.0685	-0.0059	-0.0302	-0.1776
1910	0.0267	-0.01	0.0702	0.0027	-0.0315	-0.1727
1920	0.0282	-0.0096	0.072	0.0117	-0.032	-0.1605
1930	0.0308	-0.0081	0.0752	0.0227	-0.0334	-0.1393
1940	0.0323	-0.007	0.0769	0.0262	-0.0344	-0.1277
1948	0.0339	-0.0057	0.0787	0.0275	-0.0358	-0.1155
1949	0.0359	-0.0032	0.0796	0.0148	-0.0417	-0.0978
1950	0.038	-0.0001	0.0785	0.0004	-0.0476	-0.0562
1970	-0.0246	-0.0756	-0.0147	-0.0151	0.0063	0.05
1980	-0.027	-0.0725	-0.0151	-0.0151	0.0064	0.0504
2020	0.0277	0.0017	0.0607	0.0035	-0.0649	0.0003
2030	0.0327	0.002	0.0638	0.0036	-0.0648	0.0002
2049	0.0352	0.0015	0.0654	0.0003	-0.064	-0.0024
2050	0.0364	0	0.0659	-0.0059	-0.0637	-0.0065
2070	0.0388	-0.0088	0.0631	-0.0192	-0.0586	-0.0149
2080	0.0526	-0.0328	0.0368	-0.0683	-0.0449	-0.0285
2089	0.0546	-0.0352	0.0294	-0.0827	-0.0424	-0.0303
2100	0.0536	-0.0325	0.0266	-0.0909	-0.0405	-0.0311
2110	0.0526	-0.0304	0.0257	-0.0909	-0.0405	-0.0311

2120	0.0496	-0.0236	0.0228	-0.0909	-0.0405	-0.0311
2125	0.0373	0	0.0103	-0.0429	-0.0385	-0.0342
2150	0.0254	0.0037	-0.0018	0.002	-0.0399	-0.0371
2170	0.0197	0.0023	-0.0078	0.0116	-0.0362	-0.0542
2179	0.0178	0.0009	-0.0087	0.0113	-0.0349	-0.059
2180	0.0158	-0.0016	-0.008	0.01	-0.0336	-0.0643
2210	0.01	-0.0111	-0.0033	0.0013	-0.0298	-0.0618
2218	0.0082	-0.0139	-0.002	-0.0002	-0.0278	-0.0578
2219	0.0059	-0.0152	-0.001	-0.0008	-0.0232	-0.0445
2220	0.004	-0.0144	-0.0006	-0.0019	-0.0202	-0.0298
2240	0	-0.003	0	0	-0.0001	-0.0001
2250	0	0	0	0	0	0
2260	0.006	-0.0397	-0.0092	-0.0028	-0.023	0.0261
2280	0.0085	-0.0414	-0.0109	0.003	-0.0324	0.026
2300	-0.0124	0.0152	0.0346	-0.0595	0.0469	-0.0942
2309	-0.0133	0.016	0.0355	-0.0601	0.0474	-0.1006
2310	-0.0133	0.0173	0.0362	-0.0605	0.0482	-0.1069
2340	-0.0047	0.0446	0.0471	-0.0647	0.0509	-0.1401
2349	-0.004	0.0464	0.0475	-0.0655	0.0509	-0.143
2350	-0.0033	0.0478	0.0473	-0.0662	0.0509	-0.1449
2390	0.0003	0.0525	0.0444	-0.0656	0.0505	-0.1516
2400	0.0011	0.0535	0.0439	-0.0656	0.0505	-0.1516
2410	0.0019	0.0546	0.0432	-0.0656	0.0505	-0.1516
2415	0.0104	0.0642	0.0363	-0.0386	0.046	-0.1731
2440	0.0175	0.0662	0.0297	0.0218	0.038	-0.1939
2490	0.0211	0.0612	0.0256	0.0779	0.0314	-0.2065
2540	0.0239	0.0497	0.0215	0.1519	0.0235	-0.2192
2545	0.0288	0	0.0133	0.2973	0.0235	-0.6016
2570	0.0303	-0.0191	0.0108	0.3107	0.0235	-0.7152
2579	0.0304	-0.0257	0.0103	0.3193	0.0235	-0.7413
2580	0.03	-0.0354	0.0098	0.3266	0.0235	-0.7809
2610	0.0275	-0.0893	0.0083	0.3266	0.0235	-0.8589
2620	0.0268	-0.1033	0.0079	0.3266	0.0235	-0.859
2640	0.0185	-0.2832	0.003	0.3266	0.0235	-0.8597
2650	0.0116	-0.4378	-0.0011	0.3266	0.0235	-0.9053
2660	0.0093	-0.4904	-0.0025	0.3266	0.0235	-0.9054
2690	0.0051	-0.5876	-0.005	0.3266	0.0235	-0.9101
2700	0.0044	-0.6024	-0.0054	0.3266	0.0235	-0.9101
2710	0.0039	-0.6153	-0.0057	0.3266	0.0235	-0.9101
2730	-0.0041	-0.7981	-0.0104	0.3266	0.0235	-0.9109
2820	-0.0795	-0.0329	0.0593	-0.0078	-0.062	0.0828
2830	-0.0891	-0.0413	0.0579	-0.0049	-0.0576	0.001
2839	-0.0871	-0.0419	0.0569	-0.0024	-0.0559	-0.0748
2840	-0.0841	-0.0384	0.0549	-0.0008	-0.053	-0.1349
2845	-0.0697	0	0.0364	0.0049	-0.0478	0.015
2860	-0.0556	-0.0539	0.0201	0.0105	-0.0437	0.2222
2870	-0.0538	-0.0641	0.0181	0.0105	-0.0437	0.2222

2880	-0.0472	-0.1014	0.0108	0.0106	-0.0436	0.2215
2899	-0.043	-0.1082	0.009	0.0112	-0.0427	0.1465
2900	-0.0385	-0.1086	0.0079	0.0128	-0.0425	0.0684
2920	-0.0331	-0.1	0.0048	0.0156	-0.04	-0.0143
2930	0.0209	-0.0173	0.0662	-0.021	-0.0287	-0.1913
2940	0.0165	-0.0387	0.0694	-0.0167	-0.0306	-0.1905
2949	0.0123	-0.045	0.0709	-0.0152	-0.0323	-0.1758
2950	0.0055	-0.0461	0.0719	-0.0113	-0.0325	-0.1564
2960	0.0052	-0.046	0.0719	-0.0112	-0.0325	-0.1561
2970	-0.0491	-0.03	0.0741	-0.0001	-0.0422	-0.112
2980	-0.0542	-0.0282	0.0741	0	-0.0422	-0.1119
2990	-0.0888	-0.016	0.0741	0.0001	-0.0423	-0.1113
3000	-0.089	-0.0159	0.0741	0.0002	-0.0424	-0.1111
3010	-0.1038	-0.0103	0.0739	0.0032	-0.0458	-0.0975
3019	-0.1064	-0.0087	0.0743	0.0063	-0.0509	-0.0822
3020	-0.1056	-0.0078	0.0756	0.0064	-0.0575	-0.0744
3030	-0.1055	-0.0078	0.0757	0.0063	-0.0575	-0.0741
3040	-0.1033	-0.0076	0.0772	0.0054	-0.0581	-0.0697
3050	-0.1008	-0.0074	0.0789	0.0032	-0.0588	-0.0644
3060	-0.0299	-0.0689	-0.0155	-0.0152	0.0065	0.0508
3090	-0.0325	-0.0646	-0.0162	-0.0222	0.0152	0.0902
3100	-0.0432	-0.0392	-0.0205	-0.0233	0.0165	0.096
3110	-0.0518	-0.018	-0.0241	-0.0243	0.0173	0.0988
3120	-0.054	-0.0124	-0.0251	-0.0245	0.0176	0.0991
3139	-0.055	-0.0075	-0.027	-0.0383	0.0495	0.1187
3140	-0.0532	-0.0039	-0.0294	-0.0459	0.0782	0.1213
3145	-0.0458	0	-0.0328	-0.032	0.0898	0.1186
3160	0.0026	-0.0092	-0.0522	0.0446	0.0885	0.1038
3169	0.0074	-0.0104	-0.0545	0.0448	0.0675	0.0966
3170	0.0117	-0.0096	-0.0567	0.0416	0.0554	0.0851
3200	-0.1085	-0.002	0.0787	0.0013	-0.0609	-0.0552
3210	-0.1059	-0.0038	0.0787	0.0014	-0.0608	-0.0554
3220	-0.1035	-0.0055	0.0788	0.0014	-0.0608	-0.0555
3250	-0.0135	-0.0397	0.0773	-0.0027	-0.0402	-0.1486
3270	0.0046	-0.0442	0.0771	0.0008	-0.0337	-0.1785
3280	0.0056	-0.0444	0.0771	0.0008	-0.0337	-0.1785
3290	0.0184	-0.0473	0.0771	0.0008	-0.0336	-0.1786
3300	0.0216	-0.0332	0.0745	0.0008	-0.0336	-0.1787
3310	0.0234	-0.025	0.073	0.0009	-0.0336	-0.1787
3390	0.0205	0.0351	0.0198	0.1268	0.0166	-0.1234
3400	0.0195	0.032	0.0194	0.1268	0.0166	-0.1233
3420	0.0129	0.018	0.0175	0.0788	0.0061	-0.071
3430	0.0106	0.0139	0.0172	0.0788	0.0061	-0.071
3470	0.0071	0.0055	0.0168	0.0537	0.0022	-0.131
3475	0.005	0	0.0168	0.035	0.0003	-0.0913
3500	0.003	-0.0041	0.0168	0.0163	-0.0013	-0.0653
3510	0.0023	-0.0052	0.0168	0.0163	-0.0013	-0.0653

3520	-0.006	-0.0188	0.0171	0.0159	-0.0013	-0.0648
3550	-0.0088	-0.0229	0.0172	-0.0034	-0.0013	-0.0529
3559	-0.009	-0.0237	0.0172	-0.0085	0.0002	-0.0494
3560	-0.0087	-0.0243	0.017	-0.0166	0.0017	-0.0465
3590	-0.0058	-0.0269	0.0154	-0.0349	0.0021	-0.0405
3600	-0.0035	-0.0292	0.0133	-0.035	0.0021	-0.0405
3630	-0.0013	-0.0314	0.011	-0.0473	0.0023	-0.0361
3639	-0.001	-0.0315	0.0103	-0.0566	0.0018	-0.0329
3640	-0.0008	-0.0311	0.0096	-0.0651	0.0014	-0.0309
3670	-0.0007	-0.0256	0.0066	-0.0746	0.0012	-0.02
3680	-0.0007	-0.0244	0.006	-0.0746	0.0012	-0.02
3720	-0.02	-0.091	-0.0023	-0.0293	-0.0012	-0.0637
3730	-0.0176	-0.0925	-0.0034	-0.0293	-0.0012	-0.0637
3760	-0.0145	-0.095	-0.0058	-0.0443	0.0091	-0.0389
3770	-0.0135	-0.096	-0.007	-0.0443	0.0091	-0.0389
3818	-0.0111	-0.1046	-0.0181	-0.0571	0.0233	0.0227
3819	-0.012	-0.105	-0.0194	-0.0587	0.0249	0.0377
3820	-0.013	-0.1045	-0.0203	-0.0599	0.0269	0.0529
3827	-0.0451	0	-0.0391	-0.0938	-0.0027	0.1163
3830	-0.0547	0.022	-0.0345	-0.104	-0.0374	0.0736
3840	-0.0557	0.0239	-0.0336	-0.104	-0.0375	0.0736
3868	-0.0581	0.0283	-0.0309	-0.1065	-0.0484	0.0713
3871	-0.0584	0.0288	-0.0297	-0.1074	-0.0559	0.0707
3890	-0.0576	0.0273	-0.0285	-0.1083	-0.0631	0.0705
3900	-0.0256	-0.0123	-0.0122	-0.0689	-0.0711	0.0703
3909	-0.0245	-0.0128	-0.0114	-0.0628	-0.0671	0.0695
3910	-0.0235	-0.0126	-0.0106	-0.0567	-0.0644	0.0686
3940	-0.0159	-0.0081	-0.0054	-0.0363	-0.0434	0.0625
3950	-0.0143	-0.0072	-0.0045	-0.0363	-0.0434	0.0625
3970	-0.0102	-0.0043	-0.0023	-0.0251	-0.0301	0.0524
3980	-0.0076	-0.0024	-0.001	-0.025	-0.03	0.0524
3990	-0.0044	0.0005	0.0004	-0.0156	-0.0167	0.0359
3999	-0.0039	0.0008	0.0005	-0.0128	-0.0147	0.0277
4000	-0.0033	0.0007	0.0004	-0.0113	-0.0111	0.0192
4030	-0.0005	0	0	0	0	0
4040	0	0	0	0	0	0
4070	-0.0033	-0.0518	-0.0074	0.0556	-0.02	-0.1219
4080	0.0013	-0.0533	-0.0054	0.0557	-0.02	-0.1218
4110	0.0086	-0.0558	-0.0014	0.0657	-0.0177	-0.1126
4120	0.0114	-0.0568	0.0002	0.0657	-0.0177	-0.1126
4140	0.0396	-0.0678	0.0214	0.086	-0.0136	-0.0866
4149	0.0404	-0.0686	0.0224	0.0882	-0.0138	-0.0828
4150	0.0403	-0.0697	0.0229	0.0896	-0.0139	-0.079
4190	0.0092	-0.0949	0.0343	0.1706	-0.0196	0.0013
4200	0.0082	-0.0949	0.0348	0.1706	-0.0196	0.0013
4220	0.0053	-0.0948	0.0362	0.178	-0.0216	0.0007
4229	0.005	-0.094	0.0366	0.1793	-0.0225	0.0003

4230	0.0051	-0.092	0.0372	0.1813	-0.0234	0
4260	0.0135	-0.0303	0.0505	0.1721	-0.023	-0.0149
4269	0.0136	-0.0283	0.0502	0.1675	-0.0219	-0.0157
4270	0.0136	-0.0271	0.0486	0.1628	-0.0212	-0.0169
4300	0.0121	-0.024	0.0361	0.1507	-0.0178	-0.0204
4310	0.0116	-0.023	0.0323	0.1507	-0.0178	-0.0204
4330	0.0099	-0.0201	0.0219	0.1394	-0.0148	-0.0248
4340	0.0087	-0.0182	0.0151	0.1394	-0.0148	-0.0248
4350	0.0067	-0.0154	0.0055	0.1277	-0.0118	-0.0306
4359	0.0064	-0.0144	0.0043	0.1224	-0.0108	-0.0334
4360	0.0064	-0.0129	0.0042	0.1169	-0.0093	-0.0352
4400	0.0071	-0.0035	0.0076	0.097	-0.0056	-0.0453
4580	0.0261	0.0021	0.0217	0.0584	0.0022	-0.3036
4590	0.0337	0.0011	0.0232	0.0584	0.0022	-0.3038
4610	0.0868	-0.0039	0.0309	0.0651	0.0022	-0.5497
4619	0.0929	-0.0069	0.0316	0.0667	0.002	-0.6125
4620	0.0953	-0.0141	0.0319	0.0677	0.0017	-0.674
4650	0.08	-0.3716	0.0312	0.0946	0.0017	-1.0528
4659	0.0842	-0.3832	0.0316	0.0956	0.0014	-1.0542
4660	0.0955	-0.3883	0.0326	0.0972	0.0011	-1.0545
4690	0.3392	-0.3975	0.0566	0.1097	0.0011	-1.0545
4700	0.3565	-0.3982	0.0584	0.1097	0.0011	-1.0545
4710	0.5771	-0.4065	0.0813	0.1097	0.0011	-1.0545
4740	0.653	-0.4093	0.0893	0.1127	0.0011	-1.0545
4750	0.7143	-0.4116	0.0959	0.1127	0.0011	-1.0545
4780	0.7914	-0.4145	0.1042	0.1156	0.0011	-1.0545
4789	0.8028	-0.4155	0.1053	0.1173	0.0011	-1.0545
4790	0.8075	-0.4169	0.1054	0.1189	0.0011	-1.0545
4820	0.8076	-0.426	0.1024	0.1209	0.0011	-1.0545
4830	0.8076	-0.428	0.1018	0.1209	0.0011	-1.0545
4840	0.8076	-0.4297	0.1012	0.1209	0.0011	-1.0545
4850	0.0381	0	0.0784	0.0002	-0.0477	-0.0556
4857	0.0612	0	0.0485	-0.0527	-0.0484	0.0302
4860	0.0681	-0.0054	0.0406	-0.0685	-0.0417	0.0283
4869	0.0702	-0.0074	0.0398	-0.0714	-0.033	0.0227
4870	0.0718	-0.0105	0.0408	-0.0778	-0.0243	0.0203
4890	0.0774	-0.0341	0.0525	-0.0768	-0.0152	-0.0048
4900	0.0781	-0.0376	0.0543	-0.0768	-0.0152	-0.0049
4910	0.0792	-0.0436	0.0574	-0.0766	-0.0152	-0.005
4920	0.0789	-0.0408	0.0629	-0.0765	-0.0152	-0.0051
4980	0.0039	0	0.0007	0.0596	0.0008	-0.0266
4989	0.0035	0.0003	0.0002	0.0465	-0.0006	-0.019
4990	0.003	0.0003	0	0.0381	-0.0016	-0.0116
5020	0.0005	0	0	0	0	0
5030	0	0	0	0	0	0
5040	0	0	0	0	0	0
5050	0	0	0.0001	0	0	0

