



**OPERATION AND MAINTENANCE MANUAL  
FOR  
HORIZONTAL DOUBLE BARREL CYCLONE SEPARATOR  
V-1414**

**Williams Gas Pipeline/ Transcontinental Gas Pipe Line Company  
North East Supply Enhancement (NESE)  
Station 200**

**Chester County, PA**

**PURCHASE ORDER NO.  
676280**

**DESIGNED BY:**

**GASTECH ENGINEERING LLC**

**2110 INDUSTRIAL ROAD  
SAPULPA, OK-74066**

**SALES ORDER**

**11048-01**

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## 1.0 INTRODUCTION

This manual is applicable to the installation, operation, and maintenance of the GasTech Horizontal Cyclone Separator designed and fabricated in accordance with purchase order number **676280** by **Williams Gas Pipeline**.

The process and function described herein applies to this equipment exclusively.

The purpose of this manual is to familiarize the operators with the design features and operating characteristics of the filter. Please review this manual thoroughly prior to installation and/or operation of this equipment.

## **2.0 SAFETY**

Safety is a very special commitment at GasTech. Good safety performance is an item of added value that GasTech takes pride in bringing to our projects.

The heart of our safety program is a firm commitment by all members of management, supervision and our craftsmen to prevent accidents and the conditions that lead to injuries. This commitment applies to not only our own in-house activities during fabrication, but to the design and performance of the equipment that we manufacture. Although safety flows from top down, it depends on the awareness and cooperation of each individual employee in his or her daily work assignments to meet this challenge. Management must provide effective safety training, must provide a safe environment to work in and must enforce the developed safety program.

At GasTech, safety is viewed as a quality that cannot be delegated. The level of safety performance on a project is a direct reflection of the project leadership. Each supervisor must accept the responsibility and be held accountable for the safety performance of those employees under his direct supervision. In a like manner, each employee has the responsibility to perform the work in a safe manner and for reporting unsafe acts or conditions to his supervisor. At GasTech, working safely is a condition of employment for all employees.

Carrying this safety message to the field, the end user should be aware that the equipment supplied under this contract is potentially hazardous to operate. Therefore, the end user is expected to provide adequate barriers, warning signs and supervision to prevent the exposure of any uninformed personnel to this potential hazard.

Furthermore, the owner, and/or operator, is expected to train all operation personnel, using this manual as a guide.



### 3.0 DESIGN CONDITIONS

Type of Fluid	Natural Gas
Gas Flow Rate (MMSCFD)	650 to 1172
Operating Pressure (psig)	512 to 642
Operating Temperature (°F)	50 to 70
Specific Gravity (Air = 1.0)	0.5 to 0.6 (Assumed)
Liquid Droplet Removal Efficiency	98% of $\geq 3$ micron; 99.9% of $\geq 10$ micron
Particulate Removal Efficiency	98% of $\geq 3$ micron; 99.9% of $\geq 10$ micron
Pressure Drop, Calculated (psi)	< 3
Design Pressure (psig)	860
Design Temperature (°F)	200
Minimum Design Metal Temperature (°F)	-20
Process Connection, Inlet/Outlet	36" ANSI 600#

## 4.0 EQUIPMENT DESCRIPTION

### **Horizontal Centrifugal Separator:**

Upper Barrel 72" ID x 10'-0" S/S x 860 psig mechanical design pressure at 200 F mechanical design temperature, ASME BPVC Section VIII, Division 1 constructed and stamped, with lower barrel of 12.75" OD x 10'-0" S/S x 860 psig mechanical design pressure at 200 F mechanical design temperature. GasTech designs the separator for the most limiting flow conditions: maximum gas flow rate (1,172 MMSCFD), minimum operating pressure (512 psig) and maximum operating temperature (70 F).

The gas-liquid separation is represented by horizontal cyclotubes with internal hub assembly. The internal hub assembly includes a spinner device which initiates the gas-liquid rotation or cyclonic motion. A recycling port is provided in the cyclotube design to recycle the gas back to the tube. The spinner assembly is permanently installed in each cyclotube. All cyclotubes are welded between two (2) vertical tubesheets. The direction of gas flow through the cyclotube is horizontal.

The compact horizontal centrifugal scrubber handles large gas volumes in a relatively small footprint. Due to the large centrifugal force generated by the spinning motion, liquids and solids are forced to the wall of the cyclotube where separation takes place. The separated liquids are swept toward the end of the cyclotube by the flowing gas. Prior to exiting the scrubber, the liquids and a side stream of gas are drawn through two small circumferential openings in the cyclotube. Two separation stages are provided downstream of the cyclotube. Outside the cyclotube, the liquids settle out of the gas under the influence of gravity and drain into the sump. The remaining gas is recycled back into the cyclotube through a circumferential opening. A low-pressure area along the axis of the spinning gas stream provides the necessary differential pressure driving force.

In terms of removal efficiency, the cyclotubes are capable of removing 99.9% of liquid droplets and solid particles 10 microns and larger, 99% of liquids and solids 5 microns and larger and 98% of liquids and solids 3 microns and larger which meets the performance required in the specification (98% of liquids and solids 3 microns and larger). The horizontal centrifugal scrubber is equipped with two hand-holes. One (1) 2" 600# vent/blowdown connection is provided on the upper barrel. There are two (2) liquid downcomers which are of 6" (in the cyclotube bundle section).

GasTech cyclotubes provide a high gas capacity (i.e. smaller optimized vessel size) and relatively low pressure drop. The dry gas which is free of liquids, leaves the vessel through the outlet nozzle. The liquid carryover in the effluent gas stream would be less than 0.10 US gallons per million standard cubic feet of gas passing through the horizontal

## **EQUIPMENT DESCRIPTION (cont.)**

centrifugal scrubber.

Inlet and outlet nozzles are of 36" ANSI Class 600#. Inlet and outlet nozzles will comply with ASME B16.47 Series A. The gas inlet nozzle is installed on one end of the vessel and the gas outlet nozzle is installed on the opposite end of the vessel. Inlet and gas outlet nozzles will have the same elevation with respect to grade.

The calculated pressure drop from inlet nozzle to outlet nozzle at the most limiting flow conditions: maximum gas flow rate (1,172 MMSCFD), minimum operating pressure (512 psig) and maximum operating temperature (70 F) is less than 3 psid meeting the specification requirement.

The design provided by GasTech will handle a typical liquid rate for a horizontal centrifugal separator of approximately 1 bbl/MMSCF. This liquid load converts to a liquid rate of 34.18 gpm. The liquid handling capacity of the vessel is also affected by the density of the liquid. Since no information is provided regarding the liquid rate, inlet knockout section is not provided in the current offering.

A liquid sump collects the liquids separated by the vessel and cyclotubes during normal operation. The liquid sump is equipped with two (2) 12" 600# blind flanges with hinges, one on each end for inspection and/or clean-out. Lower barrel/sump is a single vessel i.e. there is no separation plate inside, and thus will require only one (1) bridle, one (1) 2" liquid outlet and one (1) 2" drain.

The liquid storage capacity of the lower sump is about 55.15 gallons based on 10'-0" length. The lower sump collects the liquids separated by the cyclotubes. GasTech supplies the horizontal gas centrifugal separator with two (2) saddles, two (2) carbon steel lifting lugs and also grounding lugs. The horizontal centrifugal separator is provided with liquid vortex breaker to ensure smooth exit of liquids and avoid gas re-entrainment into the liquid phase.

## **5.0 EQUIPMENT LIST**

### **5.1 ASME CODE VESSEL - UPPER BARREL**

One (1) Horizontal Vessel, **75"** O.D. / **72"** I.D. X **10'-0"** Lg S/S  
with **36" 600# RF** Inlet & Outlet Nozzle Connections

### **5.2 ASME CODE VESSEL - LOWER BARREL**

One (1) Horizontal Sump, **12"** Sch **60** X **10'-0"** Lg S/S  
with **12"600# RF** Hinged Blinds for Cleanout Access

## **6.0 EQUIPMENT INSTALLATION**

1. Place the vessel assembly on a suitably designed level foundation. Install anchors. Refer to the General Arrangement drawing for anchor locations.
2. Inspect all items, both assembled and shipped loose, for any damage that may have occurred in transit. If damage is discovered, notify the appropriate authorities.
3. Remove any shipping braces that may have been employed.
4. Various instruments and equipment may have been dis-assembled prior to shipping. This was done to prevent damage and/or to comply with shipping limitations. Any such items must be reassembled prior to start-up.
5. Examine instrumentation for loose fittings tighten as required.
6. Examine all flange connections for loose bolts, tighten as required.
7. Assemble field process piping to the vessel inlet and outlet flanged connections. Sufficient support of field piping must be provided to prevent any external loads from being applied to the inlet and outlet flanges.

## 7.0 START-UP & OPERATION

**Caution:**

***Awareness and safety procedures are never to be abbreviated. The common sense of an alert operator cannot be “Designed In” to this type of equipment.***

1. Install all accessories (if any), and relief valve that were provided with the unit.
2. Connect electrical components and ground lugs as required.
3. Purge the vessel and piping.
4. With the outlet gas valve closed slowly open the inlet block valve. Never allow the pressure in the unit to exceed the maximum allowable vessel pressure stamped on the vessel nameplate. Serious injury or death could result.
5. Allow the unit to pressurize to 25 PSIG.
6. Check for leaks around all flanged or threaded joints. Correct any leaks and increase the pressure to 100 PSIG. Again, correct any leaks and increase the pressure incrementally to operating pressure. Constantly check for and correct any leaks.
7. Slowly open the gas outlet block valve and gradually start flowing gas through the unit.
8. Always monitor the unit after startup for a period sufficient to ensure proper operation.

## **8.0 EQUIPMENT MAINTENANCE**

There is very little maintenance required for a cyclone vessel. Follow your Company's safety practices concerning calibration and testing of safety devices such as relief valves, pressure switches, level switches etc. Also, check the vessel regularly for signs of corrosion, erosion, or damage. Do not operate a pressure vessel that you suspect has been damaged or is corroded or eroded.

Most maintenance activities will be cleaning the cyclone pack. Always be aware that the gas or liquid in the vessel could be flammable or poisonous, take appropriate precautions. NEVER open the vessel when it has any pressure in it.

## 9.0 TROUBLESHOOTING

It is the responsibility of the field operator to quickly identify and if possible, eliminate an operating problem. Delay in correcting a malfunction can be very costly in both capital expense and down time due to damage to the equipment.

<b>Problem:</b>	<b>Leaking flanges</b>
Possible cause:	Flange bolts need tightening
Solution:	Check gasket for damage and replace as necessary.

<b>Problem:</b>	<b>Level Switches not functioning</b>
Possible Cause:	Defective level switch
Solution:	Replace level switch



## **10.0 DRAWINGS**

## 10.1 DRAWING INDEX

<b>GASTECH DRAWING #</b>	<b>DESCRIPTION</b>
11048-100	PIPING & INSTRUMENT DIAGRAM
11048-200	GENERAL ARRANGEMENT DRAWING

## D



6

## 5

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4

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4

## 2

D

16

B

## A

2

NOTE:  
IF A MODIFIER IS NOT USED, ENTER 0

2

D



B

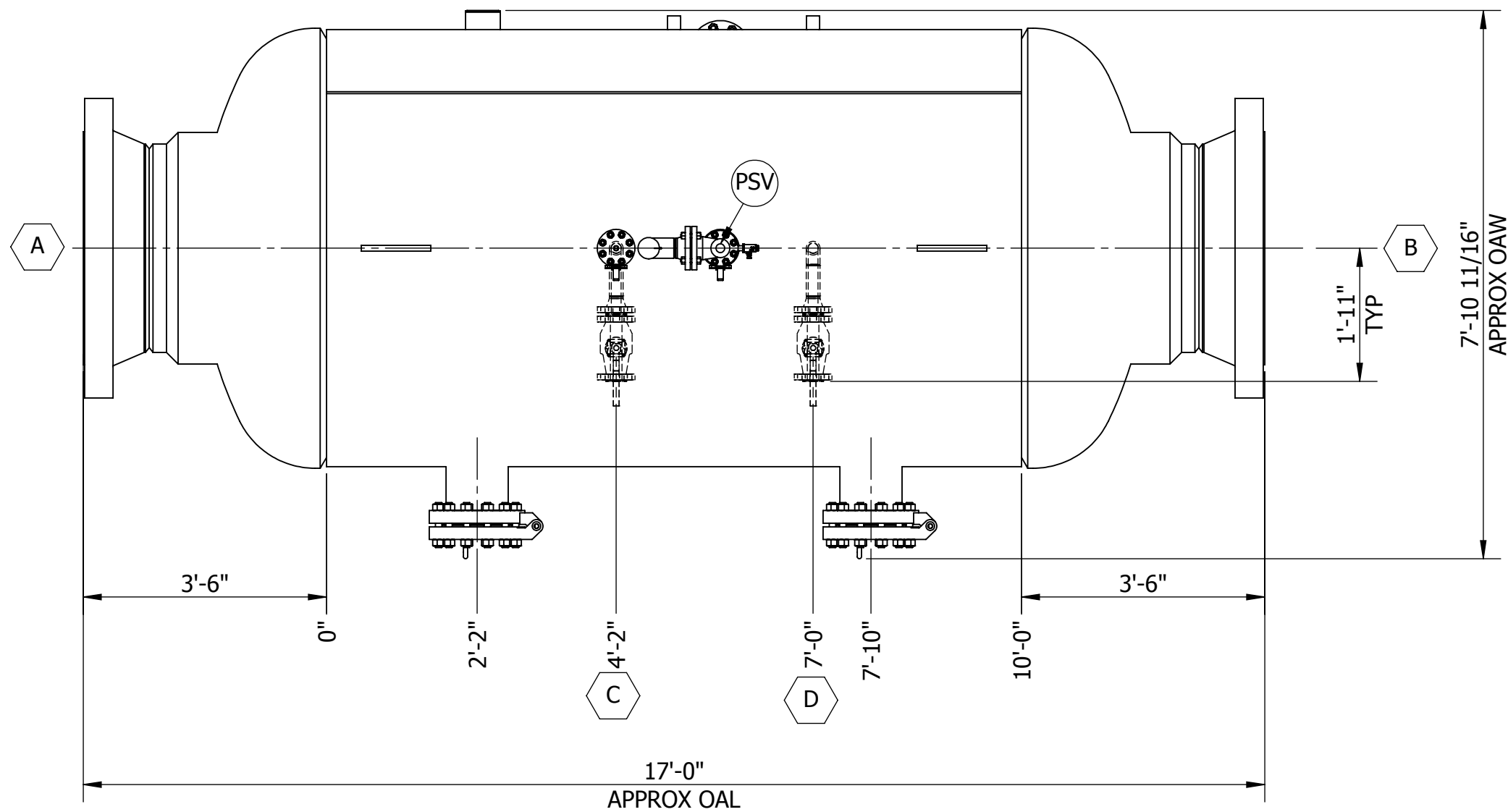
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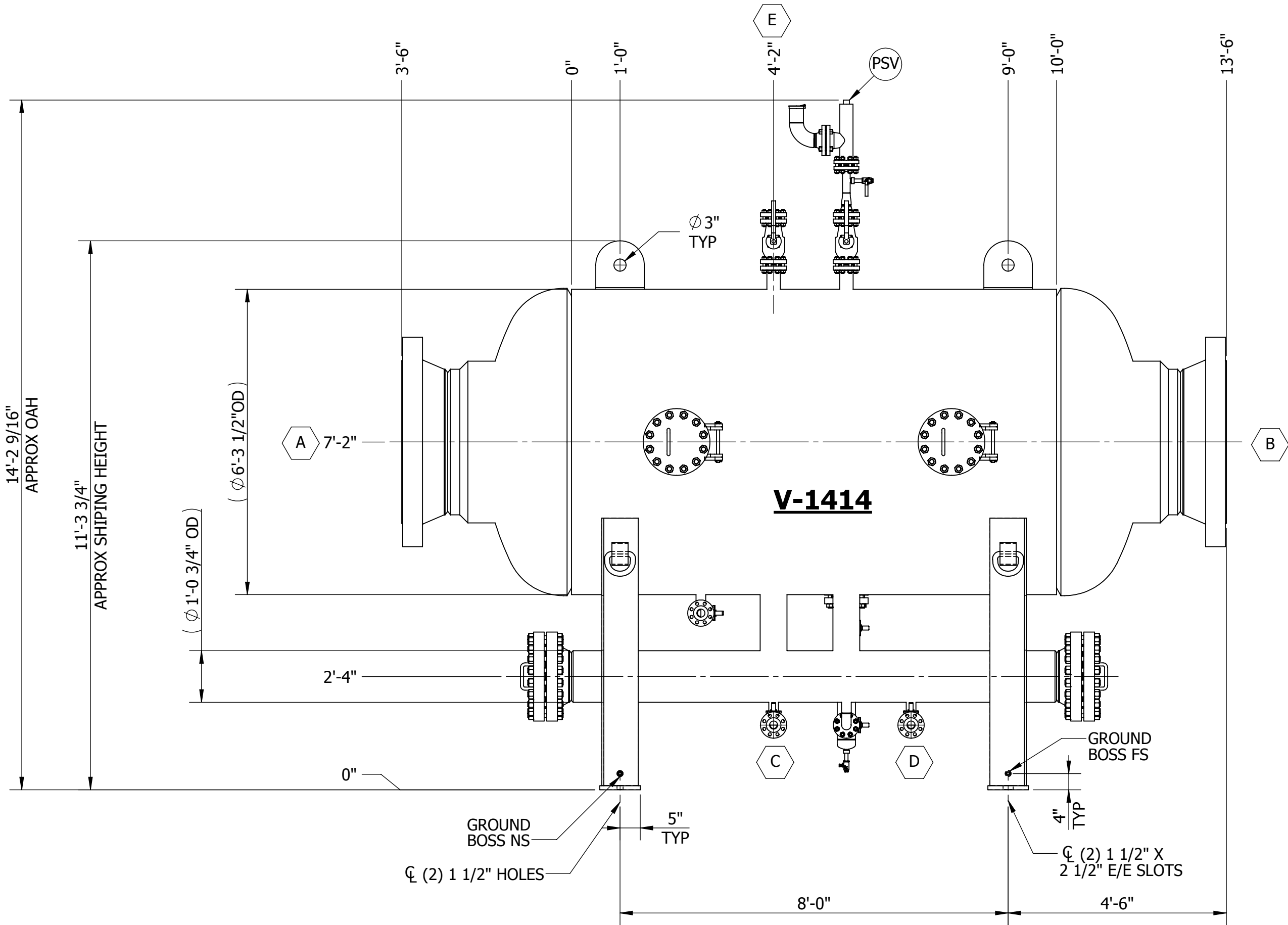
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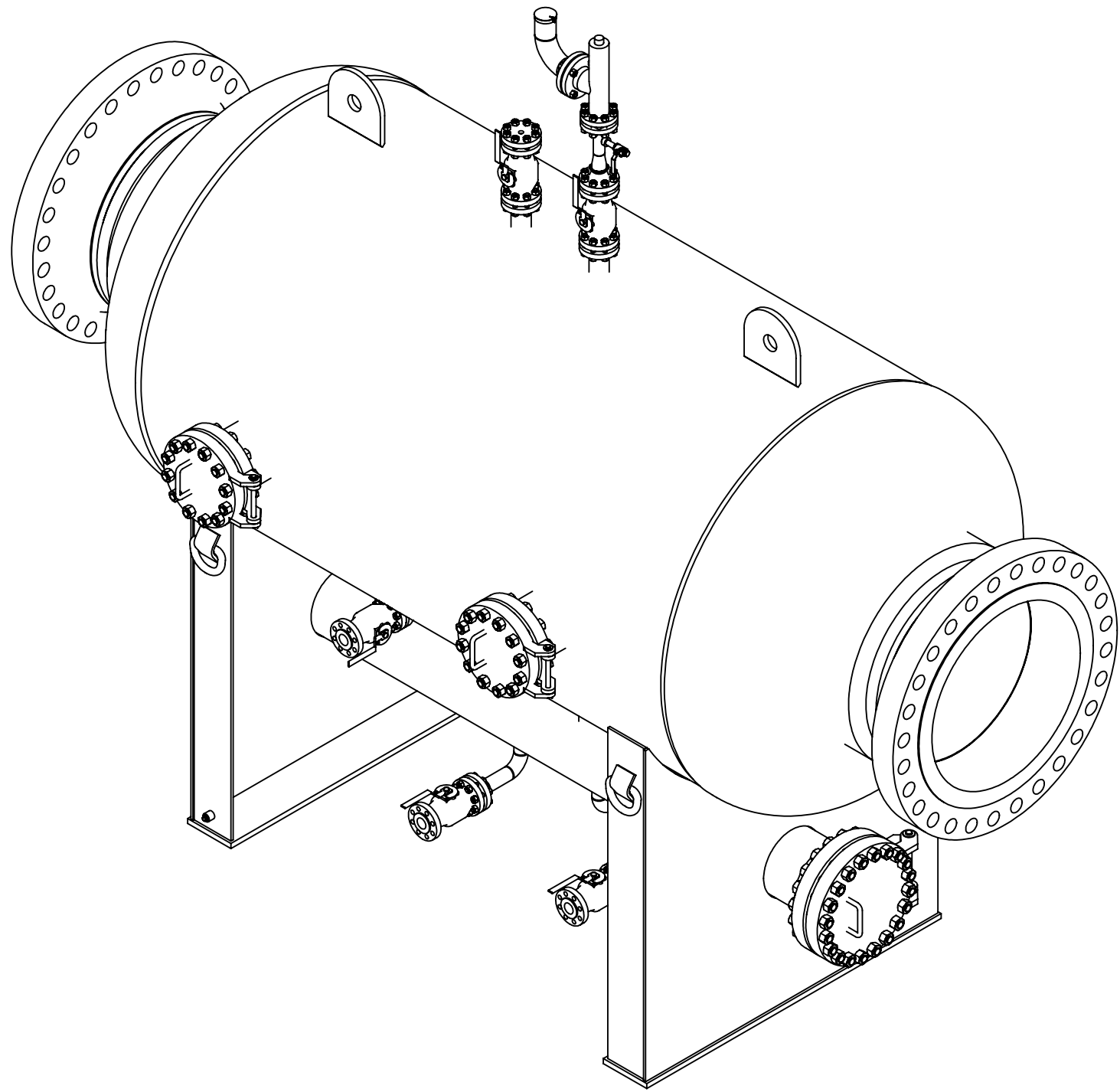
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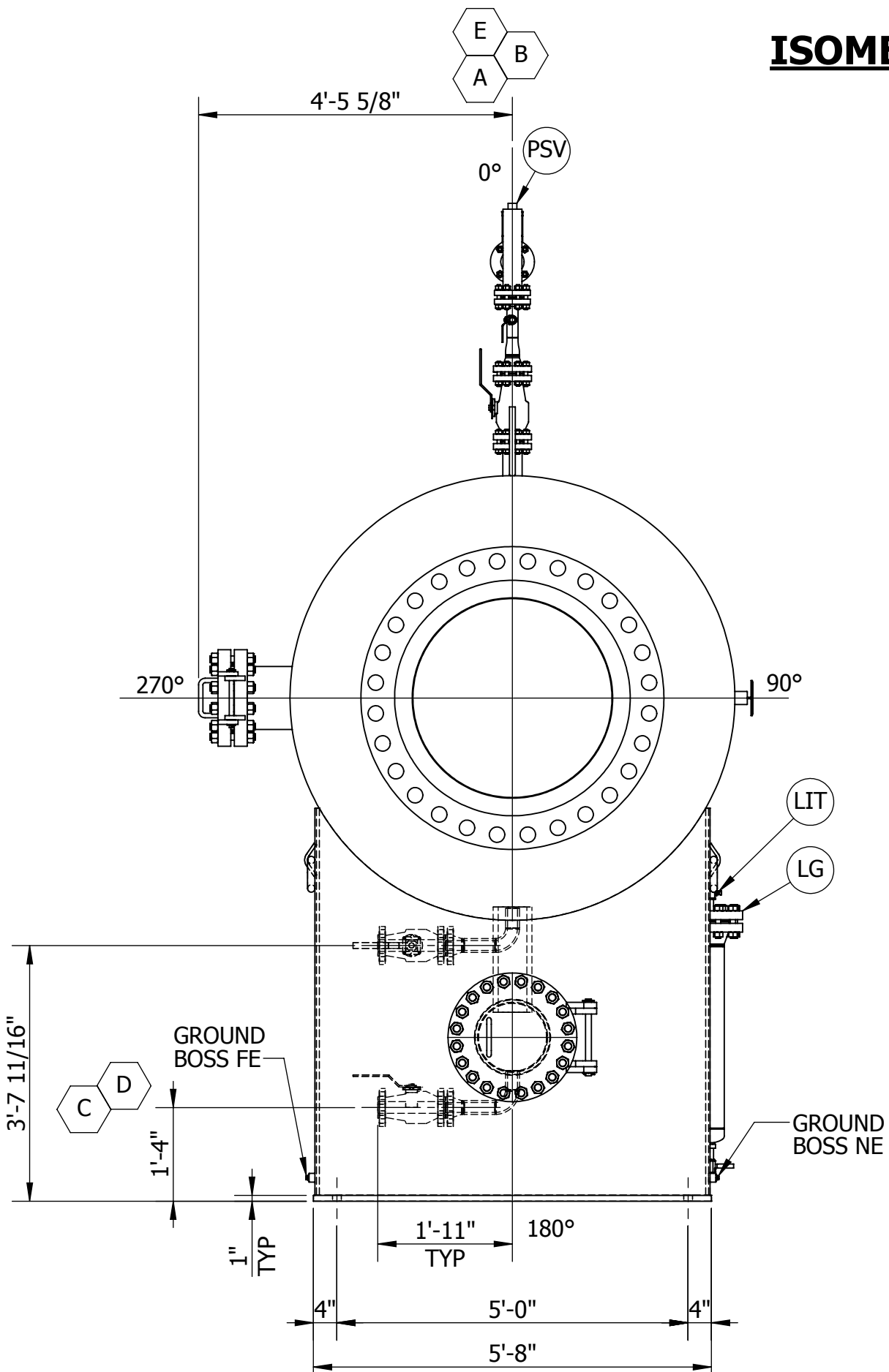
PLAN VIEW