5060	0.0006	-0.0001	0.0056	-0.0018	-0.0201	0.002
5070	0.001	-0.0001	0.0064	-0.0018	-0.0202	0.002
5080	0.0123	-0.0006	0.0128	-0.0027	-0.1187	0.0116
5089	0.0143	-0.0007	0.0126	-0.0023	-0.1396	0.0125
5090	0.0156	-0.0009	0.0108	-0.002	-0.1592	0.0138
5110	0.0245	-0.0047	-0.0325	0.0044	-0.1974	0.0184
5119	0.0261	-0.0049	-0.0349	0.0048	-0.1894	0.0185
5120	0.0288	-0.0049	-0.0354	0.0055	-0.1802	0.0185
5140	0.0462	-0.0042	-0.0313	0.0082	-0.1525	0.0191
5150	0.0492	-0.004	-0.0305	0.0082	-0.1524	0.0191
5155	0.0917	0	-0.014	0.0048	-0.0536	0.0215
5157	0.0827	0	0.0135	0.0028	0.0708	0.0254
5160	0.0186	-0.0033	0.037	-0.0289	0.1373	0.0288
5169	0.0166	-0.0039	0.0374	-0.0338	0.1399	0.0293
5170	0.0154	-0.0046	0.0371	-0.0378	0.1416	0.0298
5190	0.0143	-0.0061	0.0357	-0.0389	0.1453	0.0298
5199	0.0137	-0.0064	0.0343	-0.0375	0.1466	0.0297
5200	0.013	-0.0063	0.0321	-0.0358	0.1473	0.0294
5220	0.0043	-0.001	0.0051	-0.0086	0.0683	0.0133
5230	0.0028	-0.0005	0.0025	-0.0086	0.0682	0.0133
5240	-0.0717	-0.0418	0.0539	-0.0074	-0.0628	0.1219
5250	-0.0668	-0.0571	0.0461	-0.0074	-0.0628	0.1224
5260	-0.0651	-0.0624	0.0433	-0.0074	-0.0628	0.1225
5290	-0.0604	-0.0765	0.0362	0.0036	-0.0558	0.0963
5300	-0.0602	-0.0772	0.0358	0.0036	-0.0558	0.0962
5320	-0.0299	-0.0302	0.0525	0.0021	-0.0321	-0.1568
5340	-0.0109	-0.0347	0.0527	-0.0018	-0.024	-0.1871
5350	-0.0098	-0.0349	0.0526	-0.0018	-0.024	-0.1871
5360	0.0036	-0.0377	0.0525	-0.0018	-0.024	-0.1873
5370	0.0067	-0.023	0.0506	-0.0019	-0.024	-0.1874
5380	0.0085	-0.0144	0.0495	-0.0019	-0.0239	-0.1874
5410	0.1044	0.1632	-0.2276	-0.3171	-0.0789	-0.0918
5420	0.1084	0.1615	-0.2415	-0.3171	-0.0788	-0.0917
5440	0.1126	0.1597	-0.256	-0.3172	-0.0787	-0.0917
5450	0.1751	0.1292	-0.5242	-0.3689	-0.0124	-0.0871
5459	0.1786	0.122	-0.5373	-0.3756	-0.01	-0.0941
5470	0.1803	0.1074	-0.5417	-0.3845	-0.0032	-0.0967
5480	0.1801	0.0429	-0.5351	-0.4014	0.0041	-0.1111
5485	0.1796	0	-0.531	-0.4207	0.0063	-0.1203
5500	0.1789	-0.0443	-0.5269	-0.4121	0.0067	-0.1293
5510	0.1786	-0.0629	-0.5251	-0.404	0.0069	-0.1305
5520	0.1782	-0.0814	-0.5233	-0.4039	0.0069	-0.1306
5530	0	0	0	0	0	0
5550	0	-0.0022	0	0.0002	0.0004	0.0004
5560	0	-0.0043	0	0.0002	0.0004	0.0005
5570	-0.0001	-0.0066	0	0.0002	0.0004	0.0005
5600	-0.0003	-0.0112	0.0001	0.0012	0.0048	0.0064

5609	-0.0003	-0.0117	0.0001	0.0022	0.0059	0.0104
5610	0.0001	-0.012	-0.0001	0.0035	0.0078	0.014
5640	0.0123	-0.0173	-0.0012	-0.0132	0.0218	0.0196
5649	0.0128	-0.0172	-0.0011	-0.0159	0.0229	0.0164
5650	0.0132	-0.0168	-0.0009	-0.0191	0.0236	0.0133
5720	-0.0313	-0.021	0.0277	-0.0124	-0.0222	-0.0835
5740	-0.0205	-0.0256	0.0269	0.006	-0.0234	-0.1185
5750	-0.019	-0.026	0.027	0.006	-0.0234	-0.1185
5760	-0.0014	-0.016	-0.0101	-0.0018	-0.0025	0.0043
5770	-0.0013	-0.0161	-0.0091	-0.0018	-0.0025	0.0043
5780	-0.0012	-0.0162	-0.007	-0.0018	-0.0025	0.0043
5830	-0.0825	-0.0173	0.0713	-0.0138	-0.0648	0.0659
5860	0.0103	0.0008	0.0501	0.0027	-0.0649	0.0007
6188	0.0676	-0.0324	-0.1829	-0.4052	0.0006	-0.1245
6189	0.0696	-0.0178	-0.1906	-0.4094	0.0039	-0.1271
6190	0.0745	-0.013	-0.2063	-0.4034	0.0058	-0.1315
6200	0.0747	-0.0131	-0.2072	-0.4033	0.0058	-0.1315
6210	0.0822	-0.0153	-0.2301	-0.4032	0.0058	-0.1315
6420	0.0328	-0.0078	0.059	-0.0055	-0.0586	-0.0149
6429	0.0323	-0.0079	0.0586	-0.005	-0.0586	-0.0149
6430	0.0322	-0.0082	0.0584	-0.0049	-0.0586	-0.0149
6460	0.0333	-0.0111	0.0581	-0.0049	-0.0586	-0.0149
6470	0.0336	-0.0119	0.058	-0.0049	-0.0586	-0.0149
6480	0.0339	-0.0128	0.0579	-0.0049	-0.0586	-0.0149
6490	0.0347	-0.015	0.0576	-0.0049	-0.0586	-0.0149
6500	0.0353	-0.0166	0.0574	-0.0049	-0.0586	-0.0149
6520	-0.0056	-0.0141	0.0245	0.0064	-0.0234	-0.1189
6540	0.0195	0.0004	-0.013	-0.0265	-0.0536	-0.0165
6550	0.0239	-0.0016	-0.0096	-0.0186	-0.0509	-0.0245
6560	0.0265	-0.0025	-0.0076	-0.0185	-0.0508	-0.0246
6670	0.0381	-0.0088	0.0781	0.0262	-0.0344	-0.1277
6680	0.0439	-0.0106	0.0793	0.0262	-0.0344	-0.1277
6690	0.0495	-0.0124	0.0804	0.0262	-0.0344	-0.1277
6710	0.2122	-0.0628	0.1138	0.0262	-0.0344	-0.1277
6720	-0.0821	-0.0252	0.0648	-0.012	-0.0642	0.0749
6730	-0.0858	-0.0272	0.0642	-0.012	-0.0642	0.0749
6740	-0.0862	-0.0274	0.0642	-0.012	-0.0642	0.0749
6750	0.0271	0.0019	-0.0018	-0.0036	-0.0427	-0.0336
6770	0.031	-0.0034	-0.0031	-0.0183	-0.0507	-0.0248
6780	0.0316	-0.0044	-0.0036	-0.0183	-0.0507	-0.0248
6920	-0.1319	0.0029	0.058	-0.0236	-0.062	-0.0813
6930	-0.1311	0.0025	0.0578	-0.0236	-0.062	-0.0813
6940	-0.1302	0.002	0.0575	-0.0236	-0.062	-0.0813
6960	-0.1249	-0.0005	0.056	-0.0236	-0.062	-0.0813
6970	-0.1215	-0.0021	0.055	-0.0236	-0.062	-0.0813
7000	-0.1009	-0.0041	0.0848	0.0012	-0.0649	-0.0012
7010	-0.1009	-0.0045	0.0848	0.0012	-0.0649	-0.0012

7020	-0.1009	-0.005	0.0848	0.0012	-0.0649	-0.0012
7040	-0.1008	-0.0072	0.0849	0.0012	-0.0649	-0.0012
7050	-0.1008	-0.0088	0.085	0.0012	-0.0649	-0.0012
7080	-0.0624	0.0032	0.0637	-0.0983	-0.0181	0.0103
7090	-0.0625	0.0026	0.0623	-0.0983	-0.0181	0.0103
7100	-0.0627	0.0019	0.0607	-0.0983	-0.0181	0.0103
7120	-0.0633	-0.0002	0.0554	-0.0983	-0.0181	0.0103
7130	-0.0637	-0.0019	0.0513	-0.0983	-0.0181	0.0103
7140	-0.0277	-0.0959	0.0016	0.0198	-0.0351	-0.0645
7150	-0.0246	-0.0978	0.0025	0.0198	-0.0351	-0.0645
7160	0.0141	-0.0001	0.0386	0.0029	-0.022	-0.1602
7170	0.0285	-0.0036	0.0389	0.0029	-0.022	-0.1602
7180	0.0112	-0.0111	-0.0016	0.0003	-0.0298	-0.0618
7190	0.0131	-0.0111	0.0009	0.0003	-0.0298	-0.0618
7200	0.0139	-0.0111	0.0019	0.0003	-0.0298	-0.0618
7230	0.192	0.0387	-0.5781	-0.4014	0.0041	-0.1111
7240	0.2037	0.0345	-0.6201	-0.4014	0.0041	-0.1111
7440	0.0114	-0.0022	0.0116	-0.0422	0.0325	-0.0185
7450	0.0119	-0.0031	0.0105	-0.0422	0.0325	-0.0185
7480	0.0129	-0.006	0.0076	-0.0385	0.0307	-0.011
7490	0.0136	-0.0083	0.0054	-0.0384	0.0307	-0.011
7530	-0.0655	0.0353	0.0651	-0.052	-0.0185	0.0217
7540	-0.0646	0.037	0.0673	-0.052	-0.0185	0.0217
7580	0.1106	-0.0238	-0.3171	-0.4033	0.0059	-0.1316
7590	0.1126	-0.0244	-0.3233	-0.4033	0.0059	-0.1316
7600	0.1729	-0.0425	-0.5082	-0.4042	0.006	-0.1314
7620	0.0145	0.0668	0.0293	0.0218	0.038	-0.1939
7630	0.0143	0.0668	0.0293	0.0218	0.038	-0.1939
7640	0.0042	0.0689	0.0282	0.0218	0.038	-0.1939
7650	0.004	0.0689	0.0281	0.0218	0.038	-0.1939
7660	-0.0041	0.0706	0.0272	0.0218	0.038	-0.1939
7700	-0.0242	-0.0981	0.0027	0.0198	-0.0351	-0.0645
7710	0.0104	0.0057	0.0498	0.0027	-0.0649	0.0007
7720	0.0104	0.0081	0.0496	0.0027	-0.0649	0.0007
7750	0.0319	-0.0273	-0.0413	-0.004	-0.0782	0.0522
7760	0.0319	-0.0273	-0.0413	-0.004	-0.0782	0.0522
7770	0.0341	-0.0256	-0.0411	-0.004	-0.0782	0.0522
7790	0.0324	-0.0242	-0.0441	0.0429	0.0274	0.0347
7800	0.0339	-0.0225	-0.0459	0.0429	0.0274	0.0347
7870	0.1086	-0.0232	-0.311	-0.4032	0.0059	-0.1316
7900	0.139	-0.0324	-0.4043	-0.4035	0.0059	-0.1315
7930	0.1654	-0.0403	-0.4853	-0.404	0.006	-0.1314
7970	0.0247	0.0606	0.027	0.0779	0.0314	-0.2065
7980	0	0	0	0	0	0
8000	0.1777	-0.1131	-0.5202	-0.4039	0.0068	-0.1306
8030	-0.0007	-0.0233	0.0054	-0.0746	0.0012	-0.02
8050	-0.0059	-0.0456	0.0001	-0.0085	-0.0042	0.0115

8500	-0.0074	-0.0196	0.0256	0.0063	-0.0234	-0.1188
8510	-0.0105	-0.0289	0.0274	0.0061	-0.0234	-0.1187

Job Name: 338716-FINAL

Licensed To: ENS CANADA STRUCTURAL ENGG & PROJECT MGMT INC

DISPLACEMENTS REPORT: Nodal Movements

CASE 1 (HYD) WW+HP

Node	DX in.	DY in.	DZ in.	RX deg.	RY deg.	RZ deg.
20	0.0222	-0.0178	0.0373	-0.0794	-0.0384	0.0071
23	-0.0008	-0.0002	-0.0001	-0.0005	-0.0006	0.0038
30	-0.0033	-0.0003	-0.0003	-0.0004	-0.0012	0.0078
31	-0.0052	-0.0003	-0.0004	-0.0001	-0.0013	0.0068
40	-0.006	-0.0004	-0.0004	0	-0.0013	0.0063
50	-0.0097	-0.0005	-0.0004	0	-0.0015	0.0035
60	-0.01	-0.0005	-0.0004	0	-0.0015	0.0035
70	-0.0105	-0.0005	-0.0004	0	-0.0015	0.0035
80	0	0	0	0	0	0
100	-0.001	-0.0889	-0.0015	0.0525	0.0035	-0.1421
110	-0.001	-0.0686	-0.001	0.0525	0.0035	-0.1437
120	-0.001	-0.0624	-0.0008	0.0525	0.0035	-0.1441
140	-0.001	-0.0559	-0.0007	0.0528	0.0031	-0.1611
150	-0.001	-0.0487	-0.0006	0.0524	0.0026	-0.177
160	-0.001	-0.0406	-0.0005	0.0524	0.0025	-0.1772
170	-0.001	-0.0108	0	0.0524	0.0025	-0.1776
189	-0.001	-0.0034	0	0.043	-0.0003	-0.1505
190	-0.0009	0	0	0.016	-0.0026	-0.1281
210	0	0	0	-0.0001	0	-0.0003
220	0	0	0	0	0	0
230	-0.0001	-0.0001	0	-0.0003	-0.0002	0.0015
235	-0.0007	-0.0001	-0.0001	-0.0005	-0.0005	0.0035
250	-0.0033	-0.0032	-0.0006	-0.0017	-0.0036	0.0377
260	-0.0033	-0.0056	-0.0009	-0.0017	-0.0036	0.0379
270	-0.0033	-0.006	-0.0009	-0.0017	-0.0036	0.0379
290	-0.001	-0.0954	-0.0016	0.0525	0.0035	-0.1416
310	-0.001	-0.1013	-0.0018	0.0522	0.0037	-0.1158
320	-0.001	-0.1052	-0.0019	0.0524	0.0037	-0.0965
330	-0.001	-0.1089	-0.0021	0.0526	0.0036	-0.0742
340	-0.001	-0.1136	-0.0024	0.053	0.0034	-0.0303
350	-0.001	-0.1149	-0.0026	0.0531	0.0035	-0.0258
360	-0.001	-0.1192	-0.0032	0.0531	0.0035	-0.0253
370	-0.001	-0.1203	-0.0033	0.0531	0.0035	-0.0251
400	-0.001	-0.1198	-0.0037	0.0545	0.0005	0.0951
410	-0.001	-0.1192	-0.0037	0.0545	0.0005	0.0952
420	0	0	0	0	0	0
430	0	0	0	-0.0001	0	0

435	0.0028	0	0	0.0304	0.011	0.015
450	0.0061	-0.0126	0	0.029	0.0113	0.025
460	0.0091	-0.0202	0	0.0263	0.0112	0.0252
470	0.0138	-0.0301	0	0.0211	0.0109	0.0255
480	0.0144	-0.0313	0	0.0206	0.0108	0.0255
510	0.0153	-0.0288	0	-0.0419	-0.0009	0.0316
515	0.0161	0	0	-0.0328	0.0047	0.0266
538	0.0174	-0.0006	0	0.0214	0.0075	0.0241
540	0.0167	-0.002	0.0014	0.0239	0.0111	0.021
541	0.0173	-0.0016	0.0005	0.0268	0.0098	0.0229
550	0.0166	-0.002	0.0015	0.0238	0.0112	0.0209
560	0.0113	-0.002	0.0076	0.0237	0.0112	0.0209
570	0.0101	-0.002	0.0089	0.0237	0.0113	0.0209
590	-0.0035	-0.002	0.0243	0.0189	0.024	0.0144
599	-0.004	-0.0018	0.0246	0.0192	0.0248	0.013
600	-0.0042	-0.0014	0.024	0.0192	0.0264	0.0116
610	-0.0042	0	0.0207	0.0201	0.0276	0.0105
615	-0.0042	0	0.0029	0.025	0.0271	-0.0202
620	-0.0042	-0.0231	-0.0129	0.0309	0.0121	-0.0163
630	-0.0042	-0.024	-0.0135	0.0309	0.012	-0.0162
640	-0.0042	-0.0249	-0.0142	0.0309	0.012	-0.0161
660	-0.0042	-0.0255	-0.0147	0.0313	0.0105	-0.0118
670	-0.0042	-0.026	-0.0152	0.0301	0.0087	-0.0088
680	-0.0042	-0.0265	-0.0157	0.0301	0.0086	-0.0087
690	-0.0042	-0.027	-0.0161	0.0301	0.0086	-0.0086
695	-0.0042	0	-0.008	-0.0008	-0.0152	0.0138
710	-0.0042	0.0011	-0.0053	-0.0052	-0.0153	0.0021
720	-0.0042	0.0012	-0.0045	-0.0052	-0.0153	0.002
730	-0.0042	0.0013	-0.0036	-0.0052	-0.0153	0.002
749	-0.004	0.0013	-0.0031	-0.0064	-0.0145	0.002
750	-0.0034	0.0011	-0.0029	-0.0082	-0.0132	0.002
770	-0.0025	0.0005	-0.0029	-0.0087	-0.0125	0.0029
779	-0.002	0.0001	-0.0027	-0.0084	-0.0109	0.0031
780	-0.0017	0	-0.0024	-0.0075	-0.0102	0.0038
810	0	0	0	0	0	0
820	0	0	0	0	0	0
830	-0.001	-0.0054	0.0027	0.0567	-0.0124	0.0962
840	-0.001	-0.001	0.0033	0.0567	-0.0124	0.0962
859	-0.0013	0.0015	0.0039	0.0631	-0.0194	0.0742
860	-0.0021	0	0.0043	0.0753	-0.0263	0.0607
880	-0.0039	-0.0049	0.0043	0.0757	-0.0285	0.047
900	-0.0086	-0.0154	0.0043	0.0542	-0.033	0.0139
910	-0.0101	-0.0177	0.0043	0.0473	-0.0346	0.0128
930	-0.0144	-0.0217	0.0043	0.0109	-0.0419	0.0059
940	-0.0199	-0.0231	0.0043	0.0105	-0.042	0.0058
950	-0.0202	-0.0232	0.0043	0.0105	-0.042	0.0058
980	-0.0249	-0.0229	0.0043	-0.0045	-0.0441	-0.0011

990	-0.0273	-0.0227	0.0043	-0.0045	-0.044	-0.0024
1010	-0.032	-0.0223	0.0043	0.0008	-0.0431	-0.0049
1020	-0.0339	-0.0224	0.0043	0.001	-0.0431	-0.0049
1040	-0.0388	-0.0225	0.0043	0.0014	-0.0431	-0.0049
1050	-0.0394	-0.0225	0.0043	0.0014	-0.0431	-0.0049
1060	0.0165	-0.0061	0.0373	-0.0792	-0.0384	0.0071
1090	0.012	0	0.0373	-0.0326	-0.0384	0.0071
1100	0.0094	0.0016	0.0373	-0.0171	-0.0384	0.0071
1120	0.0043	0.0025	0.0373	-0.0034	-0.0384	0.0071
1130	0.0028	0.0026	0.0373	-0.0029	-0.0385	0.0067
1140	0.0009	0.0028	0.0373	-0.0029	-0.0385	0.0067
1150	-0.001	0.0029	0.0373	-0.0029	-0.0385	0.0067
1170	-0.0042	0.0032	0.0373	-0.0028	-0.039	0.0059
1180	-0.0103	0.0035	0.0373	-0.0015	-0.0402	0.0044
1189	-0.0118	0.0035	0.0367	0.0011	-0.0419	0.0046
1190	-0.0124	0.0033	0.0351	0.0026	-0.0436	0.0049
1195	-0.0124	0	0.0176	0.0138	-0.0465	0.0166
1210	-0.0124	-0.0086	0.0011	0.0239	-0.0477	0.029
1219	-0.0117	-0.0109	-0.0033	0.0272	-0.0479	0.0284
1230	-0.0099	-0.0102	-0.004	0.0313	-0.0479	0.0271
1250	-0.007	-0.0082	-0.004	0.0362	-0.0478	0.0264
1260	-0.0062	-0.0076	-0.004	0.0362	-0.0478	0.0264
1270	0.0015	-0.0018	-0.004	0.0362	-0.0477	0.0264
1300	0.0069	0	-0.004	-0.0006	-0.0462	0.0249
1310	0.0104	-0.0001	-0.004	-0.0009	-0.0462	0.0249
1330	-0.001	-0.0466	-0.0017	0.0559	-0.0071	0.136
1350	-0.001	-0.0407	-0.0014	0.0561	-0.0081	0.1128
1360	-0.001	-0.0313	-0.0005	0.0565	-0.0108	0.1005
1370	-0.001	-0.0268	0	0.0567	-0.0122	0.0964
1390	0.0153	-0.0273	0.0002	-0.0345	-0.0046	0.0342
1400	0.0153	-0.0254	0.0004	-0.0343	-0.0047	0.0343
1410	0.0153	-0.0179	0.0015	-0.0336	-0.0048	0.0349
1420	0.0153	-0.0155	0.0018	-0.0333	-0.0048	0.035
1430	0.0153	-0.0154	0.0018	-0.033	-0.0048	0.0351
1439	0.0147	-0.014	0.0016	-0.0245	-0.0066	0.0399
1440	0.0132	-0.0134	0.0011	-0.0076	-0.0091	0.0405
1450	0.0131	-0.0134	0.0011	-0.0074	-0.009	0.0405
1460	0.0026	-0.0134	-0.0007	-0.007	-0.0088	0.0406
1470	0.0023	-0.0134	-0.0008	-0.007	-0.0088	0.0406
1480	0	-0.0133	-0.0012	-0.007	-0.0088	0.0406
1510	-0.0033	-0.0133	-0.0017	-0.0057	-0.0058	0.0426
1540	-0.0127	-0.0137	-0.023	-0.042	0.008	-0.0153
1560	0.0002	-0.014	-0.0531	-0.0493	0.0108	-0.0231
1580	0.0028	-0.014	-0.0587	-0.0449	0.0121	-0.0226
1590	0.0032	-0.014	-0.0594	-0.0449	0.0121	-0.0226
1600	-0.0062	-0.0005	-0.0004	0.0012	-0.0013	0.0063
1610	-0.0062	-0.0005	-0.0004	0.0012	-0.0013	0.0063

1620	-0.0063	-0.0006	-0.0004	0.0012	-0.0013	0.0063
1630	-0.0159	0.0148	-0.0453	-0.0141	-0.0127	-0.0401
1640	-0.0159	0.0119	-0.0444	-0.0141	-0.0127	-0.0401
1645	-0.0159	0	-0.0405	-0.0081	-0.0169	-0.0499
1660	-0.0159	-0.0227	0.001	0.0312	-0.0265	0.0384
1670	-0.0159	-0.0209	0.0023	0.0312	-0.0265	0.0384
1680	-0.0159	-0.0192	0.0034	0.0312	-0.0265	0.0384
1700	-0.0159	-0.0175	0.0046	0.0323	-0.0263	0.0382
1705	-0.0159	0	0.0204	0.0118	-0.0329	0.0251
1720	-0.0159	0.0025	0.0241	0.0075	-0.0336	0.0202
1729	-0.0154	0.0032	0.0253	0.0037	-0.0345	0.0132
1730	-0.0141	0.0034	0.0259	-0.002	-0.035	0.0093
1760	-0.0045	0.002	0.0259	-0.0079	-0.0338	-0.0031
1770	-0.003	0.0016	0.0259	-0.009	-0.0333	-0.0097
1775	0.0021	0	0.0259	-0.0105	-0.031	-0.0322
1780	0.0067	-0.0015	0.0259	-0.007	-0.028	-0.0547
1790	0.0079	-0.0018	0.0259	-0.0048	-0.027	-0.0609
1800	0.0092	-0.0019	0.0259	-0.0022	-0.026	-0.0675
1810	0.0125	-0.0016	0.0259	0.0069	-0.0224	-0.0875
1820	0.0135	-0.0013	0.0259	0.01	-0.0211	-0.0937
1830	0.0144	-0.0008	0.0259	0.0099	-0.0202	-0.0924
1835	0.0165	0	0.0259	-0.0002	-0.0187	-0.0895
1840	0.0192	-0.0014	0.0259	-0.0131	-0.0176	-0.0853
1850	0.02	-0.0021	0.0259	-0.0131	-0.0176	-0.0853
1860	0.0208	-0.0026	0.0259	-0.0131	-0.0176	-0.0853
1870	0.0208	-0.0027	0.0259	-0.0129	-0.0176	-0.0852
1880	0.0216	-0.0032	0.0259	-0.0088	-0.0178	-0.084
1890	0.0224	-0.0035	0.0259	-0.0052	-0.0174	-0.076
1900	0.0232	-0.0036	0.0259	-0.002	-0.0172	-0.068
1910	0.0239	-0.0037	0.0259	0.0007	-0.0173	-0.0604
1920	0.0247	-0.0036	0.0259	0.0033	-0.0162	-0.056
1930	0.0259	-0.0031	0.0259	0.0076	-0.0144	-0.0482
1940	0.0265	-0.0027	0.0259	0.0098	-0.0134	-0.044
1948	0.0271	-0.0022	0.0259	0.0114	-0.0125	-0.0396
1949	0.0275	-0.0012	0.0257	0.0104	-0.0092	-0.0341
1950	0.0276	0	0.0255	0.0067	-0.006	-0.0195
1970	-0.0097	-0.0006	-0.0002	-0.0006	-0.002	-0.0034
1980	-0.0097	-0.0008	-0.0001	-0.0006	-0.002	-0.0034
2020	0.0352	-0.0003	-0.004	0.0006	-0.0461	0.0249
2030	0.0387	-0.0002	-0.004	0.0007	-0.0461	0.0249
2049	0.0401	-0.0001	-0.004	0.0042	-0.0445	0.025
2050	0.0399	0	-0.0038	0.0048	-0.0436	0.025
2070	0.0343	0	-0.0027	0.0053	-0.0393	0.0249
2080	0.0186	0	-0.0017	-0.0015	-0.0276	0.0279
2089	0.0156	0	-0.0018	-0.0029	-0.0258	0.0291
2100	0.0142	0.0001	-0.0019	-0.0041	-0.0245	0.0295
2110	0.0136	0.0002	-0.0019	-0.0041	-0.0245	0.0295

2120	0.0118	0.0005	-0.0019	-0.0041	-0.0244	0.0295
2125	0.0047	0	-0.0019	0.0137	-0.021	0.0337
2150	-0.0014	-0.0074	-0.0019	0.0276	-0.019	0.0378
2170	-0.004	-0.011	-0.0019	0.0193	-0.0157	0.0396
2179	-0.0046	-0.011	-0.0017	0.0151	-0.0134	0.0409
2180	-0.0048	-0.0096	-0.0012	0.0128	-0.0111	0.0419
2210	-0.0048	-0.0036	0.0002	0.0067	-0.0085	0.0397
2218	-0.0048	-0.0018	0.0006	0.0059	-0.0078	0.0379
2219	-0.0042	-0.0005	0.0008	0.0054	-0.0064	0.0309
2220	-0.0033	0	0.0007	0.0044	-0.0057	0.0223
2240	0	0	0	0	0	0.0001
2250	0	0	0	0	0	0
2260	-0.0033	-0.0084	-0.0011	-0.0017	-0.0036	0.0381
2280	-0.0033	-0.0111	-0.0014	-0.0033	-0.0048	0.0435
2300	-0.0362	-0.0058	0.0217	-0.0493	0.0348	-0.1098
2309	-0.0374	-0.0053	0.0224	-0.0514	0.0356	-0.1161
2310	-0.0379	-0.004	0.0231	-0.0529	0.0367	-0.1222
2340	-0.0379	0.0263	0.0316	-0.0726	0.0418	-0.1527
2349	-0.0378	0.0283	0.032	-0.0743	0.0426	-0.1554
2350	-0.0373	0.0298	0.0322	-0.0766	0.0433	-0.1571
2390	-0.0341	0.0354	0.0322	-0.0787	0.0444	-0.1624
2400	-0.0335	0.0366	0.0322	-0.0787	0.0444	-0.1624
2410	-0.0328	0.0378	0.0322	-0.0787	0.0444	-0.1624
2415	-0.0249	0.0504	0.0322	-0.0585	0.0454	-0.1793
2440	-0.0173	0.0561	0.0322	-0.002	0.0437	-0.1956
2490	-0.013	0.0537	0.0322	0.0533	0.0414	-0.2056
2540	-0.0089	0.0446	0.0322	0.1278	0.0382	-0.2155
2545	-0.0009	0	0.0322	0.2735	0.0382	-0.6064
2570	0.0015	-0.0176	0.0322	0.2871	0.0382	-0.7224
2579	0.0019	-0.0241	0.0321	0.296	0.0382	-0.7492
2580	0.0021	-0.0337	0.0317	0.3035	0.0382	-0.7896
2610	0.0021	-0.0882	0.0292	0.3035	0.0382	-0.8695
2620	0.0021	-0.1024	0.0285	0.3035	0.0382	-0.8696
2640	0.0021	-0.2845	0.0205	0.3035	0.0382	-0.8702
2650	0.0021	-0.4411	0.0139	0.3035	0.0382	-0.9175
2660	0.0021	-0.4945	0.0117	0.3035	0.0382	-0.9176
2690	0.0021	-0.5929	0.0076	0.3035	0.0382	-0.9226
2700	0.0021	-0.608	0.007	0.3035	0.0382	-0.9226
2710	0.0021	-0.6211	0.0064	0.3035	0.0382	-0.9226
2730	0.0021	-0.8064	-0.0012	0.3035	0.0382	-0.9235
2820	-0.0058	-0.0407	0.0012	0.056	-0.0077	0.0944
2830	-0.0166	-0.0406	0.0133	0.0557	-0.0059	0.0041
2839	-0.0153	-0.0398	0.0152	0.0557	-0.0055	-0.0708
2840	-0.0139	-0.0359	0.0159	0.0558	-0.0045	-0.1286
2845	-0.0139	0	0.0147	0.055	-0.0022	0.021
2860	-0.0139	-0.0555	0.0143	0.0542	-0.0001	0.2264
2870	-0.0139	-0.0659	0.0143	0.0542	0	0.2264