ELEVATION VIEW



ISOMETRIC VIEW

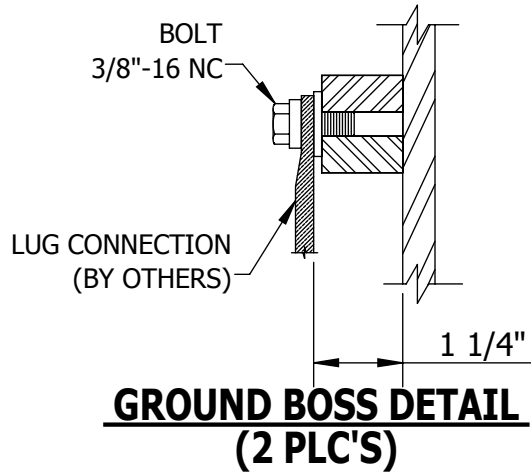


END ELEVATION VIEW

CONNECTION LEGEND

- A INLET  
36" - 600# RF FLANGE
- B OUTLET  
36" - 600# RF FLANGE
- C LIQUID OUTLET  
2" - 600# RF FLANGE
- D DRAIN  
2" - 600# RF FLANGE
- E VENT  
2" - 600# RF FLANGE

APPROX WEIGHT EMPTY: 40,500 LBS  
APPROX WEIGHT FULL: 55,000 LBS



GROUND BOSS DETAIL  
(2 PLC'S)

GENERAL NOTES:

- ALL FLANGES TO HAVE BOLT HOLES STRADDLING TRUE CENTERLINES.
- ALL CONNECTIONS TO BE PROTECTED BEFORE SHIPPING.
- DRAIN LINE AND BRIDLE PIPING SHIPPED LOOSE TO BE SUPPORTED BY OTHERS.
- HEAT TRACE AND/OR INSULATION BY OTHERS.
- SURFACE PREPARATION AND COATING SPECIFIED IN PAINT MATRIX.
- HYDRO TEST @ 1315 PSIG FOR (4) HOURS.
- LEVEL BRIDLE, RELIEF VALVE, & VENT PIPING MANUAL VALVES AND ALL NUTS, BOLTS, & GASKETS ARE TO BE SHIPPED LOOSE.

0	03/21/2018	ND	KN	BS	ISSUED FOR FABRICATION
A	03/06/2018	ND	KN	BS	ISSUED FOR CUSTOMER APPROVAL
REV.	DATE	BY	CHKD	APPD	DESCRIPTION
REVISION HISTORY					
DRAWING APPROVALS			2110 INDUSTRIAL ROAD SAPULPA, OK 74066 (918) 663-8383		
INITIALS			DATE		
DRAWN	ND	01/15/2018	TITLE		
CHECKED	SH	03/06/2018	GENERAL ARRANGEMENT, HORIZONTAL CYCLONE SEPARATOR, WO # 1185731		
APPROVED	KN	03/06/2018	REV		
THIRD ANGLE PROJECTION			0		
DIMENSIONS ARE IN INCHES WITH TOLERANCES ±1/8" UNLESS OTHERWISE NOTED			SIZE	JOB NUMBER	DRAWING NO.
			D	11048	11048-200
			PO#	676280	SHEET 1 OF 1

CUSTOMER INFO	DESIGN INFO
WILLIAMS - COMPRESSOR STATION 200, CHESTER CO, PA WO # 1185731	72" ID X 10'-0" S/S WITH 12" O 10'-0" S/S SUMP X 860 PSIG @ -20°F/200°F
THIS DOCUMENT IS THE SOLE PROPERTY OF, PREPARED AND ISSUED BY GASTECH ENGINEERING LLC AND CONTAINS CONFIDENTIAL AND PROPRIETARY INFORMATION. WITHOUT PRIOR WRITTEN CONSENT, THIS DOCUMENT AND THE INFORMATION DISCLOSED HEREIN SHALL NOT BE REPRODUCED OR TRANSFERRED TO OTHER DOCUMENTS OR SHALL NOT BE USED OR DISCLOSED TO OTHERS FOR MANUFACTURING OR FOR ANY OTHER PURPOSE EXCEPT AS SPECIFICALLY PERMITTED IN WRITING FROM GASTECH ENGINEERING LLC.	

## **11.0 VENDOR DOSSIER**

## **11.1 BILL OF MATERIAL**



JOB #: 11048  
P.O. #: 676280  
DWG. #: 11048-100

ISSUE DATE: 2/26/2018  
REVISION: 0

QUANTITIES SHOWN FOR ONE (1) UNIT

ITEM	REV	NOTE	TAG#	QTY	DESCRIPTION	MATERIAL	MANUFACTURER	MODEL #
1	0		1/2" D2S	3	VALVE, BALL, 1/2", NPT CONNECTIONS, FULL PORT, CS BODY, 4500 PSI BODYMAWP; 316 SS BALL	CS	JAMESBURY VALVES	5H-22HB-RT
2	0		2" D2R	7	2" 600# RF, BALL VALVE, F.P., W/ LEVER HANDLE, API 6D, TRUNION MOUNTED, 11.5" END TO END	CS/STD TRIM	WKM VALVES	370D4600RFXRF24YFF24WR
3	0		LG 1414	1	GAUGE, LEVEL, MAGTECH MAGNETIC LEVEL GAUGE WITH 1/4" FLIPPER STYLE FLAGS 24" OF VISIBLE LENGTH.	SS	ROSEMOUNT	L055DAC1E02400SE2AC14SB8AZD8F3F02400C0ZZ
4	0		LIT 1414	1	TRANSMITTER, LEVEL INDICATING, MAGTECH MAGNETORESTRICTIVE ANALOG LEVEL TRANSMITTER, 2 WIRE 4-20MA, 24VDC (15" MEASURING RANGE), 24" CTC CONNECTIONS, TOP MOUNT	AL	ROSEMOUNT	LTM350ZZTR1E02400S00C1E8Z
5	0		PSV 1414	1	VALVE, PRESSURE SAFETY, FIRE, 2" 600# RF X 3" 150# RF OUTLET, SET @ 860 PSIG -20 TO 200 DEG F, 28132.239 LB/HR REQUIRED	CS	CROSBY	2H3JOS-E45J
6	0		TAGS		TAGS FOR ALL INSTRUMENTS	CS/SS TRIM	U.S. SIGN	..
					TRANSCONTINENTAL GAS PIPE LINE PO#: 676280 WO#: 1185731 PROJECT: SATION 200 LOCATION: CHESTER CO, PA			

Note 1: QUANTITY CHANGE  
2: TAG NAME UPDATE  
3: DESCRIPTION UPDATE



## **11.2 VENDOR LITERATURE**

The following pages list the accessories used to assemble this unit.  
The listing is sorted in alphabetical order according to manufacturer.