2880	-0.0139	-0.1039	0.0143	0.0542	0	0.2256
2899	-0.0111	-0.1115	0.0135	0.0539	0.001	0.1538
2900	-0.0069	-0.1135	0.0115	0.0534	0.0015	0.0774
2920	-0.0001	-0.1135	-0.0001	0.053	0.0031	-0.013
2930	0.0216	-0.0072	0.0267	-0.0071	-0.0185	-0.0882
2940	0.0216	-0.0173	0.0288	-0.0029	-0.0198	-0.0894
2949	0.0203	-0.0204	0.0296	-0.0011	-0.0201	-0.0781
2950	0.0177	-0.0215	0.0299	0.0034	-0.0195	-0.0621
2960	0.0176	-0.0215	0.0299	0.0034	-0.0195	-0.0619
2970	-0.0003	-0.0216	0.0255	0.0191	-0.0238	-0.0276
2980	-0.0016	-0.0216	0.0247	0.0191	-0.0238	-0.0275
2990	-0.0101	-0.0216	0.0187	0.0194	-0.0238	-0.0271
3000	-0.0101	-0.0216	0.0187	0.0196	-0.0239	-0.0269
3010	-0.0133	-0.0216	0.0153	0.0283	-0.0253	-0.0187
3019	-0.0134	-0.021	0.014	0.0393	-0.0281	-0.0098
3020	-0.0125	-0.0194	0.0134	0.0471	-0.0313	-0.0055
3030	-0.0124	-0.0193	0.0134	0.0472	-0.0313	-0.0054
3040	-0.0112	-0.0175	0.0134	0.0478	-0.0315	-0.0028
3050	-0.0098	-0.0154	0.0134	0.0472	-0.0317	0.0002
3060	-0.0097	-0.0011	0.0001	-0.0006	-0.002	-0.0034
3090	-0.0097	-0.0013	0.0002	-0.0014	-0.0021	0.0005
3100	-0.0097	-0.001	0.0008	-0.0015	-0.0021	0.002
3110	-0.0097	-0.0004	0.0012	-0.0016	-0.002	0.0032
3120	-0.0097	-0.0002	0.0014	-0.0017	-0.002	0.0033
3139	-0.0097	0.0002	0.0014	-0.0036	0.0028	0.0104
3140	-0.0095	0.0005	0.0013	0.0021	0.0075	0.0092
3145	-0.0088	0	0.0013	0.0142	0.0096	0.0078
3160	-0.0024	-0.0225	0.0013	0.0576	0.0145	0.0002
3169	-0.0018	-0.0247	0.0005	0.0517	0.0135	-0.0009
3170	-0.0017	-0.0255	-0.0013	0.044	0.0127	-0.0032
3200	-0.0091	-0.0154	0.0066	0.0504	-0.0323	0.007
3210	-0.0094	-0.0154	0.0089	0.0503	-0.0323	0.0069
3220	-0.0097	-0.0154	0.0111	0.0502	-0.0323	0.0068
3250	0.0137	-0.0155	0.0296	0.003	-0.0226	-0.049
3270	0.0196	-0.0155	0.0298	0.0005	-0.0194	-0.0557
3280	0.0199	-0.0155	0.0298	0.0005	-0.0194	-0.0557
3290	0.0239	-0.0155	0.0299	0.0005	-0.0193	-0.0557
3300	0.0239	-0.0111	0.0283	0.0005	-0.0193	-0.0558
3310	0.0239	-0.0086	0.0274	0.0005	-0.0193	-0.0558
3390	-0.0089	0.0306	0.029	0.1042	0.035	-0.1156
3400	-0.0089	0.0277	0.0282	0.1042	0.035	-0.1155
3420	-0.0089	0.0155	0.0228	0.0592	0.0289	-0.0584
3430	-0.0089	0.0121	0.0212	0.0591	0.0289	-0.0584
3470	-0.0089	0.0048	0.0188	0.0355	0.0256	-0.118
3475	-0.0089	0	0.0175	0.0177	0.0236	-0.0769
3500	-0.0089	-0.0033	0.0163	-0.0001	0.0216	-0.05
3510	-0.0089	-0.0042	0.016	-0.0001	0.0216	-0.05

3520	-0.0089	-0.0146	0.0114	-0.0005	0.0216	-0.0495
3550	-0.0089	-0.0176	0.01	-0.0189	0.0195	-0.0386
3559	-0.0087	-0.018	0.0096	-0.0236	0.0197	-0.0358
3560	-0.0083	-0.0182	0.0093	-0.031	0.0204	-0.0336
3590	-0.0063	-0.0182	0.0067	-0.0482	0.0171	-0.0293
3600	-0.0046	-0.0182	0.0039	-0.0482	0.0171	-0.0293
3630	-0.003	-0.0182	0.0009	-0.0592	0.015	-0.026
3639	-0.0027	-0.0179	0.0002	-0.0675	0.0139	-0.0235
3640	-0.0025	-0.0171	-0.0001	-0.0748	0.0123	-0.0218
3670	-0.0017	-0.011	-0.0001	-0.0811	0.009	-0.0139
3680	-0.0015	-0.0097	-0.0001	-0.0811	0.009	-0.0139
3720	0.0049	-0.1013	0.0016	0.028	0.0092	-0.0208
3730	0.0057	-0.1013	0.0027	0.028	0.0092	-0.0207
3760	0.0056	-0.1013	0.0041	0.02	0.0111	0.0133
3770	0.0053	-0.1013	0.0046	0.02	0.0111	0.0133
3818	-0.0029	-0.1013	0.0079	0.0102	0.0138	0.0622
3819	-0.0041	-0.1008	0.0079	0.0085	0.0142	0.0716
3820	-0.0047	-0.0993	0.0077	0.0073	0.0148	0.0809
3827	-0.0047	0	-0.0045	-0.0363	0.0123	0.0975
3830	-0.0047	0.0176	-0.007	-0.0493	0.0078	0.0545
3840	-0.0047	0.019	-0.0072	-0.0493	0.0078	0.0544
3868	-0.0047	0.0222	-0.0076	-0.0526	0.0064	0.0502
3871	-0.0047	0.0227	-0.0078	-0.054	0.0054	0.0481
3890	-0.0048	0.022	-0.0078	-0.0555	0.0044	0.0466
3900	-0.0053	0.0008	-0.0078	-0.0391	-0.0003	0.0235
3909	-0.0052	0.0004	-0.0076	-0.0363	-0.0001	0.0227
3910	-0.005	0.0002	-0.0073	-0.0334	0.0002	0.0214
3940	-0.0028	0.0002	-0.004	-0.0233	0.0003	0.016
3950	-0.0024	0.0002	-0.0035	-0.0233	0.0003	0.016
3970	-0.0014	0.0002	-0.002	-0.0172	0.0005	0.0121
3980	-0.0008	0.0002	-0.0012	-0.0172	0.0005	0.0121
3990	-0.0001	0.0002	-0.0001	-0.0113	0.0006	0.0077
3999	0	0.0002	0	-0.009	0.0002	0.0057
4000	0	0.0001	0	-0.0075	-0.0002	0.0037
4030	0	0	0	0	0	0
4040	0	0	0	0	0	0
4070	0.0092	-0.0559	0.0053	0.0861	0.0029	-0.0771
4080	0.0121	-0.0559	0.0086	0.0861	0.0029	-0.077
4110	0.0159	-0.0559	0.0144	0.0964	0.0028	-0.0531
4120	0.0173	-0.0559	0.0169	0.0964	0.0028	-0.0531
4140	0.0283	-0.0559	0.0459	0.1099	0.0027	-0.0299
4149	0.0286	-0.056	0.0471	0.1109	0.0025	-0.0288
4150	0.0287	-0.0563	0.0475	0.1116	0.0024	-0.0277
4190	0.0287	-0.0608	0.0387	0.1476	0.0285	0.01
4200	0.0287	-0.0606	0.038	0.1477	0.0285	0.01
4220	0.0287	-0.0599	0.0358	0.1509	0.0336	0.0073
4229	0.0285	-0.0592	0.0354	0.1513	0.0359	0.0058

4230	0.0281	-0.0575	0.0352	0.1519	0.0382	0.0048
4260	0.0134	-0.0081	0.0352	0.1287	0.0428	-0.0223
4269	0.0128	-0.0068	0.0347	0.1228	0.0418	-0.0232
4270	0.0124	-0.0062	0.0334	0.1168	0.0413	-0.0247
4300	0.0102	-0.0062	0.0247	0.102	0.0364	-0.0282
4310	0.0095	-0.0062	0.0221	0.1019	0.0364	-0.0282
4330	0.0074	-0.0062	0.0152	0.0892	0.032	-0.029
4340	0.006	-0.0062	0.0109	0.0891	0.0319	-0.029
4350	0.004	-0.0062	0.0049	0.077	0.0275	-0.0268
4359	0.0036	-0.0059	0.0041	0.0717	0.0264	-0.0253
4360	0.0032	-0.0051	0.0038	0.0662	0.0247	-0.0242
4400	0.0013	-0.0001	0.0038	0.0462	0.0188	-0.019
4580	0.0091	0.0048	0.0221	0.0403	0.0256	-0.2936
4590	0.0165	0.0048	0.0231	0.0403	0.0256	-0.2938
4610	0.0686	0.0048	0.0285	0.0471	0.0256	-0.544
4619	0.0748	0.0021	0.0289	0.0487	0.0253	-0.6079
4620	0.0776	-0.0048	0.0289	0.0497	0.025	-0.6705
4650	0.0776	-0.3625	0.0192	0.077	0.025	-1.0554
4659	0.0823	-0.374	0.0193	0.078	0.0247	-1.0568
4660	0.0937	-0.3787	0.02	0.0796	0.0245	-1.0571
4690	0.3381	-0.3787	0.0399	0.0922	0.0245	-1.0571
4700	0.3554	-0.3787	0.0414	0.0922	0.0245	-1.0571
4710	0.5766	-0.3787	0.0607	0.0923	0.0245	-1.0571
4740	0.6527	-0.3787	0.0674	0.0952	0.0245	-1.0571
4750	0.7141	-0.3787	0.073	0.0952	0.0245	-1.0571
4780	0.7914	-0.3787	0.08	0.0982	0.0245	-1.0571
4789	0.8029	-0.3792	0.0811	0.0999	0.0245	-1.0571
4790	0.8079	-0.3803	0.0816	0.1015	0.0245	-1.0571
4820	0.8097	-0.388	0.0816	0.1035	0.0245	-1.0571
4830	0.8101	-0.3897	0.0816	0.1035	0.0245	-1.0571
4840	0.8105	-0.3912	0.0816	0.1035	0.0245	-1.0571
4850	0.0276	0	0.0254	0.0067	-0.0059	-0.0193
4857	0.0276	0	0.0248	0.0032	0.0034	0.0096
4860	0.0276	-0.0017	0.0256	0.0022	0.0058	0.0091
4869	0.0275	-0.002	0.0259	0.0025	0.0082	0.0071
4870	0.0271	-0.002	0.026	0.0029	0.0104	0.0059
4890	0.0237	-0.0009	0.026	0.0053	0.0127	-0.0006
4900	0.0231	-0.0006	0.026	0.0053	0.0127	-0.0007
4910	0.0221	-0.0002	0.026	0.0053	0.0127	-0.0007
4920	0.0221	-0.0002	0.0256	0.0053	0.0127	-0.0007
4980	0.0001	-0.0001	0.0006	0.0275	0.0102	-0.008
4989	0	-0.0001	0.0003	0.0211	0.0077	-0.0033
4990	0	-0.0001	0.0001	0.0168	0.0045	0.0005
5020	0	0	0	0	0	0
5030	0	0	0	0	0	0
5040	0	0	0	0	0	0
5050	0	0	0	0	0	0

5060	0	-0.0001	0	-0.0022	0	0.0022
5070	0	-0.0001	0	-0.0022	0	0.0022
5080	0	-0.0008	0	-0.0037	0	0.0128
5089	0	-0.0009	0	-0.0033	0.0001	0.0137
5090	0	-0.0011	0	-0.0031	0.0001	0.0151
5110	0	-0.0052	0	0.0039	0	0.0195
5119	0	-0.0054	0	0.0044	-0.0001	0.0193
5120	0	-0.0055	0	0.0052	-0.0001	0.0192
5140	0	-0.0048	0	0.0083	-0.0002	0.0189
5150	0	-0.0046	0	0.0083	-0.0002	0.0189
5155	0.0002	0	0	0.0074	-0.0006	0.018
5157	0.0007	0	0	-0.0052	-0.0008	0.0164
5160	0.0011	-0.0035	0	-0.0019	-0.0005	0.015
5169	0.001	-0.0035	0	-0.0017	-0.0005	0.015
5170	0.0008	-0.0035	0	-0.0015	-0.0005	0.0149
5190	0.0003	-0.0035	-0.0001	-0.0014	-0.0005	0.0148
5199	0.0001	-0.0034	-0.0001	-0.0013	-0.0005	0.0148
5200	0	-0.0032	-0.0001	-0.0012	-0.0005	0.0146
5220	0	-0.0005	0	-0.0003	-0.0002	0.0071
5230	0	-0.0003	0	-0.0003	-0.0002	0.007
5240	-0.001	-0.0528	-0.002	0.0559	-0.0071	0.1363
5250	-0.001	-0.0698	-0.0029	0.0559	-0.007	0.1368
5260	-0.001	-0.0758	-0.0032	0.0559	-0.007	0.1368
5290	-0.001	-0.0913	-0.0038	0.0546	0.0003	0.1005
5300	-0.001	-0.092	-0.0038	0.0546	0.0003	0.1005
5320	-0.0031	-0.0222	0.0264	0.0257	-0.0258	-0.0675
5340	0.0057	-0.0222	0.029	0.0154	-0.0208	-0.1
5350	0.0063	-0.0222	0.0291	0.0154	-0.0208	-0.1
5360	0.0135	-0.0222	0.0302	0.0154	-0.0208	-0.1002
5370	0.0135	-0.0143	0.0286	0.0153	-0.0208	-0.1003
5380	0.0135	-0.0097	0.0276	0.0152	-0.0208	-0.1003
5410	-0.0141	0.0119	-0.045	-0.0149	-0.0116	-0.0381
5420	-0.0125	0.0119	-0.0457	-0.0149	-0.0116	-0.038
5440	-0.0107	0.0119	-0.0464	-0.0149	-0.0116	-0.038
5450	0.0108	0.0119	-0.062	-0.0243	0.006	-0.0226
5459	0.0115	0.0115	-0.0629	-0.0261	0.0073	-0.0219
5470	0.0115	0.0105	-0.0633	-0.03	0.0098	-0.0214
5480	0.0097	0.0049	-0.0633	-0.041	0.0116	-0.0217
5485	0.0085	0	-0.0633	-0.0553	0.0121	-0.0219
5500	0.0072	-0.0063	-0.0633	-0.0515	0.012	-0.0221
5510	0.0067	-0.0085	-0.0633	-0.045	0.0121	-0.0226
5520	0.0061	-0.0105	-0.0633	-0.0449	0.0121	-0.0226
5530	0	0	0	0	0	0
5550	0	0	0	0.0002	0.0002	0.0004
5560	0	0	0	0.0003	0.0002	0.0004
5570	-0.0001	0	0	0.0003	0.0002	0.0005
5600	-0.0003	0	0.0002	0.0029	0.0023	0.0058

5609	-0.0004	0	0.0002	0.0048	0.003	0.0095
5610	-0.0004	-0.0002	0.0003	0.0067	0.004	0.0129
5640	0.0007	-0.0057	0.0024	0.0038	0.0124	0.0113
5649	0.0008	-0.0058	0.0025	0.0017	0.0131	0.0077
5650	0.0009	-0.0058	0.0026	-0.0005	0.0135	0.0038
5720	-0.0037	0.0024	0.0342	-0.0047	-0.0349	0.006
5740	-0.0043	0.0023	0.0335	-0.0069	-0.0339	0.0028
5750	-0.0043	0.0023	0.0335	-0.0069	-0.0339	0.0028
5760	-0.0009	-0.0007	-0.0001	0.0032	-0.0006	0.0038
5770	-0.0009	-0.0006	-0.0001	0.0032	-0.0006	0.0038
5780	-0.0009	-0.0004	-0.0001	0.0032	-0.0006	0.0038
5830	-0.001	-0.0224	0.0006	0.0567	-0.0122	0.0963
5860	0.0228	-0.0003	-0.004	-0.0005	-0.0462	0.0249
6188	-0.0117	-0.0087	-0.023	-0.0433	0.0089	-0.0177
6189	-0.011	-0.0071	-0.0237	-0.0452	0.0105	-0.0191
6190	-0.0101	-0.0064	-0.0254	-0.0474	0.0115	-0.0217
6200	-0.0101	-0.0064	-0.0255	-0.0474	0.0115	-0.0217
6210	-0.0088	-0.0064	-0.0282	-0.0474	0.0115	-0.0217
6420	0.0303	-0.0015	-0.0027	0.019	-0.0393	0.0249
6429	0.0298	-0.0017	-0.0026	0.0195	-0.0393	0.0249
6430	0.0295	-0.0017	-0.0024	0.0196	-0.0393	0.0249
6460	0.0277	-0.0017	-0.001	0.0196	-0.0393	0.0249
6470	0.0271	-0.0017	-0.0006	0.0196	-0.0393	0.0249
6480	0.0266	-0.0017	-0.0001	0.0196	-0.0393	0.0249
6490	0.0252	-0.0017	0.0009	0.0196	-0.0393	0.0249
6500	0.0242	-0.0017	0.0017	0.0196	-0.0393	0.0249
6520	-0.0045	0.002	0.0287	-0.0069	-0.0339	0.0027
6540	-0.0147	-0.0159	0.0046	0.0341	-0.0252	0.0381
6550	-0.0126	-0.0129	0.0046	0.036	-0.0233	0.038
6560	-0.0115	-0.0111	0.0046	0.036	-0.0233	0.038
6670	0.0285	-0.0027	0.0263	0.0098	-0.0134	-0.044
6680	0.0305	-0.0027	0.0268	0.0098	-0.0134	-0.044
6690	0.0324	-0.0027	0.0272	0.0098	-0.0134	-0.044
6710	0.0886	-0.0028	0.0397	0.0098	-0.0134	-0.044
6720	-0.0053	-0.0313	0.0019	0.0565	-0.0108	0.1005
6730	-0.0102	-0.0313	0.0047	0.0565	-0.0108	0.1005
6740	-0.0108	-0.0313	0.005	0.0565	-0.0108	0.1005
6750	-0.0031	-0.0074	-0.0006	0.0297	-0.0201	0.0378
6770	-0.0081	-0.0074	0.0037	0.0359	-0.0232	0.038
6780	-0.0091	-0.0074	0.0046	0.0359	-0.0232	0.038
6920	-0.0271	-0.0227	0.0038	-0.0045	-0.044	-0.0024
6930	-0.0271	-0.0227	0.0038	-0.0045	-0.044	-0.0024
6940	-0.027	-0.0227	0.0037	-0.0045	-0.044	-0.0024
6960	-0.0269	-0.0227	0.0034	-0.0045	-0.044	-0.0024
6970	-0.0268	-0.0227	0.0032	-0.0045	-0.044	-0.0024
7000	-0.0087	-0.0049	0.012	0.0757	-0.0285	0.047
7010	-0.0092	-0.0049	0.0128	0.0757	-0.0285	0.047

7020	-0.0097	-0.0049	0.0137	0.0757	-0.0285	0.047
7040	-0.0123	-0.0049	0.0178	0.0757	-0.0285	0.047
7050	-0.0142	-0.0049	0.0209	0.0757	-0.0285	0.047
7080	0.0087	0.0015	0.0356	-0.0171	-0.0384	0.0071
7090	0.0086	0.0015	0.0353	-0.0171	-0.0384	0.0071
7100	0.0085	0.0015	0.0351	-0.0171	-0.0384	0.0071
7120	0.0081	0.0015	0.0341	-0.0171	-0.0384	0.0071
7130	0.0078	0.0015	0.0334	-0.0171	-0.0384	0.0071
7140	0.0022	-0.1089	0.0001	0.0526	0.0036	-0.0742
7150	0.0058	-0.1089	0.0027	0.0526	0.0036	-0.0742
7160	0.0107	-0.0018	0.0257	-0.0048	-0.027	-0.0609
7170	0.0162	-0.0018	0.0252	-0.0048	-0.027	-0.0609
7180	-0.0044	-0.0033	0.0002	0.0056	-0.0085	0.0397
7190	-0.0039	-0.003	0.0002	0.0056	-0.0085	0.0397
7200	-0.0036	-0.0028	0.0002	0.0056	-0.0085	0.0397
7230	0.012	0.0049	-0.0677	-0.041	0.0116	-0.0217
7240	0.0143	0.0049	-0.072	-0.041	0.0116	-0.0217
7440	-0.0056	-0.0058	0.0068	-0.0189	0.0217	-0.0328
7450	-0.0048	-0.0058	0.0064	-0.0188	0.0217	-0.0328
7480	-0.0027	-0.0058	0.0051	-0.0151	0.02	-0.0247
7490	-0.0013	-0.0058	0.0043	-0.0151	0.02	-0.0246
7530	-0.0036	0.0032	0.0376	-0.0028	-0.039	0.0059
7540	-0.0034	0.0032	0.0377	-0.0028	-0.039	0.0059
7580	-0.0041	-0.0064	-0.0384	-0.0475	0.0116	-0.0218
7590	-0.0038	-0.0064	-0.0391	-0.0475	0.0116	-0.0218
7600	0.0062	-0.0063	-0.061	-0.048	0.0117	-0.0219
7620	-0.0203	0.0561	0.0323	-0.002	0.0437	-0.1956
7630	-0.0205	0.0561	0.0323	-0.002	0.0437	-0.1956
7640	-0.0308	0.0561	0.0324	-0.002	0.0437	-0.1956
7650	-0.031	0.0561	0.0324	-0.002	0.0437	-0.1956
7660	-0.0391	0.0561	0.0325	-0.002	0.0437	-0.1956
7700	0.0062	-0.1089	0.003	0.0526	0.0036	-0.0742
7710	0.0259	-0.0003	-0.004	-0.0005	-0.0462	0.0249
7720	0.0274	-0.0003	-0.0039	-0.0005	-0.0462	0.0249
7750	0.0183	-0.0179	0.0044	-0.0336	-0.0048	0.0349
7760	0.0184	-0.0179	0.0045	-0.0336	-0.0048	0.0349
7770	0.0198	-0.0179	0.0059	-0.0336	-0.0048	0.0349
7790	0.0114	-0.0202	-0.0023	0.0263	0.0112	0.0252
7800	0.0124	-0.0202	-0.0034	0.0263	0.0112	0.0252
7870	-0.0045	-0.0064	-0.0377	-0.0475	0.0116	-0.0218
7900	0.0006	-0.0064	-0.0487	-0.0477	0.0116	-0.0218
7930	0.005	-0.0064	-0.0583	-0.048	0.0116	-0.0219
7970	-0.0094	0.0537	0.0332	0.0533	0.0414	-0.2056
7980	0	0	0	0	0	0
8000	0.0052	-0.014	-0.0633	-0.0448	0.0121	-0.0226
8030	-0.0014	-0.0086	-0.0001	-0.081	0.009	-0.0139
8050	-0.005	-0.0004	-0.0004	-0.0006	-0.0013	0.0068

8500	-0.0045	0.0021	0.0303	-0.0069	-0.0339	0.0028
8510	-0.0045	0.0023	0.033	-0.0069	-0.0339	0.0028



Swift Engineering Inc.



RELIEF HEADER SIZING

Job No N/A
Client National Process Equipment
Project Meter Skid (CMT Unit)
Case PSV-08071B Relief Back Pressure Check (3/16 in PCV-08071A Trim Size)

Rev 0
Page 1
Date: 13-Oct-15
Time

Table with columns for FROM/TO SEGMENT NO, DESCRIPTION, and various pressure/flow parameters (Vent Cap, Headers 1-7, PSV-08116A, PSV-08070A, PSV-08071A, PSV-08071B, PSV-08071C, PSV-08071D). Includes rows for ATM PRESSURE (psia), GAS FLOW, REYNOLDS NUMBER, MACH NUMBER, and BACK PRESSURE.

Professional Engineer seal for Timothy M. Lee, dated Oct 13, 2015, with handwritten signature and 'Verified Calculations' text.



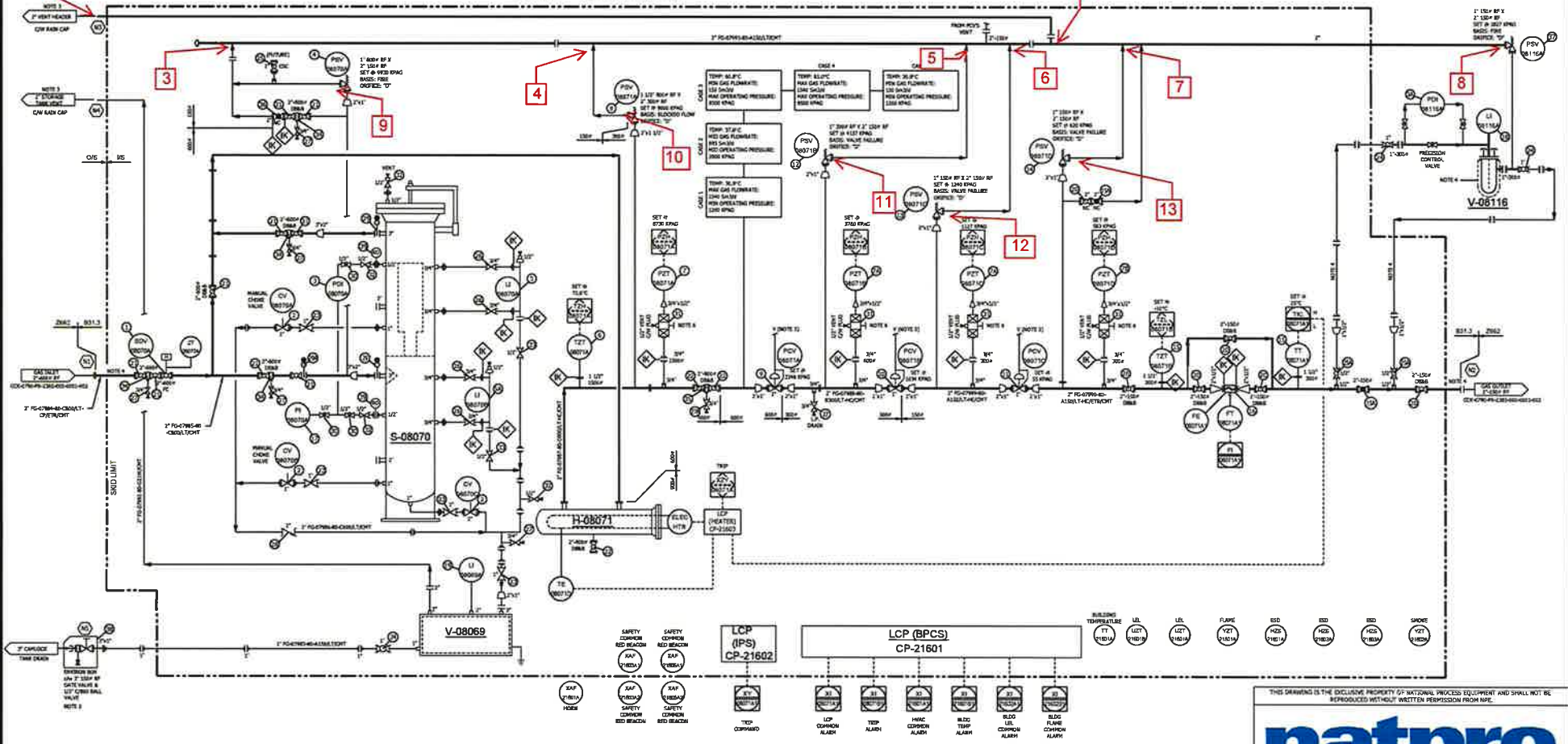
Swift Engineering Inc.



Program Purpose:	Vent Header Sizing Program
Inputs:	1) Mass flow rates 2) MW, Z, temperature, viscosity, specific heat 3) Pipe length, diameter 4) Fittings L/D and other restrictions 5) Pipe connectivity - used to sum pressure drops
Outputs:	1) Pressure Drop 2) Mach number
Limitations:	1) Calculations are isothermal
Hints:	Connectivity specified using segment numbers (labels are for information only) For segment numbering please refer to labels on P&ID. Design: Limit Mach Number to 0.75 (for Vent Header) Under no conditions allow for Mach No > 1.0 Back pressure build-up is limited to or less 10% of PSV set pressure for conventional PSV's Back pressure build-up is limited from 30% to 50% of PSV set pressure for balanced bellows PSV's (consult manufacturer for exact number) Rating: Handles pressure drops for sonic flow (Mach No. > 1)
Sources:	API RP 521 "Program sizes pipe and flare manifolds for compressible flow," by Paul Kandell, PEDCo Inc., Chem. Eng., June 29, 1981
Revision Date/Author:	13/10/2015 J.S./T.L.
Notes:	1. Headers & back pressure buildup were based on largest relief from PSV-08071B. 2. No double jeopardy case (no simultaneous relief of PSVs) was considered in calculations. 3. Assume PSV outlet temperature is at operating temperature or lower 4. PSV-08071B Relief load is based on PCV-08071A with a trim size of 3/16 in.

Labels are for references only.

S-08070 COALESCE FILTER NAME: JONES MODEL: JPMG-315-CE-8 SIZE: 219mm x 256mm S/S DP/DT: AS CW: AS CA: 3.05	H-08071 NATURAL GAS ELECTRIC HEATER NAME: CH HEAT RATED HEAT DUTY: 6.4 MW(3000/6042/3 PHASE) VESSEL SIZE: 166mm OD x 1694mm LG DP/DT: 9930 kPaG +45/93°C CW: AS CA: 1.6 INSULATION: PERSONNEL PROTECTION ONLY	V-08069 CONDENSATE STORAGE TANK NAME: STEELDRUM MODEL: 100 GAL DOUBLE WALL STEEL TANK SIZE: 711mm OD x 1219mm LG DP/DT: ATMOSPHERIC SKID LIMIT	V-08116 MERCAPTAN GAS ODOORIZER NAME: TAPLEY ASSOCIATES MODEL: 3-30 SIZE: 406mm OD x 762mm LG DP/DT: 2058 kPaG +45/64°C CA: 0
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CONN	SIZE	RATING	DESCRIPTION
N1	2"	600# RF	PACKAGE INLET
N2	2"	150# RF	PACKAGE OUTLET
N3	2"	-	VENT HEADER (VENT TO ATMOSPHERE)
N4	2"	-	TANK VENT (VENT TO ATMOSPHERE)
N5	3"	CAMLOCK	TANK DRAIN

- GENERAL NOTES:**
- DELETED.
 - NATPRO SCOPE OF SUPPLY.
 - (N)(M) TO BE ROUTED TO SAFE LOCATION. VENT TO ATMOSPHERE.
 - ELECTRIC HEAT TRACING & INSULATION AT LEAST 1M INSIDE THE BUILDING SHOULD BE PROVIDED BY OTHERS. TO 2" VENT HEADER.
 - SS SPOOLS TO BE SS316/L CW 3/4" XS SCH NIPPLES.
 - INDICATING ISOLATION KIT
 - PIPING HEAT CONSERVATION AFTER ELECTRICAL HEATER BY NPE.

REV	DESCRIPTION	DATE	CHK	APP	DATE
8	REVISED AS PER CUSTOMER'S REQUIREMENT	08/14	AA	AA	08/14/14
7	REVISED AS PER CUSTOMER'S REQUIREMENT	08/14	AA	AA	08/14/14
6	REVISED TAGGING & ASSESSING, ADDED GEN. NOTE 8	08/14	GG	ET	08/14/14
5	REVISED AS PER CUSTOMER'S MARKUPS	08/14	GG	ET	08/14/14
4	REVISED AS PER CUSTOMER'S COMMENTS	08/14	GG	ET	08/14/14
3	REVISED AS TITLE BLOTTING & ADDED LINE NUMBERS	08/14	GG	ET	08/14/14
2	REVISED AS PER CUSTOMER'S COMMENTS	08/14	GG	ET	08/14/14
1	REVISED AS PER CUSTOMER'S COMMENTS	08/14	GG	ET	08/14/14
0	ISSUED FOR APPROVAL	08/14	GG	ET	08/14/14

CMT NG PRESSURE REDUCTION SKID PACKAGE P & ID

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF NATPRO PROCESS EQUIPMENT AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION FROM NPE.