## CROSBY STYLE JOS-E, JBS-E, JLT\*-JBS-E, JLT\*-JOS-E VALVES INSTALLATION AND MAINTENANCE INSTRUCTIONS

Before installation these instructions must be fully read and understood



### ATTENTION

*The safety of lives and property often depends on the proper operation of the pressure relief valves. Consequently, the valves should be kept clean and should be periodically tested and reconditioned to make sure they function properly.*

### WARNING

*Suitability of the material and product for the use contemplated by the buyer is the sole responsibility of the buyer. Also storage, installation and proper use and application are the sole responsibility of the purchaser. Pentair Valves & Controls disclaims any and all liability arising out of same. Any installation, maintenance, adjustment, repair and testing performed on pressure relief valves should be done in accordance with the requirements of all applicable Codes and Standards under which those performing such work should maintain proper authorization through appropriate governing authorities. No repair, assembly and test work done by other than Pentair Valves & Controls shall be covered by the warranty extended by Crosby to its customers. You assume full responsibility for your work. In maintaining and repairing Crosby products you should use only parts manufactured by Pentair Valves & Controls. Call your nearest PV&C regional sales office or representative for a Crosby service engineer should you wish assistance with your field needs.*

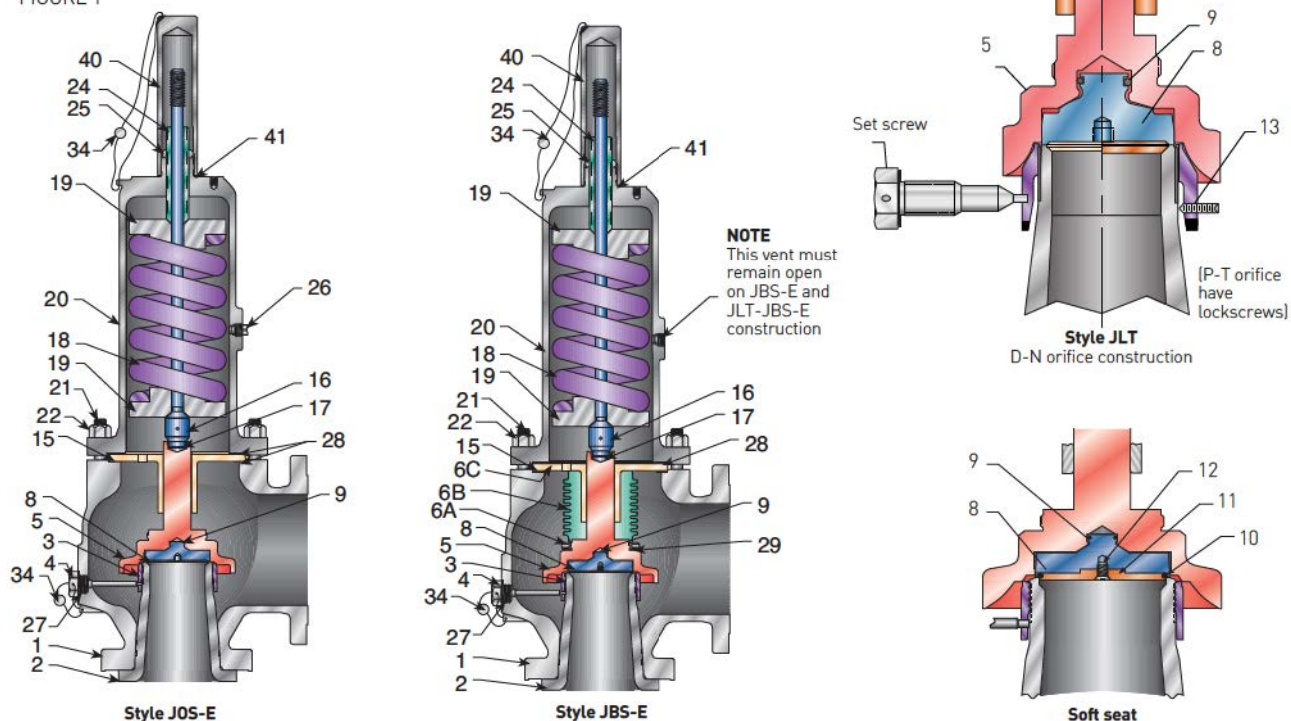
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# CROSBY STYLE JOS-E, JBS-E, JLT\*-JBS-E, JLT\*-JOS-E VALVES

## INSTALLATION AND MAINTENANCE INSTRUCTIONS

FIGURE 1



### PARTS LIST

No.	Part name	Notes
1	Body	
2	Nozzle	
3	Nozzle ring	3
4	Set screw	3, except P-T orifice JLT
4A	Set screw	3, (M-T orifice)
4B	Set screw rod	3, (M-T orifice)
4C	Set screw pin	3, (M-T orifice)
5	Disc holder	2
6A	Bellows tailpiece	2
6B	Bellows	2
6C	Bellows flange	2
8	Disc insert	1
9	Retention clip	1
10	O-ring	1
11	O-ring retainer	2
12	Retainer screw(s)	2
13	Nozzle ring lockscrew	P-T orifice JLT
14	Set screw plug	P-T orifice JLT (not shown)
15	Guide	3

No.	Part name	Notes
16	Spindle	3
17	Spindle cotter pin	1 (L-T orifice)
18	Spring	3
19	Spring washers	3
20	Bonnet	
21	Bonnet stud	
22	Bonnet stud nut	
24	Adjusting bolt	
25	Adjusting bolt nut	
26	Pipe plug	
27	Set screw gasket	1
28	Guide gasket	2
29	Tailpiece gasket	1
34	Seal and wire	
35	Seal clip (not shown)	
36	Nameplate (not shown)	
40	Screwed cap	
41	Cap gasket	1
	Gasket kit	1, 4

### NOTES

- Consumable spare parts: valve parts which should be replaced as part of any disassembly, and discs and disc inserts which must be replaced if seats are damaged.
- Repair spare parts: valve parts exposed to wear and/or corrosion during normal operation. They are in fluid flow paths and may require replacement as part of any repair.
- Insurance spare parts: valve parts exposed to process or environmental wear and/or corrosion and may require replacement as part of a major repair. Pentair Valves & Controls recommends that sufficient inventory of spare parts be maintained to support process requirements. Always be sure to use genuine Crosby parts to ensure continued product performance and warranty.
- Contains complete set of gaskets for all style of valves.

# CROSBY STYLE JOS-E, JBS-E, JLT\*-JBS-E, JLT\*-JOS-E VALVES

## INSTALLATION AND MAINTENANCE INSTRUCTIONS

UNION		SIZE STYLE 1D2 JOS-E-15-J	
SHOP NO. 61300000E	SET PRESS. PSI 100	GDTF PSI 91	
SERIAL NO. A00012345	BACK PRESS. PSI 10	TC PSI 1	
CAP 245 SCFM AT 60F		OVER PRESS. 10%	

FIGURE 2 - Sample nameplate

### Ordering spare parts

When ordering spare parts, the valve size, style and assembly number and/or serial number should be given together with set pressure, part name and reference number from page 2. The valve assembly number is shown on the valve nameplate as, "Shop Number". Spare parts may be ordered from any Pentair Valves & Controls Regional Sales Office or Representative.

### Safety precautions

Proper handling, storage, installation, maintenance and operation is essential to the safe and reliable functioning of any pressure relief product.

Precautionary statements in the form of warnings, cautions and notes are used throughout this instruction to emphasize important and critical factors where applicable.

### Examples:

#### WARNING

*An operating procedure or practice which if not strictly observed may result in injury to personnel or loss of life.*

#### CAUTION

*An operating procedure or practice which if not strictly observed may result in damage to or destruction of equipment.*

These precautionary statements are by no means exhaustive. Pentair Valves & Controls cannot be expected to know, evaluate, and advise customers of all the possible applications and operating conditions for its products or of the possible hazardous consequences which may result from the misapplication or misuse of such products.

Consequently, the improper handling, storage, installation, use or maintenance of any Pentair Valves & Controls product by a non Pentair Valves & Controls employee may void any Pentair Valves & Controls guarantees or warranties with respect to such product.

All personnel working with Pentair Valves & Controls products should be adequately trained and thoroughly familiar with the contents of the appropriate instruction manual(s).

Pentair Valves & Controls cannot evaluate all conditions in which the products may be used.

However, Pentair Valves & Controls offers the following general safety suggestions:

- Never subject valves to sharp impact loads. Rough handling (striking, bumping, dropping, etc.) may alter the pressure setting, deform valve parts and adversely affect seat tightness and valve performance. Striking a valve which is under pressure can cause premature actuation.
- Always lower the system pressure to the pressure level specified in the instruction before making any adjustment to the valve. Furthermore, always install a proper test rod to gag an installed valve before making any ring adjustments on the valve.
- Ear and eye protection should be used when working on a valve which has pressure.
- Never stand in front of the discharge outlet of a pressure relief valve which is under pressure.
- Always stand to the side of and at a safe distance from the valve discharge and use extreme care when observing a valve for leakage.

The above precautions and suggestions are by no means exhaustive and the user should always approach and use any pressure relief valve with great care.

Operation, Installation and Safety Instructions are available at [www.pentair.com/valves](http://www.pentair.com/valves) or from your local Pentair Valves & Controls regional sales office or representative.



# CROSBY STYLE JOS-E, JBS-E, JLT\*-JBS-E, JLT\*-JOS-E VALVES

## INSTALLATION AND MAINTENANCE INSTRUCTIONS

---

### 1 INTRODUCTION

Crosby Style JOS-E/JBS-E pressure relief valves have been selected for installation because of their performance features, reliability and ease of maintenance. Adherence to the installation and maintenance procedures specified herein will provide the utmost in safety, a minimum of maintenance, and a long service life. Crosby Style JOS-E, JBS-E and JLT-E Valves are manufactured in accordance with the requirements of Section VIII Pressure Vessels, ASME Boiler and Pressure Vessel Code. Style JOS-E is a conventional closed bonnet valve. Style JBS-E has a balanced bellows for minimizing the effect of back pressure. Style JLT-E is a high performance valve designed specifically for liquid service. The JLT-E features patented contoured liquid trim in a standard JOS-E/JBS-E envelope.

### 2 STORAGE AND HANDLING

Valves are often on hand at the job site months before they are installed. Unless properly stored and protected, valve performance may be adversely affected. Rough handling and dirt may damage or cause misalignment of the valve parts. It is recommended that the valves be left in their original shipping containers and that they be stored in a warehouse or at a minimum on a dry surface with a protective covering until they are used.

### 3 INSTALLATION

#### 3.1 Care in handling

Pressure relief valves must be handled carefully and never subjected to sharp impact loads. They should not be struck, bumped or dropped. Rough handling may alter the pressure setting, deform valve parts and adversely affect seat tightness and valve performance.

When it is necessary to use a hoist, the chain or sling should be placed around the valve body and bonnet in a manner that will ensure that the valve is in a vertical position to facilitate installation. The valve should never be lifted or handled using the lifting lever inlet and outlet protectors should remain in place until the valve is ready to be installed on the system.

#### 3.2 Inspection

Pressure relief valves should be visually inspected before they are installed to ensure that no damage has occurred during shipment or while in storage.

All protective material, sealing plugs and any extraneous material inside the valve body or nozzle must be removed.

The valve nameplate and other identifying tags should be checked to ensure that the particular valve is being installed at the location for which it was intended.

The valve seals protecting the spring setting and ring adjustments should be intact. If seals are not intact, the valve should be inspected, tested and seals properly installed before use.

#### 3.3 Inlet piping

Pressure relief valves should be mounted vertically in an upright position either directly on a nozzle from the pressure vessel or on a short connecting fitting that provides direct and unobstructed flow between the vessel and the valve. Installing a pressure relief valve in other than this recommended position might adversely affect its operation. Where rounded or beveled approaches cannot be provided ahead of the valve it is recommended that one size larger nozzle or fitting be used. A valve should never be installed on a fitting having a smaller inside diameter than the inlet connection of the valve.

Inlet piping (nozzles) must be designed to withstand the total resultant forces due to the valve discharging at the maximum accumulated pressure and the expected piping loads. The magnitudes of the bending moment exerted on the inlet piping will depend on the configuration and method of supporting the outlet piping.

Many valves are damaged when first placed in service because of failure to clean the connections properly when installed. Both the valve inlet and the vessel and/or line on which the valve is mounted must be thoroughly cleaned of all foreign material. The inlet connection bolts or studs should be drawn down evenly to avoid straining the valve body with possible distortion of the nozzle flange or base.

# CROSBY STYLE JOS-E, JBS-E, JLT\*-JBS-E, JLT\*-JOS-E VALVES

## INSTALLATION AND MAINTENANCE INSTRUCTIONS

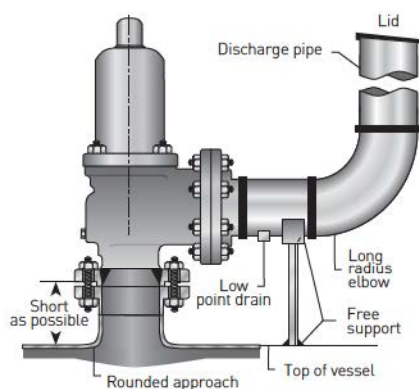


FIGURE 3 - Recommended installation discharging to atmosphere

### 3.4 Outlet piping

Outlet piping should be simple and direct. Where possible, for non-hazardous fluids, a short discharge pipe or vertical riser connected through a long radius elbow venting directly to atmosphere is recommended. Such discharge piping should be at least the same size as the valve outlet.

All discharge piping should be run as direct as is practicable to the point of final release for disposal. Valve effluent must discharge to a safe disposal area.

Where discharge piping is long, due consideration shall be given to the use of long radius elbows, and the reduction of excessive line strains through the use of expansion joints and proper means of support to minimize line sway and vibration under operating conditions. Adequate drainage is required to prevent corrosive media from collecting in the discharge side of the pressure relief valve. When required, low point drains shall be provided in the discharge pipe. Particular care must be observed to ensure that the drains are directed or piped to a safe disposal area. In installations where the pressure relief valve discharges into a closed system, care must be taken to ensure that built up and superimposed back pressure has been properly calculated, specified, and accounted for when sizing and selecting the valve.

Where built up back pressure is expected to exceed 10% of set pressure or if superimposed back pressure is variable, a bellows valve is required.

## 4 HYDROSTATIC PRESSURE TESTS

### 4.1 Hydrostatic test of vessel or system

When a pressure vessel or system is to be hydrostatically tested, it is recommended that the pressure relief valve be removed and a blank flange be installed in its place. This practice precludes the possibility of any damage to the pressure relief valve. Bent spindles and damaged valve seats are problems that can be caused by improper hydrostatic test procedures.

Blank flanges must be removed and the pressure relief valve reinstalled before the vessel is placed in service.

When the hydrostatic test must be performed with the valve in place, a test gag may be used. Crosby Style JOS-E/JBS-E valves are designed to accommodate test gags for use with each type of cap. In the case of the Type C cap with lifting lever, the lifting lever assembly must be replaced with a hydrostatic test cap and test rod prior to hydrostatic testing. When test rods are used, care must be exercised to prevent overtightening that could damage the valve spindle and valve seats. A test rod which is hand tight will generally provide sufficient force to hold the valve closed.

After the hydrostatic test, the test rod (gag) must be removed and replaced by either a cap plug or a cap not fitted with a test rod.

### 4.2 Hydrostatic test of outlet system

When a hydrostatic test must be conducted on the outlet piping system, with the valve in place, special consideration must be given not to exceed the design pressure limits of the downstream side of the pressure relief valve. The outlet side of a pressure relief valve is known as the secondary pressure zone.

This zone is normally designed to a lower pressure rating than the inlet and frequently is designed to a lower pressure rating than the outlet flange. This is particularly true in the case of balanced bellows designs and in the larger valve sizes.

Consult Crosby products specifications for the back pressure design limits of the Style JOSE/JBS-E or JLT-E valves.



# CROSBY STYLE JOS-E, JBS-E, JLT\*-JBS-E, JLT\*-JOS-E VALVES

## INSTALLATION AND MAINTENANCE INSTRUCTIONS

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### 5 SETTING, TESTING AND ADJUSTMENTS

#### 5.1 New valves

Every new Crosby J series Pressure Relief Valve is fully tested and sealed prior to shipment. The external adjustment points of each valve are sealed to ensure that no changes have been made to the valve after shipment and that the valve has not been disassembled or tampered with. The seals and nameplates are your assurance that the valve has been built and tested to the applicable Codes and Standards and are the physical evidence of our product warranty.

All new Crosby J series valves are fully tested prior to shipment on the appropriate testing medium, so there is no need to pre-test the valve prior to installation. If pre-testing is required, in order to maintain the product warranty, a Crosby authorized service organization should be contacted to perform the testing. Contact your local sales representative or visit our website to locate the authorized service organization closest to your location. By choosing an authorized service organization to perform testing you can be assured that the correct testing procedure is followed which will save time and cost by avoiding possible valve damage caused by improper testing methods.

In any event, if pre-testing is to be performed, several important cautions should be observed. First it is vital that the appropriate test fluid is used to test any valve. See Section 5.5, this will insure accuracy of the test results as well as avoid possible damage to the valve.

All Crosby J series valves are tested for seat tightness after the final set point test and prior to shipment from the factory. If further seat tightness testing is required before installation, it is recommended that the test be performed prior to any set point verification testing. Repeated pressure testing of a metal seated valve can cause damage to the sealing surfaces leading to seat leakage.

Testing on a low volume test stand requires specific testing techniques in order to ensure accurate test results and to avoid damage to the sealing surfaces of the valve. In many cases this requires temporary adjustment of the nozzle ring during the test as described in Section 5.8 and specifically in Section 5.8.1. For valves with set points in excess of 500 psig, it is recommended that when testing on a low volume test bench, the lift be temporarily restricted by use of a gag or other suitable device.

However, it is good practice to inspect the valve prior to installation.

This inspection determines any damage which may have occurred due to rough handling in transit or storage and initiates appropriate service records.

#### 5.2 Reconditioned valves

Valves which have not been in service for extended periods due to plant shutdown or long term storage, or valves which have been repaired or reconditioned, should also be tested before being put into operation.

#### CAUTION

*Improper testing may cause valve damage and seat leakage.*

#### 5.3 Valves removed from service

Valves being removed from service should be tested on a shop test bench before being disassembled to determine the set pressure and seat tightness. This is an important phase of the maintenance routine and the test results should be recorded for review and determination of necessary corrective action. The "as received from service" condition of a pressure relief valve is a most useful tool in establishing the proper time interval between inspections.

#### 5.4 The test bench

The quality and condition of the shop test bench is paramount to obtaining proper test results. The test bench must be free of leaks and the test fluid must be clean. Solids or other foreign material in the test medium will damage the seating surfaces of the pressure relief valve being tested.

The test pressure gage must be calibrated and have a range proper to the pressure level of the valve setting. Set pressure should fall within the middle third of the dial range of the test gage. The test bench provides an accurate and convenient facility for determining valve set pressure and seat tightness. It does not duplicate all of the field conditions to which a pressure relief valve will be exposed while in service. It is not practical to attempt to measure relieving capacity or blowdown using a test bench.

#### 5.5 Test fluids - set pressure test

The test fluid should be air or nitrogen for valves used on gas and vapor service and water for valves used on liquid service. Valves for steam service should be tested on steam. It may be necessary to make a correction to the adjusted set pressure to compensate for the difference in temperature of the test fluids (see appropriate instruction).

# CROSBY STYLE JOS-E, JBS-E, JLT\*-JBS-E, JLT\*-JOS-E VALVES

## INSTALLATION AND MAINTENANCE INSTRUCTIONS

### 5.6 Valve operation

Crosby Style JOS-E/JBS-E valves intended for compressible fluid service and tested with air or steam will open with a sharp clear popping action at the set point. Valves for liquid service tested with water are considered open when there is a continuous unbroken stream of liquid flowing from the valve.

### 5.7 Set pressure changes

Set pressure changes beyond the Crosby specified spring range will necessitate a change in the valve spring assembly consisting of the spring and two fitted spring washers. The new spring and washers must be obtained from Crosby and the valve must be reset and the nameplate restamped by an authorized valve repair facility.

### 5.8 Set pressure adjustment

Before making any adjustments, reduce the pressure under the valve seat to at least 10% below the stamped opening pressure. This will prevent seat damage due to turning of the disc on the nozzle seat and minimize the chance of an inadvertent valve opening. A strong [high] ring position is necessary to obtain a good clean popping action of the valve on air or gas with the limited volume available on the test bench.

5.8.1 [Not required for testing on liquid.] Remove the nozzle ring set screw and raise the nozzle ring until it touches the disc holder, then back it down two (2) notches. Exercise care in counting the number of notches moved so that the ring can be returned to its proper position following testing. Moving the notches on the nozzle ring to the left will lower the nozzle ring. Replace the nozzle ring set screw before each set pressure test. The set screw must engage one of the ring notches, being careful that it does not bear on the top of a tooth.

5.8.2 Remove the cap or lifting lever following the instruction for valve disassembly. [See paragraph 6]

5.8.3 Loosen the adjusting bolt nut and turn the adjusting bolt clockwise to increase set pressure or counterclockwise to reduce set pressure.

5.8.4 Retighten the adjusting bolt nut following each adjustment.

5.8.5 Two or three consecutive valve openings at the same pressure are necessary to accurately verify the opening pressure.

5.8.6 Once the set pressure has been established, lower the nozzle ring to the installed ring position as indicated in Table 1 and replace the nozzle ring set screw as described above. Seal wire the adjusting bolt and adjusting ring set screw with identifying seals.

### 5.9 Nozzle ring settings

The nozzle ring adjustment is made at the factory and resetting in service is seldom necessary. Should it be necessary to change blowdown or reduce valve simmer, the nozzle ring may be adjusted as follows: [see the next paragraph for P, Q, R and T Orifice Style JLT]

### CAUTION

*Should any adjustments be made while the valve is installed on a pressurized system, the valve should be gagged while ring adjustments are made.*

TABLE 1

Service	Orifice size	Nozzle ring setting (below highest lock position)
<b>Styles JOS-E/JBS-E pressure relief valve recommended nozzle ring settings</b>		
Vapor and gases	D through J	-5
	K through N	-10
	P through T	-15
<b>Styles JLT-E pressure relief valve recommended nozzle ring settings</b>		
Liquids and gases	D, E, and F	-2
	G, H, and J	-3
	K and L	-5
	M and N	-10
	P and Q [see table 2]	
	R and T [see table 2]	

### NOTE

Minus sign indicates number of ring notches below starting position of nozzle ring which is the highest position with the valve closed (contact with disc holder)



# CROSBY STYLE JOS-E, JBS-E, JLT\*-JBS-E, JLT\*-JOS-E VALVES

## INSTALLATION AND MAINTENANCE INSTRUCTIONS

**TABLE 2**

JLT-E orifice size	Nozzle ring setting - Total revolutions below highest lock position
P and Q	% Revolution
R and T	1 Revolution

**TABLE 4 - (JOS/JOS-E style only)**

Orifice size	Saturated steam set pressure (max) (psig)
D, E, F, G, H, J, K, L	1500
M	1100
N, P	1000
Q	600
R, T, T2	300

**TABLE 5 - Saturated steam service**

Air set pressure correction factors at ambient temperature	
Set pressure (psig)	% Increase in spring set pressure
15-400	3%
401-1000	4%
1001-1500	5%

**TABLE 3**

Operating temperature (°F)	% Excess pressure
0 - 150	-
151 - 600	1%
601 - 800	2%
801 - 1000	3%

5.9.1 Remove the nozzle ring set screw and insert a screwdriver to engage the ring notches.

5.9.2 Turning the ring to the right raises the ring, thereby increasing blowdown. Turning the ring to the left lowers the ring, thereby decreasing the blowdown.