PROJECT NAME: CARMON CREEK PROJECT
CUSTOMER: SHELL CANADA c/o JACOBS ENGINEERING
LOCATION: CMT FIELD FACILITIES AND INFRASTRUCTURE PHASE 1 & 2
TAG: 0735A-08030

SLIP: 338716 **QUOTE:** CGY2014-85 **PO#:** 4512-109-130

DATE: JUL 04/14 **DWG#:** 338716-100-Rev8
DATE: JUL 04/14 **DATE:** JUL 04/14

APP: COG **DATE:** JUL 04/14 **PAGE:** 1 OF 4 **CAD:** N/A **REV:** B

Job No:	N/A		Rev:	0
Client:	National Process Equipment		Page:	1
Project:	CMT Meter Skid		Date:	10/19/2015
Scope:	PSV&PCV Datasheet Verifications		By:	JS/TL

NOTE: Datasheet Document is verified based on the information provided by Spartan Controls and National Process Equipment

Pressure Safety Valve

Tag#	Set Point	Orifice size	Relief Capacity	Swift Remark
PSV-08070A	9930 kPag	D	435 kg/hr	Datasheet Verified
PSV-08071A	9600 kPag	D	1540 Sm ³ /day	Datasheet Verified
PSV-08071B	4137 kPag	D	30504 Sm ³ /day	Datasheet Verified
PSV-08071C	1240 kPag	D	5949 Sm ³ /day	Datasheet Verified
PSV-08071D	620 kPag	D	4341 Sm ³ /day	Datasheet Verified
PSV-08116A	1827 kPag	D	269.52 kg/hr	Datasheet Verified

Pressure Control Valve

Tag#	Set Point	Trim size	Swift Remark
PCV-08071A	3348 kPag	3/16"	Datasheet Verified
PCV-08071B	1034 kPag	1/8"	Datasheet Verified
PCV-08071C	55 kPag	3/16"	Datasheet Verified

Signature:

Timmy Lee
TIMMY LEE

Date:

Oct. 19, 2015

Verified that PCVs' setpoints are matching PID.

Pressure Relief Valve Data Sheet

Date Prepared: 2015-10-09 10:52

General Job Data

Customer	Requisition #	Job #	Job Description	
		2282974SQ		
Prepared By	Checked By	Approved By	Job Status	Revision #
Brady Swallowell			Sizing/Selecting	0

PSV Identification

Tag #	Tag Description	Tag Status	P / ID	Discharge To	Revision #	
PSV-08070A	0735-PSV-1	Valve Selected			0	
Plant #	Drawing #	Index #	Issue For	Service Inlet Line #	Outlet Line #	Revised By
						Shrenuj Dave

Sizing Basis

ASME Code	Cause of Over Pressure	Fluid State	Rupture Disk Coeff.	NACE
ASME Sec. VIII	Fire	Vapor (Mass)	No Rupture Disk, 1	No

Process Parameters

MAWP	- Kpa G	Max. Design T.	- °C	Min. Design T.	- °C
Operating Pressure	8500 Kpa G	Operating Temp.	40 °C	Constant Back P.	0 Kpa G
Set Pressure	9930 Kpa G	Relief Temp.	167.98 °C	Variable Back P.	19 Kpa G
Operating to Set %	85.599 %	Percent Over P.	21 %	Over Pressure	2085.3 Kpa G
Atm Pressure	101.33 Kpa Abs	Relief Pressure	12117 Kpa Abs	Cold Diff. Test P.	9930 Kpa G

Compressible State

Fluid	-	Molecular Weight	17.58 Mol Wt	Gas Flow Const.	342
Req. Flow Cap.	-	Specific Gravity	0.60683 sp gr	Compressibility	-
Calculated Area	0.012513 in ²	Specific Heat Ratio	1.25		

Resolved ASME Area: 0.012513 in² (Resolved by Maximum) Resolved API Area: 0.011261 in²

Model Selection

Manufacturer	Farris	API Letter	D	Inlet Size	1.0 in	Outlet Size	2.0 in
Model Number	26DA13-120/LC	API Area	0.110 in ²	In. Rating	600 #	Out. Rating	150 #
Valve Design	Conventional	ASME Area	0.150 in ²	In. Facing	RF	Out. Facing	RF
Cap Constrn	Screwed Cap	Test Gag	No	Quantity	1	NACE	No

Name Plate Capacity:

Water		Air		Steam	
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Model Materials

Body	LCB (SA-352 Gr. LCB)	Bonnet	LCB (SA-352 Gr. LCB)
Nozzle	316 ss	Disc	316 ss
Guide	316 ss	Spring	Chrome Alloy
Bellows	N/A		

Pressure Relief Valve Data Sheet

Date Prepared: 10/8/2015 4:07:57 PM

General Job Data

Customer	Requisition #	Job #	Job Description	
		2275446SQ		
Prepared By	Checked By	Approved By	Job Status	Revision #
Brady Swallowell			Sizing/Selecting	6

PSV Identification

Tag #	Tag Description	Tag Status	P / ID	Discharge To	Revision #	
PSV-08071A	0735-PSV-2	Valve Selected			0	
Plant #	Drawing #	Index #	Issue For	Service Inlet Line #	Outlet Line #	Revised By
						Shrenuj Dave

Sizing Basis

ASME Code	Cause of Over Pressure	Fluid State	Rupture Disk Coeff.	NACE
ASME Sec. VIII	-	Gas (Volume)	No Rupture Disk, 1	No

Process Parameters

MAWP	- Kpa G	Max. Design T.	- °C	Min. Design T.	0 °C
Operating Pressure	8500 Kpa G	Operating Temp.	61 °C	Constant Back P.	0 Kpa G
Set Pressure	9600 Kpa G	Relief Temp.	80 °C	Variable Back P.	19 Kpa G
Operating to Set %	88.542 %	Percent Over P.	10 %	Over Pressure	960 Kpa G
Atm Pressure	101.33 Kpa Abs	Relief Pressure	10661 Kpa Abs	Cold Diff. Test P.	9600 Kpa G

Compressible State

Fluid	-	Molecular Weight	17.58 Mol Wt	Gas Flow Const.	342
Req. Flow Cap.	1540 Sm ³ /day	Specific Gravity	0.60683 sp gr	Compressibility	1
Calculated Area	0.001392 in ²	Specific Heat Ratio	1.25		

Resolved ASME Area: 0.001392 in² (Resolved by Maximum) Resolved API Area: 0.001253 in²

Model Selection

Manufacturer	Farris	API Letter	D	Inlet Size	1.5 in	Outlet Size	2.0 in
Model Number	26DA14-120/LC	API Area	0.110 in ²	In. Rating	900 #	Out. Rating	300 #
Valve Design	Conventional	ASME Area	0.150 in ²	In. Facing	RF	Out. Facing	RF
Cap Constrn	Screwed Cap	Test Gag	No	Quantity	1	NACE	No

Name Plate Capacity:

Water		Air		Steam	
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Model Materials

Body	LCB (SA-352 Gr. LCB)	Bonnet	LCB (SA-352 Gr. LCB)
Nozzle	316 ss	Disc	316 ss
Guide	316 ss	Spring	Chrome Alloy
Bellows	N/A		

Sizing Scenarios

Scenario	Fluid State	Cause of Over P.	Relief Load Capacity	Max Rel Cap	Relief T.	React. Force	Noise Atm (dBa)	Noise Flare (dBa)	Required Area
Case A	Gas	Unknown	1540 Sm ³ /day	165974Sm ³ /day	80 °C	44.239 N	108.77	81.576	0.001392 in ²

Scenario: Case A / Gas Volume

Required Flow Capacity	V_{gas}	1540 Sm ³ /day	$A_{conven} = \frac{V_{gas} \sqrt{G_{gas} T_{relief} Z}}{1.175 C K^{Gas} K_{CCF} P_{relief} K_b}$	
Relief Temperature	T_{relief}	80 °C		
Compressibility	Z	1		
Gas Flow Constant	C	342		
Discharge Coeff. (0.9 x K_d)	K^{Gas}	0.8577	$A_{pilot} = \frac{V_{gas} \sqrt{G_{gas} T_{relief} Z}}{1.175 C K^{Gas} K_{CCF} P_{relief} K_b}$	
Flow	$Flow$	Critical		
Rupture Disk Coefficient	K_{CCF}	1		
Relief Pressure	P_{relief}	10661 Kpa Abs		
Molecular Weight	M_{vapor}	17.58 Mol Wt	Fluid Type (User Defined)	-
Vapor Flow Factor	K_b	1	Specific Gravity	G_{gas} 0.60683 sp gr
Vapor Flow Factor	K_v	-	Ratio of Specific Heats	k 1.25
			Discharge Coefficient	K_d 0.953
			ASME Area (Actual)	0.001392 in ²

SizeMaster 4.3.3.4, DB: L:\FarrisSizeMaster\Sizing 2014

End of PSV-08071A Data Sheet

Pressure Relief Valve Data Sheet

Date Prepared: 2015-10-09 11:00

General Job Data

Customer	Requisition #	Job #	Job Description	
		2275446SQ		
Prepared By	Checked By	Approved By	Job Status	Revision #
Brady Swallowell			Sizing/Selecting	6

PSV Identification

Tag #	Tag Description	Tag Status	P / ID	Discharge To	Revision #	
PSV-08071B	0735-PSV-3	Valve Selected			0	
Plant #	Drawing #	Index #	Issue For	Service Inlet Line #	Outlet Line #	Revised By
						Shrenuj Dave

Sizing Basis

ASME Code	Cause of Over Pressure	Fluid State	Rupture Disk Coeff.	NACE
ASME Sec. VIII	Valve Failure	Gas (Volume)	No Rupture Disk, 1	No

Process Parameters

MAWP	- Kpa G	Max. Design T.	- °C	Min. Design T.	- °C
Operating Pressure	3448 Kpa G	Operating Temp.	42 °C	Constant Back P.	0 Kpa G
Set Pressure	4137 Kpa G	Relief Temp.	60 °C	Variable Back P.	44 Kpa G
Operating to Set %	83.345 %	Percent Over P.	10 %	Over Pressure	413.7 Kpa G
Atm Pressure	101.33 Kpa Abs	Relief Pressure	4652 Kpa Abs	Cold Diff. Test P.	4137 Kpa G

Compressible State

Fluid	-	Molecular Weight	17.58 Mol Wt	Gas Flow Const.	342
Req. Flow Cap.	30504 Sm ³ /day	Specific Gravity	0.60683 sp gr	Compressibility	1
Calculated Area	0.061364 in ²	Specific Heat Ratio	1.25		

Resolved ASME Area: 0.061364 in² (Resolved by Maximum) Resolved API Area: 0.055228 in²

Model Selection

Manufacturer	Farris	API Letter	D	Inlet Size	1.0 in	Outlet Size	2.0 in
Model Number	26DA12-120/LC	API Area	0.110 in ²	In. Rating	300 #	Out. Rating	150 #
Valve Design	Conventional	ASME Area	0.150 in ²	In. Facing	RF	Out. Facing	RF
Cap Constrm	Screwed Cap	Test Gag	No	Quantity	1	NACE	No

Name Plate Capacity:

Water		Air		Steam	
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Model Materials

Body	LCB (SA-352 Gr. LCB)	Bonnet	LCB (SA-352 Gr. LCB)
Nozzle	316 ss	Disc	316 ss
Guide	316 ss	Spring	Chrome Alloy
Bellows	N/A		

Sizing Scenarios

Scenario	Fluid State	Cause of Over P.	Relief Load Capacity	Max Rel Cap	Relief T.	React. Force	Noise Alm (dBa)	Noise Flare (dBa)	Required Area
Case A	Gas	Valve Failure	30504 Sm ³ /day	74565 Sm ³ /day	60 °C	199.39 N	105.04	78.778	0.061364 in ²

Scenario: Case A / Gas Volume -- Valve Failure

Required Flow Capacity	V_{gas}	1271 Sm ³ /hr	$A_{conven} = \frac{V_{gas} \sqrt{G_{gas} T_{relief} Z}}{1.175 C K^{Gas} K_{CCF} P_{relief} K_b}$	
Relief Temperature	T_{relief}	60 °C		
Compressibility	Z	1	$A_{bellow} = \frac{V_{gas} \sqrt{G_{gas} T_{relief} Z}}{1.175 C K^{Gas} K_{CCF} P_{relief} K_v}$	
Gas Flow Constant	C	342	$A_{pilot} = \frac{V_{gas} \sqrt{G_{gas} T_{relief} Z}}{1.175 C K^{Gas} K_{CCF} P_{relief} K_b}$	
Discharge Coeff. (0.9 x K_d)	K^{Gas}	0.8577		
Flow	$Flow$	Critical		
Rupture Disk Coefficient	K_{CCF}	1	Fluid Type (User Defined)	-
Relief Pressure	P_{relief}	4652 Kpa Abs	Specific Gravity	G_{gas} 0.60683 sp gr
Molecular Weight	M_{vapor}	17.58 Mol Wt	Ratio of Specific Heats	k 1.25
Vapor Flow Factor	K_b	1	Discharge Coefficient	K_d 0.953
Vapor Flow Factor	K_v	-	ASME Area (Actual)	0.061364 in ²

Pressure Relief Valve Data Sheet

Date Prepared: 10/8/2015 4:08:06 PM

General Job Data

Customer	Requisition #	Job #	Job Description	
		2275446SQ		
Prepared By	Checked By	Approved By	Job Status	Revision #
Brady Swallowell			Sizing/Selecting	6

PSV Identification

Tag #	Tag Description	Tag Status	P / ID	Discharge To	Revision #	
PSV-08071C	0735-PSV-4	Valve Selected			0	
Plant #	Drawing #	Index #	Issue For	Service Inlet Line #	Outlet Line #	Revised By
						Shrenuj Dave

Sizing Basis

ASME Code	Cause of Over Pressure	Fluid State	Rupture Disk Coeff.	NACE
ASME Sec. VIII	Valve Failure	Gas (Volume)	No Rupture Disk, 1	No

Process Parameters

MAWP	- Kpa G	Max. Design T.	- °C	Min. Design T.	- °C
Operating Pressure	1034 Kpa G	Operating Temp.	39.2 °C	Constant Back P.	0 Kpa G
Set Pressure	1240 Kpa G	Relief Temp.	58 °C	Variable Back P.	35 Kpa G
Operating to Set %	83.387 %	Percent Over P.	10 %	Over Pressure	124 Kpa G
Atm Pressure	101.33 Kpa Abs	Relief Pressure	1465.3 Kpa Abs	Cold Diff. Test P.	1240 Kpa G

Compressible State

Fluid	-	Molecular Weight	17.58 Mol Wt	Gas Flow Const.	342
Req. Flow Cap.	5949 Sm ³ /day	Specific Gravity	0.60683 sp gr	Compressibility	1
Calculated Area	0.037879 in ²	Specific Heat Ratio	1.25		

Resolved ASME Area: 0.037879 in² (Resolved by Maximum) Resolved API Area: 0.034091 in²

Model Selection

Manufacturer	Farris	API Letter	D	Inlet Size	1.0 in	Outlet Size	2.0 in
Model Number	26DA10-120/LC	API Area	0.110 in ²	In. Rating	150 #	Out. Rating	150 #
Valve Design	Conventional	ASME Area	0.150 in ²	In. Facing	RF	Out. Facing	RF
Cap Constrn	Screwed Cap	Test Gag	No	Quantity	1	NACE	No

Name Plate Capacity:

Water		Air		Steam	
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Model Materials

Body	LCB (SA-352 Gr. LCB)	Bonnet	LCB (SA-352 Gr. LCB)
Nozzle	316 ss	Disc	316 ss
Guide	316 ss	Spring	Chrome Alloy
Bellows	N/A		

Sizing Scenarios

Scenario	Fluid State	Cause of Over P.	Relief Load Capacity	Max Rel Cap	Relief T.	React. Force	Noise Atm (dBa)	Noise Flare (dBa)	Required Area
Case A	Gas	Valve Failure	5949 Sm ³ /day	23558 Sm ³ /day	58 °C	92.369 N	100.01	75.005	0.037879 in ²

Scenario: Case A / Gas Volume -- Valve Failure

Required Flow Capacity	V_{gas}	5949 Sm ³ /day	$A_{conver} = \frac{V_{gas} \sqrt{G_{gas} T_{relief} Z}}{1.175 C K^{Gas} K_{CCF} P_{relief} K_b}$	
Relief Temperature	T_{relief}	58 °C		
Compressibility	Z	1		
Gas Flow Constant	C	342	$A_{bellow} = \frac{V_{gas} \sqrt{G_{gas} T_{relief} Z}}{1.175 C K^{Gas} K_{CCF} P_{relief} K_v}$	
Discharge Coeff. (0.9 x K_d)	K^{Gas}	0.8577		
Flow	$Flow$	Critical	$A_{pilot} = \frac{V_{gas} \sqrt{G_{gas} T_{relief} Z}}{1.175 C K^{Gas} K_{CCF} P_{relief} K_b}$	
Rupture Disk Coefficient	K_{CCF}	1		
Relief Pressure	P_{relief}	1465.3 Kpa Abs	Fluid Type (User Defined)	-
Molecular Weight	M_{vapor}	17.58 Mol Wt	Specific Gravity	G_{gas} 0.60683 sp gr
Vapor Flow Factor	K_b	1	Ratio of Specific Heats	k 1.25
Vapor Flow Factor	K_v	-	Discharge Coefficient	K_d 0.953
			ASME Area (Actual)	0.037879 in ²