5.9.3 Do not lower the nozzle ring to the point where the valve begins to have excessive simmer. Raising of the ring will reduce simmer.

5.9.4 The nozzle ring should not be moved more than two notches before retesting. When making adjustments, always keep count of the number of notches and the direction in which the nozzle ring is moved. This will permit returning to the original setting in case of error.

5.9.5 Style JLT

The Style JLT in the P, Q, R and T Orifice sizes is preset at the factory and cannot be externally adjusted in the field, since the special contoured skirt on the disc holder prevents engagement of the set screw with the nozzle ring. As a result the nozzle ring is not slotted and is held in place by three set screws. The position of the nozzle ring must be set prior to valve assembly as follows:

- Screw the nozzle ring (3) on to the nozzle. The top of the nozzle ring should be below the nozzle seating surface.
- Install the disc insert retention clip (9) onto the disc insert. Assemble the disc insert (8) and disc holder (5). The disc insert should snap into place using hand force only.

C. Lower the disc holder and disc insert carefully onto the nozzle.

D. Reach through the valve body outlet and turn the nozzle ring until it lightly touches the disc holder. This is the highest lock position.

E. Carefully remove the disc holder and disc insert from the valve.

F. Lower the nozzle ring (turn to the left) the total number of revolutions shown in Table 2.

G. Carefully tighten each of the set screws on the nozzle ring to hold the ring in position.

### 5.10 Cold differential test pressure adjustments

When a pressure relief valve is on a test bench at room temperature and atmospheric pressure, and is to be installed on a system operating at a higher temperature and/or a higher back pressure, a compensating adjustment is necessary. The test pressure required to have the valve open at the desired set pressure under actual service conditions is known as the cold differential test pressure.

#### 5.10.1 Temperature correction

When a Crosby Style JOS-E/JBS-E or JLT-E valve is set on air or water at room temperature and then used at a higher service temperature, the test pressure shall be corrected to exceed the set pressure using the temperature correction shown in Table 3.

**Note:** this table is not applicable to steam service valves.

#### 5.10.2 Back pressure correction

Conventional valves without balancing bellows set with atmospheric pressure at the outlet and intended for use under elevated constant back pressure conditions shall be adjusted so that the test pressure is equal to the set pressure minus the expected back pressure. See example below:

Set pressure	100 psi
Constant back pressure	10 psi
Cold differential test pressure	90 psi

In all instances, the spring should be selected based on the cold differential test pressure; in the example above, 90 psi. See sample nameplate on page 3 which shows how temperature and back pressure is indicated.

#### 5.10.3 Saturated Steam Correction Factors

Crosby Style JOS and JOS-E pressure relief valves that are used for saturated steam service and are within the set pressure limits established in Table 4 may be set on air at ambient temperature, provided the correction factors in Table 5 are applied to the valve set pressure.

# CROSBY STYLE JOS-E, JBS-E, JLT\*-JBS-E, JLT\*-JOS-E VALVES

## INSTALLATION AND MAINTENANCE INSTRUCTIONS

FIGURE 4  
Typical test arrangement

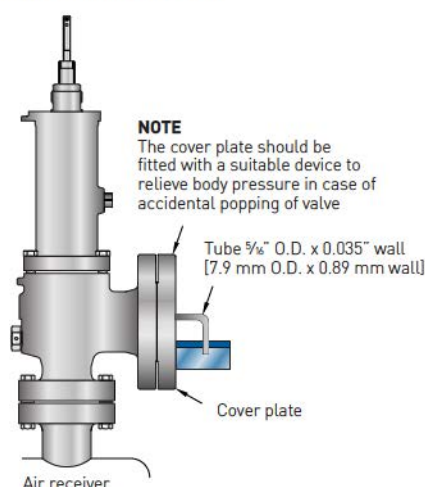
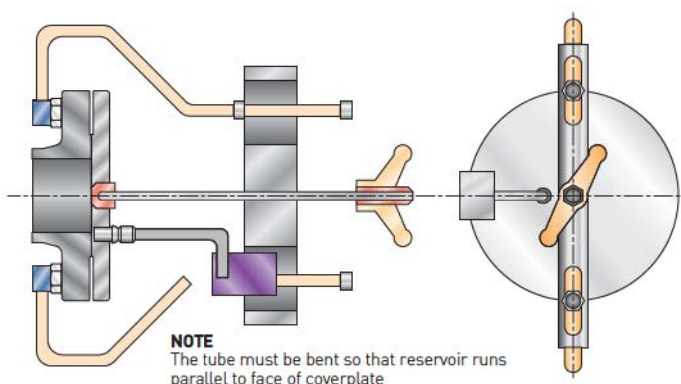


FIGURE 5  
Seat leak apparatus for 150 and 300 lb. outlets 1" to 10" sizes



### 5.11 Seat leakage tests

Ambiguous terms such as "bubble-tight," "drop tight," "zero leakage" and "commercial tightness" are sometimes used to describe seat tightness. These terms, however, lack uniform definition and true practical meaning.

- Test procedure

API standard 527 provides a standard for "commercial" tightness and has been adopted by industry and users in order to clarify testing methods and tightness criteria. This standard applies to flanged inlet nozzle type pressure relief valves.

- Test apparatus

A typical test arrangement for determining seat tightness for pressure relief valves per API standard 527 is shown in Figure 4. Leakage is measured using a 5/8 inch OD tube with 0.035 inch wall. The tube end is cut square and smooth, is parallel to and 1/2 inch below the surface of the water. A snap-on type test clamp shown in Figure 5 is available.

- Procedure

With the valve mounted vertically, the leakage rate in bubbles per minute shall be determined with pressure at the pressure relief valve inlet raised up to and held at 90 percent of the set pressure (or cold differential test pressure - CDTP) immediately after popping. This applies except for valves set at 50 psig or below, in which case the pressure shall be held at 5 psig below the set pressure immediately after popping. The test pressure shall be applied for a minimum of one minute for valves of inlet sizes through 2"; two minutes for sizes 2 1/2", 3" and 4"; five minutes for sizes 6" and 8". Air (or nitrogen) at approximately ambient temperature shall be used as the pressure medium.

- Tightness standard

#### Metal-to-metal seated valves

The leakage rate in bubbles per minute shall be observed for at least one minute and shall not exceed the values indicated in Table 6.

#### Soft seated valves

For soft seated valves there shall be no leakage for one minute (zero bubbles for one minute).

- Crosby seat tightness standard-liquid service valves (Style JLT-E)

Crosby liquid service pressure relief valves are checked for seat tightness by a quantitative seat leakage test.

TABLE 6 - Maximum seat leakage rate - Metal seated pressure relief valves

Set pressure psig (barg)	Effective orifice sizes 0.307 In <sup>2</sup> and smaller D, E and F				Effective orifice sizes larger than 0.307 In <sup>2</sup> G orifice and larger		
	Max. bubbles per minute	Approximate leakage rate per 24 hours		Max. bubbles per minute	Approximate leakage rate per 24 hours		
		Standard cubic feet	Standard cubic meters		Standard cubic feet	Standard cubic meters	
15-1000 [1.03-68.9]	40	0.6	0.017	20	0.30	0.0085	
1500 [103.4]	60	0.9	0.026	30	0.45	0.0130	
2000 [137.9]	80	1.2	0.034	40	0.60	0.0170	
2500 [172.4]	100	1.5	0.043	50	0.75	0.0210	
3000 [206.8]	100	1.5	0.043	60	0.90	0.0260	
4000 [275.8]	100	1.5	0.043	80	1.20	0.0340	
5000 [344.8]	100	1.5	0.043	100	1.50	0.0430	
6000 [413.7]	100	1.5	0.043	100	1.50	0.0430	



# CROSBY STYLE JOS-E, JBS-E, JLT\*-JBS-E, JLT\*-JOS-E VALVES

## INSTALLATION AND MAINTENANCE INSTRUCTIONS

All of the test fluid passing through an assembled valve is collected and measured per the following test procedure:

1. The inlet pressure is adjusted to a test pressure which is 90% of the cold differential test pressure. Valves set below 50 psig are tested at 5 psig below the cold differential test pressure.
2. The test pressure is maintained for a period of not less than ten minutes.

### • Allowable leak rate

The maximum allowable leakage rate should not exceed 10 cubic centimeters per hour per inch of diameter of nominal valve inlet size. For nominal valve sizes of 1 inch or less, the leakage rate shall not exceed 10 cubic centimeters per hour. For soft seated valves there shall be no leakage for one minute.

### • Soft seated valves

For exceptional seat tightness, Crosby offers an O-ring soft seat design. Refer to Figure 13. The Crosby soft seat design will provide a valve that has no visible leakage at a test pressure of 90 percent of the set pressure or cold differential test pressure. Soft seated valves are tested using the same test procedure used for metal-to-metal seated valves.

## 6 VALVE MAINTENANCE

### CAUTION

*Valves in hazardous fluid service and any other materials classified as dangerous must be neutralized immediately after removal from service.*

### 6.1 Visual inspection and neutralizing

A visual inspection shall be made when valves are first removed from service. The presence of deposits or corrosion products in the valve and in the piping should be recorded and valves should be cleaned to the extent possible prior to disassembly. Check the condition of external surfaces for any indication of corrosive atmospheric attack or evidence of mechanical damage.

### 6.2 Disassembly

Crosby JOS-E/JBS-E valves should be disassembled as described below. Parts identification may be found in Figure 1 on page 2. The parts from each valve should be properly marked and segregated to keep them separate from parts used in other valves.

- 6.2.1 Remove the cap (40) and cap gasket (41). If the valve has a lifting lever device follow the instructions in Section 6.7.

- 6.2.2 Remove the nozzle ring set screw (4) and set screw gasket (27). Record the position of the nozzle ring (3) with respect to the disc holder (5) by counting the number of notches required to raise the ring until it just touches the disc holder. This information will be needed again when reassembling the valve. (Measure the revolutions for P, Q, R and T orifice style JLT. See Table 2)
- 6.2.3 Loosen the adjusting bolt nut (25). Before releasing the spring load, make note of the depth of the adjusting bolt in the bonnet and count the number of turns required to remove the spring load. This information will help when reassembling the valve to its approximate original setting.
- 6.2.4 Release all of the spring load by rotating the adjusting bolt (24) in a counterclockwise direction.
- 6.2.5 Remove the bonnet stud nuts (22).
- 6.2.6 Lift the bonnet (20) straight up to clear the spindle (16) and valve spring (18). Exercise care when lifting the bonnet as the spring and spindle will then be free to fall aside.
- 6.2.7 The spring and spring washers (19) can now be lifted off the spindle (16). The spring and spring washers are fitted together and must be kept together as a subassembly. Spring washers are not interchangeable between ends of the spring.