SizeMaster 4.3.3.4, DB: L:\FarrisSizeMaster\Sizing 2014

End of PSV-08071C Data Sheet

Pressure Relief Valve Data Sheet

Date Prepared: 10/8/2015 4:08:10 PM

General Job Data

Customer	Requisition #	Job #	Job Description	
		2275446SQ		
Prepared By	Checked By	Approved By	Job Status	Revision #
Brady Swallowell			Sizing/Selecting	6

PSV Identification

Tag #	Tag Description	Tag Status	P / ID	Discharge To	Revision #		
PSV-08071D	0735-PSV-5	Valve Selected			0		
Plant #	Drawing #	Index #	Issue For	Service	Inlet Line #	Outlet Line #	Revised By
							Shrenuj Dave

Sizing Basis

ASME Code	Cause of Over Pressure	Fluid State	Rupture Disk Coeff.	NACE
ASME Sec. VIII	Valve Failure	Gas (Volume)	No Rupture Disk, 1	No

Process Parameters

MAWP	- Kpa G	Max. Design T.	- °C	Min. Design T.	- °C
Operating Pressure	55 Kpa G	Operating Temp.	34.4 °C	Constant Back P.	0 Kpa G
Set Pressure	620 Kpa G	Relief Temp.	53 °C	Variable Back P.	19 Kpa G
Operating to Set %	8.871 %	Percent Over P.	10 %	Over Pressure	62 Kpa G
Atm Pressure	101.33 Kpa Abs	Relief Pressure	783.33 Kpa Abs	Cold Diff. Test P.	620 Kpa G

Compressible State

Fluid	-	Molecular Weight	17.58 Mol Wt	Gas Flow Const.	342
Req. Flow Cap.	4341 Sm ³ /day	Specific Gravity	0.60683 sp gr	Compressibility	1
Calculated Area	0.051314 in ²	Specific Heat Ratio	1.25		

Resolved ASME Area: 0.051314 in² (Resolved by Maximum) Resolved API Area: 0.046182 in²

Model Selection

Manufacturer	Farris	API Letter	D	Inlet Size	1.0 in	Outlet Size	2.0 in
Model Number	26DA10-120/LC	API Area	0.110 in ²	In. Rating	150 #	Out. Rating	150 #
Valve Design	Conventional	ASME Area	0.150 in ²	In. Facing	RF	Out. Facing	RF
Cap Constrn	Screwed Cap	Test Gag	No	Quantity	1	NACE	No

Name Plate Capacity:

Water		Air		Steam	
-------	--	-----	--	-------	--

Model Materials

Body	LCB (SA-352 Gr. LCB)	Bonnet	LCB (SA-352 Gr. LCB)
Nozzle	316 ss	Disc	316 ss
Guide	316 ss	Spring	Chrome Alloy
Bellows	N/A		

Sizing Scenarios

Scenario	Fluid State	Cause of Over P.	Relief Load Capacity	Max Rel Cap	Relief T.	React. Force	Noise Atm (dBa)	Noise Flare (dBa)	Required Area
Case A	Gas	Valve Failure	4341 Sm ³ /day	12690 Sm ³ /day	53 °C	54.026 N	96.308	72.231	0.051314 in ²

Scenario: Case A / Gas Volume -- Valve Failure

Required Flow Capacity	V_{gas}	4341 Sm ³ /day
Relief Temperature	T_{relief}	53 °C
Compressibility	Z	1
Gas Flow Constant	C	342
Discharge Coeff. (0.9 x K_d)	K^{Gas}	0.8577
Flow	$Flow$	Critical
Rupture Disk Coefficient	K_{CCF}	1
Relief Pressure	P_{relief}	783.33 Kpa Abs
Molecular Weight	M_{vapor}	17.58 Mol Wt
Vapor Flow Factor	K_b	1
Vapor Flow Factor	K_v	-

$$A_{conven} = \frac{V_{gas} \sqrt{G_{gas} T_{relief} Z}}{1.175 C K^{Gas} K_{CCF} P_{relief} K_b}$$

$$A_{below} = \frac{V_{gas} \sqrt{G_{gas} T_{relief} Z}}{1.175 C K^{Gas} K_{CCF} P_{relief} K_v}$$

$$A_{pilot} = \frac{V_{gas} \sqrt{G_{gas} T_{relief} Z}}{1.175 C K^{Gas} K_{CCF} P_{relief} K_b}$$

Fluid Type (User Defined)		-
Specific Gravity	G_{gas}	0.60683 sp gr
Ratio of Specific Heats	k	1.25
Discharge Coefficient	K_d	0.953
ASME Area (Actual)		0.051314 in ²

Pressure Relief Valve Data Sheet

Date Prepared: 10/8/2015 4:07:20 PM

General Job Data

Customer	Requisition #	Job #	Job Description	
		2314258SQ		
Prepared By	Checked By	Approved By	Job Status	Revision #
Brady Swallowell			Sizing/Selecting	5

PSV Identification

Tag #	Tag Description	Tag Status	P / ID	Discharge To	Revision #	
PSV-08116A	0735-PSV-6	Valve Selected			0	
Plant #	Drawing #	Index #	Issue For	Service Inlet Line #	Outlet Line #	Revised By
						Shrenuj Dave

Sizing Basis

ASME Code	Cause of Over Pressure	Fluid State	Rupture Disk Coeff.	NACE
ASME Sec. VIII	Fire	Vapor (Mass)	No Rupture Disk, 1	No

Process Parameters

MAWP	- Kpa G	Max. Design T.	- °C	Min. Design T.	- °C
Operating Pressure	55 Kpa G	Operating Temp.	34.4 °C	Constant Back P.	0 Kpa G
Set Pressure	1827 Kpa G	Relief Temp.	176.67 °C	Variable Back P.	19 Kpa G
Operating to Set %	3.0104 %	Percent Over P.	21 %	Over Pressure	383.67 Kpa G
Atm Pressure	101.33 Kpa Abs	Relief Pressure	2312 Kpa Abs	Cold Diff. Test P.	1827 Kpa G

Compressible State

Fluid	-	Molecular Weight	48.1 Mol Wt	Gas Flow Const.	336.88
Req. Flow Cap.	269.52 kg/hr	Specific Gravity	1.6603 sp gr	Compressibility	1
Calculated Area	0.025161 in ²	Specific Heat Ratio	1.1988		

Resolved ASME Area: 0.025161 in² (Resolved by Maximum) Resolved API Area: 0.022645 in²

Model Selection

Manufacturer	Farris	API Letter	D	Inlet Size	1.0 in	Outlet Size	2.0 in
Model Number	26DA10-120/LC	API Area	0.110 in ²	In. Rating	150 #	Out. Rating	150 #
Valve Design	Conventional	ASME Area	0.150 in ²	In. Facing	RF	Out. Facing	RF
Cap Constrn	Screwed Cap	Test Gag	No	Quantity	1	NACE	No

Name Plate Capacity:

Water		Air		Steam	
-------	--	-----	--	-------	--

Model Materials

Body	LCB (SA-352 Gr. LCB)	Bonnet	LCB (SA-352 Gr. LCB)
Nozzle	316 ss	Disc	316 ss
Gulde	316 ss	Spring	Chrome Alloy
Bellows	N/A		

Sizing Scenarios

Scenario	Fluid State	Cause of Over P.	Relief Load Capacity	Max Rel Cap	Relief T.	React. Force	Noise Atm (dBa)	Noise Flare (dBa)	Required Area
Fire Vapor Generation	Vapor	Fire	269.52 kg/hr	1606.8 kg/hr	176.67 °C	60.387 N	100.22	75.164	0.025161 in ²

Scenario: Fire Vapor Generation / Vapor Mass -- Fire

Required Flow Capacity	W_{vapor}	269.52 kg/hr
Relief Temperature	T_{relief}	176.67 °C
Compressibility	Z	1
Gas Flow Constant	C	336.88
Discharge Coeff. (0.9 x K_d)	K_{Gas}	0.8577
Flow	$Flow$	Critical
Rupture Disk Coefficient	K_{CCF}	1
Relief Pressure	P_{relief}	2312 Kpa Abs
Molecular Weight	M_{vapor}	48.1 Mol Wt
Vapor Flow Factor	K_b	1
Vapor Flow Factor	K_v	-

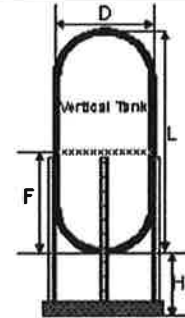
$$A_{conven} = \frac{W_{vapor} \sqrt{T_{relief}} \sqrt{Z}}{C K_{Gas} K_{CCF} P_{relief} \sqrt{M_{vapor} K_b}}$$

$$A_{ballow} = \frac{W_{vapor} \sqrt{T_{relief}} \sqrt{Z}}{C K_{Gas} K_{CCF} P_{relief} \sqrt{M_{vapor} K_v}}$$

$$A_{pilot} = \frac{W_{vapor} \sqrt{T_{relief}} \sqrt{Z}}{C K_{Gas} K_{CCF} P_{relief} \sqrt{M_{vapor} K_b}}$$

Vessel Type		Vertical Cylinder
Vessel Elevation	H	0.5 ft
Vessel Diameter	D	1.3333 ft
Liquid Depth	F	1.6667 ft
Vessel Length	L	2.5 ft
Vessel Ends Shape		Elliptical Ends
Effective Liquid Level	E	1.6667 ft

Fluid Type (User Defined)		-
Specific Gravity	G_{gas}	1.6603 sp gr
Ratio of Specific Heats	k	1.1988
Discharge Coefficient	K_d	0.953
ASME Area (Actual)		0.025161 in ²



- Vertical Cylinder, Spherical Ends:

$$A_{wet} = \pi E D$$

- Vertical Cylinder, Elliptical Ends:

$$A_{wet} = \begin{cases} E < L \rightarrow \pi D \left(E + 1.66 \frac{D}{4} \right) \\ E = L \rightarrow \pi D \left(E + 1.66 \frac{D}{2} \right) \end{cases}$$

- Vertical Cylinder, Flat Ends:

$$A_{wet} = \begin{cases} E < L \rightarrow \pi D \left(E + \frac{D}{4} \right) \\ E = L \rightarrow \pi D \left(E + \frac{D}{2} \right) \end{cases}$$

- Where:

$$K = [25, H + F]$$

$$E = [0, K - H]$$

Wetted Surface Area	A_{wet}	9.2991 ft ²	$W_{vapor} = \frac{Q}{LH}$	$Q = RF_{env} A_{wet}^{0.82}$
Environmental Factor	F_{env}	Bare Vessel, 1	Latent Heat	LH 220 Btu/lb
Fire Heat Absorbption Rate	R	API500 Adequate, 21000 Btu/hr·ft ²	Total Heat Input	Q 130720 Btu/hr

SizeMaster 4.3.3.4, DB: L:\FarrisSizeMaster\Sizing 2014 End of PSV-08116A Data Sheet

PCV-1

Table 11. Types 627H and 627HM Capacities for NPS 1 / DN 25 Body Size⁽¹⁾ (continued)

OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR CODE	OUTLET PRESSURE SETTING, psig / bar	INLET PRESSURE, psig / bar	CAPACITIES IN SCFH / Nm ³ /h OF 0.6 SPECIFIC GRAVITY NATURAL GAS					
			Orifice Size, Inches / mm					
			3/32 / 2.4	1/8 / 3.2	3/16 / 4.8	1/4 / 6.4	3/8 / 9.5	1/2 / 13
240 to 500 psig / 16.5 to 34.5 bar 10B3079X012 Red	250 / 17.2	300 / 20.7	2500 ⁽²⁾ / 67.0	4500 ⁽²⁾ / 121	9300 / 249	14,000 / 375	25,000 / 670	37,000 / 992
		400 / 27.6	3600 ⁽²⁾ / 96.5	6400 ⁽²⁾ / 172	14,300 / 383	21,400 / 574	36,000 / 965	49,000 / 1313
		500 / 34.5	4400 / 118	8090 / 217	18,300 / 490	26,300 / 705	42,000 / 1126	62,000 / 1662
		750 / 51.7	6600 / 177	12,000 / 322	27,200 / 729	37,100 / 994	57,000 / 1528	
		1000 / 69.0	8700 / 233	16,000 / 429	36,100 / 967	47,400 / 1270		
		1250 / 86.2	11,000 / 295	19,000 / 509	45,000 / 1206	57,000 / 1528		
		1500 / 103	13,000 / 348	22,000 / 590	54,000 / 1447			
		1750 / 121	15,000 / 402	25,000 / 670	63,000 / 1688			
	2000 / 138	17,000 / 456	28,000 / 750	71,000 / 1903				
	300 / 20.7	350 / 24.1	2900 ⁽²⁾ / 77.7	5150 ⁽²⁾ / 136	11,300 / 303	16,400 / 493	31,000 / 831	45,000 / 1206
		400 / 27.6	3500 ⁽²⁾ / 93.8	6200 ⁽²⁾ / 166	13,700 / 367	23,400 / 827	40,000 / 1072	52,000 / 1394
		500 / 34.5	4400 / 118	8090 / 217	18,300 / 480	32,000 / 858	53,000 / 1420	67,000 / 1798
		750 / 51.7	6600 / 177	12,000 / 322	27,200 / 729	48,000 / 1286	80,000 / 2144	
		1000 / 69.0	8700 / 233	16,000 / 429	36,100 / 967	62,000 / 1662		
		1250 / 86.2	11,000 / 295	19,000 / 509	45,000 / 1206	70,000 / 2117		
		1500 / 103	13,000 / 348	22,000 / 590	54,000 / 1447			
		1750 / 121	15,000 / 402	25,000 / 670	63,000 / 1688			
	2000 / 138	17,000 / 456	28,000 / 750	71,000 / 1903				
	400 / 27.6	450 / 31.0	3600 ⁽²⁾ / 96.5	6400 ⁽²⁾ / 172	14,000 / 375	25,000 / 870	47,000 / 1260	67,000 / 1798
		500 / 34.5	4400 ⁽²⁾ / 118	8090 ⁽²⁾ / 217	18,300 / 490	32,000 / 858	54,000 / 1447	77,000 / 2064
		750 / 51.7	6600 / 177	12,000 / 322	27,200 / 729	49,000 / 1313	91,000 / 2439	
		1000 / 69.0	8700 / 233	16,000 / 429	36,100 / 967	65,000 / 1742		
		1250 / 86.2	11,000 / 295	19,000 / 509	45,000 / 1206	81,000 / 2171		
		1500 / 103	13,000 / 348	22,000 / 590	54,000 / 1447			
		1750 / 121	15,000 / 402	25,000 / 670	63,000 / 1688			
		2000 / 138	17,000 / 456	28,000 / 750	71,000 / 1903			
	500 / 34.5	550 / 37.9	4300 ⁽²⁾ / 115	7700 ⁽²⁾ / 206	18,800 / 450	33,000 / 884	62,000 / 1662	90,000 / 2412
		600 / 41.4	4800 ⁽²⁾ / 131	8600 ⁽²⁾ / 236	19,400 / 520	37,000 / 992	70,000 / 1876	104,000 / 2787
		750 / 51.7	6600 / 177	12,000 / 322	27,200 / 729	49,000 / 1313	88,000 / 2356	140,000 / 3752
		1000 / 69.0	8700 / 233	16,000 / 429	36,100 / 967	65,000 / 1742	130,000 / 3484	
1250 / 86.2		11,000 / 295	19,000 / 509	45,000 / 1206	81,000 / 2171			
1500 / 103		13,000 / 348	22,000 / 590	54,000 / 1447	97,000 / 2800			
1750 / 121		15,000 / 402	25,000 / 670	63,000 / 1688				
2000 / 138		17,000 / 456	28,000 / 750	71,000 / 1903				

1. Capacity is based on 20% droop unless otherwise noted below.
 2. Small orifices and low pressure drops may cause the setpoint to shift ±15 psig / 1.0 bar.
 [Blank] - Blank areas indicate where maximum operating inlet pressure for a given orifice is exceeded.