FIGURE 6

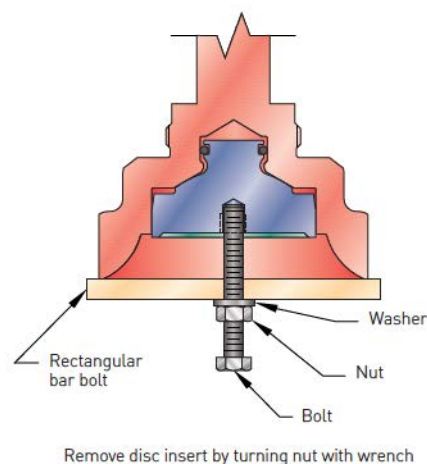
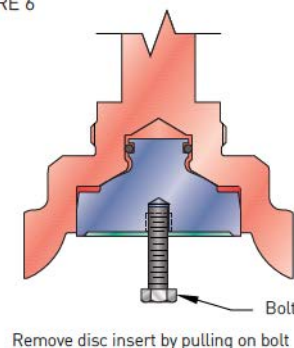


FIGURE 7

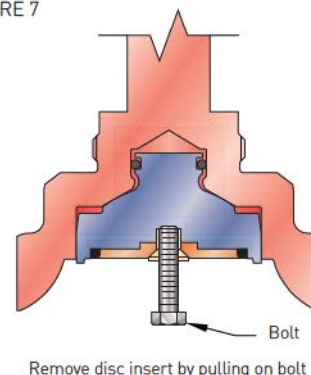


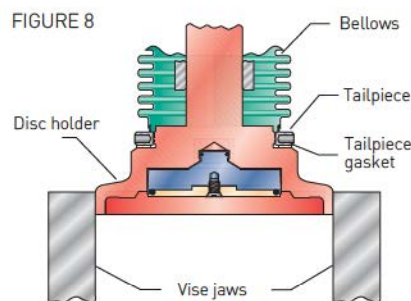
TABLE 7 - JOS-E / JBS-E disc insert threaded hole sizes

Orifice size	Thread size (UNC)
D, E	# 10 - 24
F, G, H	1/4 - 20
J, K, L	1/4 - 20
M, N, P, Q, R, T	3/8 - 16

## CROSBY STYLE JOS-E, JBS-E, JLT\*-JBS-E, JLT\*-JOS-E VALVES

### INSTALLATION AND MAINTENANCE INSTRUCTIONS

FIGURE 8



6.2.8 Remove the spindle, guide [15], disc holder and disc insert [8]. For balanced bellows valves (Style JBS-E and JLT-JBS-E) special care must be taken not to damage the bellows subassembly [6]. If parts are difficult to remove, due to the presence of corrosive or foreign materials, soaking in a suitable solvent may be required.

6.2.9 Remove the spindle from the disc holder.

6.2.10 Lift the guide off the disc holder.

6.2.11 Disc insert removal

**Note:** for removal of threaded inserts supplied with JOS/JBS valves, see IS-V3137A.

- Orifice sizes D through M (metal seats)  
Screw a standard bolt into the tapped hole (see Table 7) in the face of the disc insert. Using hand force pull the bolt straight out. The disc insert with the retention clip [9] should come out with moderate force. If the valve has been in dirty service, it may be necessary to use a suitable solvent to aid in removal. If additional pullout force is required, a bolt with a T handle may be used. The method described below for orifice sizes N through T may be used if necessary.

- Orifice sizes N through T (metal seats)  
Safety precautions should be followed whenever heavy parts are being lifted or transported. Dropping disc holder assembly may dislodge the insert. The removal of the insert is accomplished by the use of a tool as shown in Figure 6. This tool consists of a rectangular steel bar which spans the outside diameter of the disc holder with a center hole through which the standard bolt can be inserted before screwing into the disc insert. A nut and washer is also required as shown. Tightening the nut with a wrench will exert a pulling force on the disc insert and cause it to be removed from the disc holder.

- Orifice sizes D through K (O-ring seats)  
The O-ring seat design for Orifice sizes D through K has a retaining screw in the center of the disc insert. A drilled and tapped hole (4-40 UNC) is provided in the center of the retaining screw for removal of the disc insert (Figure 7). Screw a standard bolt into the hole in the retaining screw. Using hand force pull the bolt straight out. The disc insert with the retention spring should come out with moderate force.

- Orifice sizes L through T (O-ring seats)  
Safety precautions should be followed whenever heavy parts are being lifted or transported. Dropping the disc holder may dislodge the insert. Remove the three retaining screws from the insert. Remove the retainer and O-ring seat. A tapped hole (refer to Table 7) is provided in the disc insert for insertion of a removal bolt. Follow instructions for metal seated insert removal.

6.2.12 For bellows valves only, place the disc holder in a vise (the larger sizes may require a 3-jaw vise) as shown in Figure 8. Using a suitable wrench unscrew the tailpiece and bellows from the disc holder.

6.2.13 Remove the nozzle ring [3] from the nozzle [2].

6.2.14 Remove the nozzle [2] from the valve body [1] if necessary. Unless the valve seat on the nozzle has been mechanically damaged or shows signs of corrosive attack, it will not be necessary to remove the nozzle. In most cases the nozzle can be reconditioned without removal from the valve body. To remove the nozzle, turn the valve body over taking care not to damage the bonnet studs [21]. Turn the nozzle counterclockwise by using the wrench flats on the nozzle flange or a nozzle wrench designed to clamp onto the nozzle flange.

### 6.3 Cleaning

External parts such as the valve body, bonnet and cap should be cleaned by immersion in a bath such as hot Oakite solution or equivalent. These external parts may be cleaned by wire brushing, provided the brushes used do not damage nor contaminate the base metals. Only clean stainless steel brushes should be used on stainless steel components. The internal parts such as the guide, disc holder, disc insert, nozzle ring and spindle should be cleaned by immersion in a commercial high alkaline detergent. Guiding surfaces on the disc holder and guide may be polished using a fine emery cloth. The bellows and other metal parts may be cleaned using acetone or alcohol, then rinsed with clean tap water and dried.



# CROSBY STYLE JOS-E, JBS-E, JLT\*-JBS-E, JLT\*-JOS-E VALVES

## INSTALLATION AND MAINTENANCE INSTRUCTIONS

### 6.4 Inspection

Check all valve parts for wear and corrosion. The valve seats on both the nozzle and disc insert must be examined to determine if they have been damaged. Most often, lapping the valve seats is all that is necessary to restore them to their original condition.

If the inspection shows that the valve seats are badly damaged, remachining will be necessary or it may be advisable to replace these parts. When the time element is a factor, it may be advantageous to replace damaged parts from spare parts stock, thereby permitting the replaced part to be checked and reworked at leisure. (See Figure 10 and Table 8 for critical dimensions.) The valve spring (18) should be inspected for evidence of cracking, pitting or deformation. The bellows (6B) in a Style JBS-E and JLT-JBS-E valve should be inspected for evidence of cracking, pitting or deformation that might develop into a leak. The bearing surfaces on the guide and disc holder should be checked for residual product build up and any evidence of scoring. Inspection of valve components is important to ensure proper valve performance. Damaged valve parts must be repaired or replaced.

Spindle assemblies should be checked for excessive runout. For D to K orifice the total runout between the spindle point to top of the spindle rod should be less than 0.015 inch. For L orifice and larger it should be less than 0.030 inch.

Check and inspect all gaskets for evidence of damage (creases, gouges, cuts) or corrosion. Metal gaskets may be re-used if found to be undamaged. All organic fiber or soft gaskets should be replaced.

### 6.5 Reconditioning of valve seats

The tightness of a valve and its proper operation depend directly on the condition of the seats. Many pressure relief valve problems are due to eroded or damaged seats. The standard Crosby Style JOS-E/JBS-E/JLT-E valve is constructed with a flat metal-to-metal seat. It is important that seating surfaces be properly refurbished by lapping with a flat cast iron lap coated with the correct lapping compound.

#### 6.5.1 Lapping procedures

Unless the seats have been badly damaged by dirt or scale, lapping the seating surfaces should restore them to their original condition. Never lap the disc insert against the nozzle. Lap each part separately against a cast-iron lapping block of the proper size. These blocks hold the lapping compound in their surface pores and must be recharged frequently. Lap the block against the seat. Never rotate the block continuously, but use an oscillating motion. Extreme care should be taken throughout to make certain

that the seats are kept perfectly flat.

If considerable lapping is required, spread a thin coat of medium coarse lapping compound on the block. After lapping with the medium coarse compound, lap again with a medium grade compound. Unless much lapping is called for, the first step can be omitted. Next, lap again using a fine grade compound. When all nicks and marks have disappeared, remove all the compound from the block and seat. Apply polish compound to another block and lap the seat.

As the lapping nears completion, only the compound left in the pores of the block should be present. This should give a very smooth finish. If scratches appear, the cause is probably dirty lapping compound. These scratches should be removed by using compound free from foreign material. Disc inserts should be lapped in the same way as nozzles. The disc insert must be removed from the holder before lapping. Before the disc insert is placed back in the holder all foreign material should be removed from both parts. The insert must be free when in the holder. If the disc insert is damaged too badly to be reconditioned by lapping, it should be replaced. Remachining the insert will change critical dimensions, affect the action of the valve and is not recommended.

#### • Lapping blocks

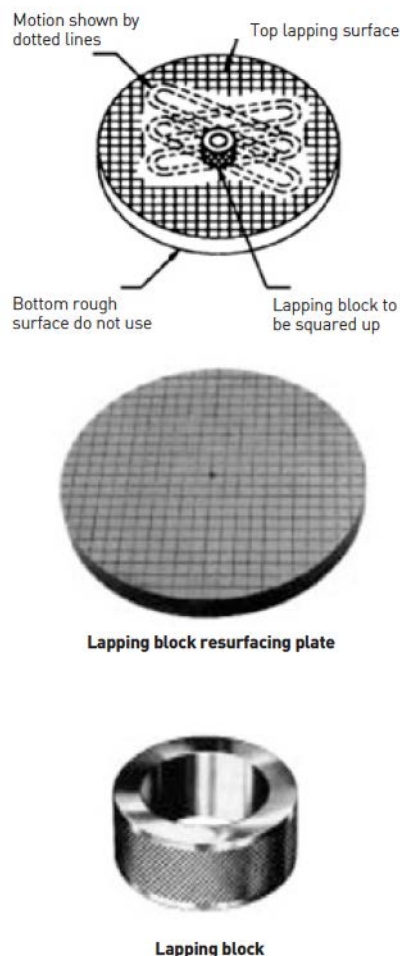
Lapping blocks are made of a special grade of annealed cast iron. There is a block for each orifice size. Each block has two perfectly flat working sides and it is essential that they retain this high degree of flatness to produce a truly flat seating surface on either the disc insert or the nozzle. Before a lapping block is used, it should be checked for flatness and reconditioned after use on a lapping plate. The block should be lapped in a figure eight motion, applying uniform pressure while rotating the lapping block against the plate as shown in Figure 9.