Table 12. Types 627H and 627HM Capacities for NPS 2 / DN 50 Body Size⁽¹⁾

OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR CODE	OUTLET PRESSURE SETTING, psig / bar	INLET PRESSURE, psig / bar	CAPACITIES IN SCFH / Nm ³ /h OF 0.6 SPECIFIC GRAVITY NATURAL GAS					
			Orifice Size, Inches / mm					
			3/32 / 2.4	1/8 / 3.2	3/16 / 4.8	1/4 / 6.4	3/8 / 9.5	1/2 / 13
140 to 250 psig / 9.6 to 17.2 bar 10B3078X012 Blue	150 / 10.3	200 / 13.8	1760 ⁽²⁾ / 47.2	3200 ⁽²⁾ / 85.8	7290 / 195	13,700 / 367	24,100 / 646	31,000 / 831
		250 / 17.2	2260 ⁽²⁾ / 60.6	4100 ⁽²⁾ / 110	9200 / 247	16,100 / 431	28,800 / 766	40,000 / 1072
		300 / 20.7	2700 / 72.4	4910 / 132	11,200 / 300	19,300 / 517	31,000 / 831	48,000 / 1233
		400 / 27.6	3600 / 96.5	6500 / 174	14,800 / 397	25,000 / 670	40,000 / 1072	50,000 / 1340
		500 / 34.5	4400 / 118	8090 / 217	18,300 / 490	32,000 / 858		
		750 / 51.7	6600 / 177	12,000 / 322	27,200 / 729	48,000 / 1286		
		1000 / 69.0	8700 / 233	16,000 / 429	36,100 / 967	65,000 / 1742		
		1250 / 86.2	11,000 / 295	19,000 / 509	45,000 / 1206			
		1500 / 103	13,000 / 348	22,000 / 590	54,000 / 1447			
		1750 / 121	15,000 / 402	25,000 / 670	63,000 / 1688			
2000 / 138	17,000 / 456	28,000 / 750						

1. Capacity is based on 20% droop unless otherwise noted below.
 2. Small orifices and low pressure drops may cause the setpoint to shift ±15 psig / 1.0 bar.
 [Blank] - Blank areas indicate where maximum operating inlet pressure for a given orifice is exceeded.

- continued -

Table 7. Types 627, 627M, and 627MR Capacities for NPS 1 / DN 25 Body Size⁽¹⁾ (continued)

OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR CODE	OUTLET PRESSURE SETTING, psig / bar	INLET PRESSURE, psig / bar	CAPACITIES IN SCFH / Nm ³ /h OF 0.8 SPECIFIC GRAVITY NATURAL GAS					
			Orifice Size, Inches / mm					
			3/32 / 2.4	1/8 / 3.2	3/16 / 4.8	1/4 / 6.4	3/8 / 9.6	1/2 / 13
35 to 80 psig / 2.4 to 5.5 bar 10B3078X012 Blue	60 / 4.1	75 / 5.2	700 / 18.8	1230 / 33.0	2780 / 74.0	4880 / 131	8630 / 231	16,100 / 431
		100 / 6.9	970 / 26.0	1740 / 46.6	4010 / 107	7000 / 188	13,000 / 348	19,300 / 517
		150 / 10.3	1420 / 38.1	2580 / 69.1	5850 / 157	10,500 / 281	18,900 / 507	32,800 / 879
		200 / 13.8	1850 / 49.6	3370 / 90.3	7830 / 204	13,700 / 367	24,000 / 643	42,200 / 1131
		300 / 20.7	2700 / 72.4	4910 / 132	11,200 / 300	20,100 / 539	32,500 / 871	69,100 / 1852
		500 / 34.5	4400 / 118	8090 / 217	18,300 / 490	32,900 / 882	64,000 / 1715	94,300 / 2527
		750 / 51.7	6600 / 177	12,000 / 322	27,200 / 729	43,380 / 1183	66,000 / 1789	130,000 / 3484
		1000 / 69.0	8700 / 233	16,000 / 429	36,100 / 967	50,300 / 1348	67,700 / 1814	
		1250 / 86.2	11,000 / 295	19,000 / 509	45,000 / 1206	57,000 / 1528		
		1500 / 103	13,000 / 348	22,000 / 590	54,000 / 1447	63,000 / 1688		
	1750 / 121	15,000 / 402	25,000 / 670	63,000 / 1688				
	2000 / 138	17,000 / 456	28,000 / 750					
	80 / 5.5	100 / 6.9	900 / 24.1	1600 / 42.9	3750 / 101	6650 / 178	12,200 / 327	18,600 / 498
		150 / 10.3	1410 / 37.8	2580 / 69.1	5850 / 157	10,500 / 281	21,100 / 565	33,600 / 900
		200 / 13.8	1850 / 49.6	3370 / 90.3	7630 / 204	13,700 / 367	28,400 / 761	44,100 / 1182
		300 / 20.7	2700 / 72.4	4910 / 132	11,200 / 300	20,100 / 539	43,300 / 1160	75,400 / 2021
		500 / 34.5	4400 / 118	8090 / 217	18,300 / 490	32,900 / 882	71,600 / 1919	110,000 / 2948
		750 / 51.7	6600 / 177	12,000 / 322	27,200 / 729	48,900 / 1311	105,500 / 2827	135,000 / 3618
		1000 / 69.0	8700 / 233	16,000 / 429	36,100 / 967	64,900 / 1739	118,000 / 3182	
		1250 / 86.2	11,000 / 295	19,000 / 509	45,000 / 1206	80,000 / 2144		
1500 / 103		13,000 / 348	22,000 / 590	54,000 / 1447	98,000 / 2573			
1750 / 121		15,000 / 402	25,000 / 670	63,000 / 1688				
2000 / 138	17,000 / 456	28,000 / 750						
70 to 150 psig / 4.8 to 10.3 bar 10B3079X012 Red	100 / 6.9	150 / 10.3	1170 / 31.4	2510 / 67.3	5540 / 148	8710 / 233	16,000 / 429	24,000 / 643
		200 / 13.8	1850 / 49.6	3370 / 90.3	7630 / 204	12,000 / 322	21,300 / 571	34,100 / 914
		300 / 20.7	2700 / 72.4	4910 / 132	11,200 / 300	19,400 / 520	30,100 / 807	53,200 / 1426
		500 / 34.5	4400 / 118	8090 / 217	18,300 / 490	31,800 / 852	66,500 / 1782	83,900 / 2249
		750 / 51.7	6600 / 177	12,000 / 322	27,200 / 729	47,300 / 1268	95,300 / 2554	117,000 / 3136
		1000 / 69.0	8700 / 233	16,000 / 429	36,100 / 967	59,700 / 1600	100,000 / 2680	
		1250 / 86.2	11,000 / 295	19,000 / 509	45,000 / 1206	72,000 / 1930	114,000 / 3055	
		1500 / 103	13,000 / 348	22,000 / 590	54,000 / 1447	86,000 / 2305		
		1750 / 121	15,000 / 402	25,000 / 670	63,000 / 1688	95,000 / 2546		
		2000 / 138	17,000 / 456	28,000 / 750	71,000 / 1903			
	125 / 8.6	150 / 10.3	1250 / 33.5	2340 / 62.7	5340 / 143	9470 / 254	15,700 / 421	20,900 / 557
		200 / 13.8	1830 / 49.0	3320 / 89.0	7550 / 202	13,400 / 359	28,100 / 753	32,900 / 879
		300 / 20.7	2700 / 72.4	4910 / 132	11,200 / 300	20,100 / 539	36,300 / 973	52,600 / 1410
		500 / 34.5	4400 / 118	8090 / 217	18,300 / 490	32,900 / 882	70,600 / 1897	109,000 / 2921
		750 / 51.7	6600 / 177	12,000 / 322	27,200 / 729	48,900 / 1311	104,000 / 2787	158,000 / 4234
		1000 / 69.0	8700 / 233	16,000 / 429	36,100 / 967	64,800 / 1737	138,000 / 3698	160,000 / 4288
		1250 / 86.2	11,000 / 295	19,000 / 509	45,000 / 1206	80,000 / 2144	145,000 / 3886	
		1500 / 103	13,000 / 348	22,000 / 590	54,000 / 1447	96,000 / 2573		
		1750 / 121	15,000 / 402	25,000 / 670	63,000 / 1688	112,000 / 3002		
		2000 / 138	17,000 / 456	28,000 / 750	71,000 / 1903			
150 / 10.3	200 / 13.8	1780 / 47.2	3200 / 85.8	7290 / 195	12,900 / 346	21,400 / 574	33,600 / 900	
	300 / 20.7	2700 / 72.4	4910 / 132	11,200 / 300	17,200 / 461	40,100 / 1075	55,900 / 1498	
	500 / 34.5	4400 / 118	8090 / 217	18,300 / 490	32,900 / 882	70,300 / 1884	111,000 / 2975	
	750 / 51.7	6600 / 177	12,000 / 322	27,200 / 729	48,900 / 1311	104,000 / 2787	160,000 / 4288	
	1000 / 69.0	8700 / 233	16,000 / 429	36,100 / 967	64,800 / 1737	138,000 / 3698	162,000 / 4342	
	1250 / 86.2	11,000 / 295	19,000 / 509	45,000 / 1206	80,000 / 2144	150,000 / 4020		
	1500 / 103	13,000 / 348	22,000 / 590	54,000 / 1447	96,000 / 2573			
	1750 / 121	15,000 / 402	25,000 / 670	63,000 / 1688	112,000 / 3002			
	2000 / 138	17,000 / 456	28,000 / 750	71,000 / 1903				

1. Capacity is based on 20% droop unless otherwise noted below.
 - Blank areas indicate where maximum operating inlet pressure for a given orifice is exceeded.
 - Shaded areas indicate where a Type 627MR regulator should not be used because unbalanced forces can cause the internal relief valve to start-to-discharge during normal operation. Refer to Table 4.

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Table 7. Types 627, 627M, and 627MR Capacities for NPS 1 / DN 25 Body Size⁽¹⁾

OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR CODE	OUTLET PRESSURE SETTING, psig / bar	INLET PRESSURE, psig / bar	CAPACITIES IN SCFH / Nm ³ /h OF 0.6 SPECIFIC GRAVITY NATURAL GAS						
			Orifice Size, Inches / mm						
			3/32 / 2.4	1/8 / 3.2	3/16 / 4.8	1/4 / 6.4	3/8 / 9.6	1/2 / 13	
5 to 20 psig ⁽²⁾ / 0.34 to 1.4 bar 10B3078X012 Yellow	5 / 0.34 ⁽³⁾	10 / 0.69	170 / 4.6	330 / 8.8	710 / 19.0	1100 / 29.5	1900 / 50.9	2500 / 67.0	
		15 / 1.0	240 / 6.4	390 / 10.5	890 / 23.9	1600 / 42.9	2500 / 67.0	3350 / 89.8	
		20 / 1.4	290 / 7.8	500 / 13.4	1160 / 31.1	2080 / 55.2	3400 / 91.1	4450 / 119	
		30 / 2.1	380 / 10.2	670 / 18.0	1560 / 41.8	2800 / 75.0	4750 / 127	6800 / 185	
		60 / 4.1	640 / 17.2	1170 / 31.4	2600 / 69.7	4710 / 126	8140 / 218	13,700 / 367	
		75 / 5.2	770 / 20.6	1410 / 37.8	3150 / 84.4	5710 / 153	9790 / 262	14,500 / 389	
	10 / 0.7	100 / 6.9	990 / 26.5	1800 / 48.2	4070 / 109	7310 / 196	12,500 / 335	16,000 / 429	
		15 / 1.0	210 / 5.6	375 / 10.1	880 / 23.6	1590 / 42.8	2480 / 66.5	3300 / 88.4	
		20 / 1.4	280 / 7.5	490 / 13.1	1150 / 30.8	2050 / 54.9	3360 / 90.6	4410 / 118	
		30 / 2.1	380 / 10.2	670 / 18.0	1560 / 41.8	2800 / 75.0	4720 / 126	6840 / 183	
		60 / 4.1	640 / 17.2	1170 / 31.4	2600 / 69.7	4710 / 126	8140 / 218	13,700 / 367	
		75 / 5.2	770 / 20.6	1410 / 37.8	3150 / 84.4	5710 / 153	9790 / 262	14,500 / 389	
		100 / 6.9	990 / 26.5	1800 / 48.2	4070 / 109	7310 / 196	12,500 / 335	16,000 / 429	
		150 / 10.3	1420 / 38.1	2580 / 69.1	5850 / 157	10,500 / 281	17,000 / 458	18,000 / 482	
		200 / 13.8	1850 / 49.6	3370 / 90.3	7630 / 204	13,700 / 367	18,000 / 482	18,500 / 496	
		300 / 20.7	2700 / 72.4	4810 / 132	11,200 / 300	19,800 / 531	20,000 / 536		
		500 / 34.5	4400 / 118	8090 / 217	15,700 / 421	20,000 / 536			
		750 / 51.7	5400 / 145	12,000 / 322	18,000 / 482				
		1000 / 69.0	5800 / 155	14,000 / 375					
		1250 / 86.2	6300 / 169						
	1500 / 103	6600 / 177							
	1750 / 121	6800 / 182							
	2000 / 138	7600 / 204							
	20 / 1.4	30 / 2.1	350 / 9.4	820 / 18.6	1450 / 38.9	2580 / 69.1	4360 / 117	6290 / 169	
		50 / 3.4	550 / 14.7	1000 / 26.8	2280 / 61.1	4090 / 110	7870 / 211	14,100 / 378	
		60 / 4.1	640 / 17.2	1170 / 31.4	2640 / 70.8	4750 / 127	8690 / 260	14,500 / 389	
		100 / 6.9	990 / 26.5	1800 / 48.2	4070 / 109	7310 / 196	13,900 / 373	23,300 / 624	
		150 / 10.3	1420 / 38.1	2580 / 69.1	5850 / 157	10,500 / 281	17,700 / 474	34,200 / 917	
		200 / 13.8	1850 / 49.6	3370 / 90.3	7630 / 204	13,700 / 367	26,600 / 713	39,100 / 1048	
		300 / 20.7	2700 / 72.4	4810 / 132	11,200 / 300	20,100 / 539	37,000 / 992		
		500 / 34.5	4400 / 118	8090 / 217	16,300 / 490	32,900 / 882			
		750 / 51.7	6800 / 177	12,000 / 322	23,600 / 632				
		1000 / 69.0	8900 / 239	16,000 / 429					
		1250 / 86.2	10,000 / 268						
		1500 / 103	10,400 / 279						
		1750 / 121	12,000 / 322						
		2000 / 138	14,000 / 375						
	15 to 40 psig / 1.0 to 2.6 bar 10B3077X012 Green	40 / 2.8	80 / 4.1	610 / 18.3	1090 / 29.2	2530 / 67.8	4510 / 121	9290 / 249	9420 / 252
			75 / 5.2	760 / 20.4	1370 / 36.7	3080 / 82.5	5640 / 151	10,800 / 289	16,500 / 442
			100 / 6.9	990 / 26.5	1790 / 48.0	4070 / 109	7310 / 196	14,700 / 394	21,900 / 587
			150 / 10.3	1420 / 38.1	2580 / 69.1	5850 / 157	10,500 / 281	20,500 / 549	34,500 / 925
			200 / 13.8	1850 / 49.6	3370 / 90.3	7630 / 204	13,700 / 367	27,100 / 726	46,400 / 1244
			300 / 20.7	2700 / 72.4	4810 / 132	11,200 / 300	20,100 / 539	40,100 / 1075	67,100 / 1798
			500 / 34.5	4400 / 118	8090 / 217	16,300 / 490	32,900 / 882	63,900 / 1713	
			750 / 51.7	6800 / 177	12,000 / 322	27,200 / 729	39,400 / 1058		
1000 / 69.0			8700 / 233	16,000 / 429	36,100 / 967				
1250 / 86.2			11,000 / 295	19,000 / 509					
1500 / 103			13,000 / 348	22,000 / 590					
1750 / 121			15,000 / 402						
2000 / 138			17,000 / 456						

1. Capacity is based on 20% droop unless otherwise noted below.
 2. For pressure settings under 10 psig / 0.69 bar, inlet pressure should be limited to approximately 100 psig / 6.9 bar so the setpoint adjustment can be obtained.
 3. For 5 psig / 0.34 bar pressure setpoint the droop is 2 psig / 0.14 bar.
 [Blank area] - Blank areas indicate where maximum operating inlet pressure for a given orifice is exceeded.
 [Shaded area] - Shaded areas indicate where a Type 627MR regulator should not be used because unbalanced forces can cause the internal relief valve to start-to-discharge during normal operation. Refer to Table 4.

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