#### • Lapping compounds

Experience has proven that medium coarse, medium fine, and polish lapping compounds will properly condition any damaged pressure relief valve seat except where the damage requires remachining. The following lapping compounds, or their commercial equivalents are suggested:

Grit compound no.	Description
320	Medium coarse
400	Medium
600	Fine
900	Polish

FIGURE 9



# CROSBY STYLE JOS-E, JBS-E, JLT\*-JBS-E, JLT\*-JOS-E VALVES

## INSTALLATION AND MAINTENANCE INSTRUCTIONS

**TABLE 8 - Minimum nozzle face to seat dimensions (see figure 10)**

Orifice	Valve type								
	12, 14, 15, 16	22, 24, 25, 26	34, 35, 36, 37	47	42, 44, 45, 46	57	55, 56	64, 65, 66, 67	75, 76, 77
D	3.453	3.453	3.453	3.453	3.453	3.675	3.675	3.675	4.796
E	3.453	3.453	3.453	3.453	3.453	3.675	3.675	3.675	4.796
F	4.013	4.013	4.013	4.013	4.013	4.013	4.013	4.013	4.633
G	3.763	3.763	3.763	3.763	3.763	3.763	3.763	4.763	4.763
H	3.889	3.889	3.889	3.889	4.826	4.826	4.826	4.826	-
2J3	4.326	4.326	-	-	-	-	-	-	-
2½J4	-	-	4.357	4.357	5.107	5.107	-	-	-
3J4	-	-	6.232	6.232	6.232	6.232	6.441	6.441	-
K	4.701	4.701	4.701	4.701	5.826	5.826	7.013	7.013	-
L	5.045	5.045	5.263	5.263	5.263	6.236	6.236	6.236	-
M	5.576	5.576	5.576	5.576	5.576	6.389	6.389	-	-
N	6.117	6.117	6.117	6.117	6.117	-	-	-	-
P	5.857	5.857	7.607	7.607	7.607	-	-	-	-
Q	7.732	7.732	7.732	7.732	7.732	-	-	-	-
R	8.117	8.117	8.117	8.117	8.117	-	-	-	-
T, T2	9.576	9.576	9.576	-	*9.576	-	-	-	-

\* Type 42, 44 not available

**TABLE 9 - Disc insert minimum seat heights**

Orifice	D and E	F	G	H	J	K	L	M	N	P	Q	R	T
"A"	0.332	0.370	0.369	0.398	0.429	0.531	0.546	0.605	0.632	0.692	0.783	0.781	0.839
"B"	0.021	0.025	0.030	0.036	0.044	0.051	0.063	0.070	0.076	0.091	0.118	0.139	0.176
	0.023	0.027	0.032	0.038	0.046	0.053	0.065	0.072	0.078	0.093	0.120	0.141	0.178

### 6.5.2 Machining of nozzle seats

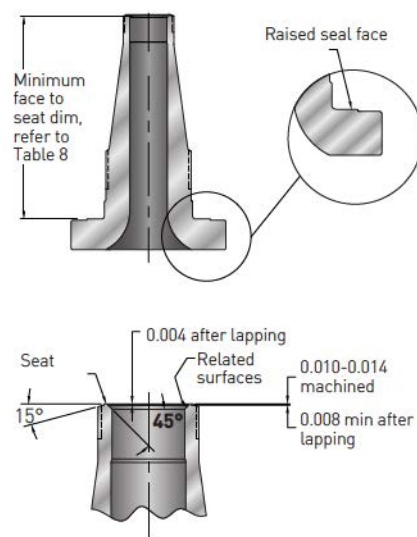
If machining of the nozzle seat or other major repairs are necessary, it is recommended that the valve be returned to a Pentair Valves & Controls facility for repair. All parts must be accurately machined per Crosby specifications. No pressure relief valve will be tight, nor will it operate properly unless all parts are correctly machined. The most satisfactory way to machine a nozzle is to remove it from the valve body. However, it may also be machined while assembled within the valve body. In any event, it is vitally important that the seating surfaces run absolutely true before machining. Machining dimensions for Crosby Style JOS-E/JBS-E valves with metal-to-metal nozzle seats are shown in Figure 10 and Table 8. Remove only enough metal to restore the surface to its original condition. Turning to the smoothest possible finish will facilitate lapping. The nozzle must be replaced when minimum face to seat dimension is reached. This critical dimension is shown in Table 8.

### 6.5.3 Machining of disc insert seats

When the damage to the disc insert seat is too severe to be removed by lapping, the disc insert may be machined and lapped provided that minimum seat height is maintained (Figure 11 and Table 9).

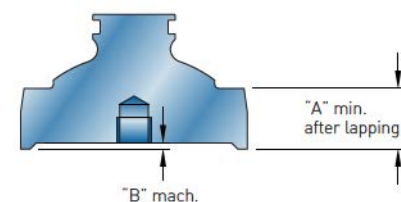
**FIGURE 10**

Nozzle seat critical dimensions



**FIGURE 11**

Disc insert minimum seat height (Table 9)





# CROSBY STYLE JOS-E, JBS-E, JLT\*-JBS-E, JLT\*-JOS-E VALVES

## INSTALLATION AND MAINTENANCE INSTRUCTIONS

### 6.6 Assembly

All components should be clean. Before assembling the following parts, lubricate with pure nickel "Never-Seez."

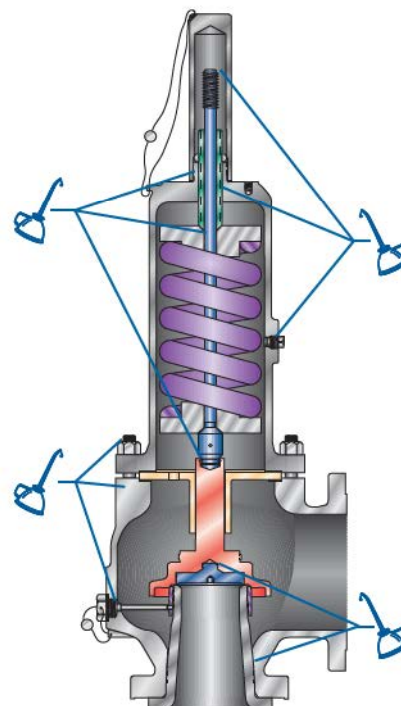
- Nozzle and body threads
- Nozzle and body seating surface
- All studs and nut threads
- Spindle and threads
- Set screw threads
- Spring washer bevels
- Adjusting bolt and bonnet threads
- Bonnet pipe plug
- Cap threads
- All metal gaskets
- Dog shaft bearing threads
- Disc holder threads (bellows valves only)

Lubricate the spindle point thrust bearing and disc insert bearing with pure nickel "Never-Seez." Special attention should be given to the guiding surfaces, bearing surfaces and gasket surfaces to ensure that they are clean, undamaged and ready for assembly. (Figure 12) For parts identification, refer to Figure 1.

- 6.6.1 Before installing the nozzle (2) apply lubricant to the flange surface in contact with the valve body (1) and on the body to nozzle threads. Screw the nozzle (2) into the valve body (1) and tighten with a nozzle wrench.
- 6.6.2 Screw the nozzle ring (3) onto the nozzle (2).  
**Note:** the top of the nozzle ring should be above the nozzle seating surface. For P, Q, R and T Orifice Style JLT, position the nozzle ring per Table 2.
- 6.6.3 For bellows valves only, place the disc holder in a vise (larger sizes may require a 3 jaw vise) as shown in Figure 8. Install the tailpiece gasket (29). Screw the bellows assembly onto the disc holder. Tighten with a suitable wrench.
- 6.6.4 Assemble the disc insert (8) and the disc holder (5). [See Figure 14 for O-ring soft seat assembly]  
Install the disc insert retention clip (9) onto the disc insert.  
Install the disc insert into the disc holder. The disc insert should snap into place using handforce only.  
Safety precautions should be followed whenever heavy parts are being lifted or transported.  
Dropping disc holder assembly may dislodge the insert.
- 6.6.5 Assemble the disc holder (5) and guide (15) by sliding the guide over the disc holder.  
**Note:** the guide for D and E orifice valves protrudes up into the valve bonnet.
- 6.6.6 Install the two guide gaskets (28), one above and one below the guide.  
**Note:** when assembling bellows valves, the bellows flange eliminates the need for a bottom guide gasket.

- 6.6.7 While holding the top of the disc holder, install the guide into the body. Align the hole of the guide with the body outlet. Once the guide is seated, the disc holder and disc insert can be lowered onto the nozzle.  
**Note:** lower the nozzle ring below the seats so that it moves freely.
- 6.6.8 Place the spring (18) and washers (19) onto the spindle (16) and assemble the spindle to the disc holder (5) with the spindle cotter pins.  
**Note:** no cotter pins are required in D through K orifice sizes all other orifice sizes use two cotter pins.
- 6.6.9 Lower the bonnet (20) over the spindle and spring assembly onto the bonnet studs (21) in the body. Position the bonnet counter bore on the O.D. of the guide and lower the bonnet onto the guide.
- 6.6.10 Screw the bonnet nuts (22) onto the bonnet studs and tighten down evenly to prevent unnecessary strain and possible misalignment.
- 6.6.11 Screw the adjusting bolt (24) and nut (25) into the top of the bonnet to apply force on the spring. (The original set pressure can be approximated by screwing the adjusting bolt down to the predetermined measurement.)
- 6.6.12 Move the nozzle ring up until it touches the disc holder, then lower it two notches. This is a test stand setting only.
- 6.6.13 Place the set screw gasket (27) onto the set screw (4) and screw the set screw into the body engaging the nozzle ring. The nozzle ring should move back and forth slightly after the set screw is tightened.
- 6.6.14 The valve is now ready for testing.  
After testing, the following measures should be taken:
  - Be sure that adjusting bolt nut (25) is locked.
  - Return the nozzle ring to either the original recorded position or to the recommended position shown in Table 1.
  - Install the cap or lifting device. See Figure 13 for lifting lever assembly.
  - Seal the cap or lifting lever device and nozzle ring set screw to prevent tampering.

FIGURE 12  
Recommended lubrication points



## CROSBY STYLE JOS-E, JBS-E, JLT\*-JBS-E, JLT\*-JOS-E VALVES

### INSTALLATION AND MAINTENANCE INSTRUCTIONS

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#### 6.7 Assembly of cap and lifting lever devices

Styles JOS-E, JBS-E and JLT-E pressure relief valves are furnished with several different caps and lifting lever devices. The following describes assembly of the available types of cap construction.

(Disassembly is the reverse of assembly).

For part identification refer to Figure 13.

- Type A and J

Install the cap gasket and screw the cap onto the top of the bonnet. Tighten the cap with a strap wrench.

- Type B and K

Install the cap gasket and screw the cap onto the top of the bonnet. Tighten the cap with a strap wrench. Install the cap plug gasket and screw cap plug into the cap. The test rod is installed only during system hydrostatic testing. Never install the test rod unless performing system hydrostatic testing.

- Type C

Screw the spindle nut onto the spindle. Place the cap on the bonnet. Install the forked lever and forked lever pin. Attach the lever to the cap using the lever pin and secure with the lever pin cotter.

Adjust the spindle nut until the forked lever rests on the lever and there is a  $\frac{1}{16}$  inch minimum of play between the forked lever and the spindle nut. The spindle nut may be adjusted by removing the forked lever pin, forked lever and cap. When the spindle nut is in proper adjustment, install the spindle nut cotter pin. Replace the cap and forked lever and install the forked lever pin and forked lever pin cotter.

Position the lever opposite the valve outlet and install the four (4) cap set screws and tighten them against the groove in the top of the bonnet.

- Type D

Install the cap gasket on the bonnet. Screw the spindle nut onto the spindle. Place the dog in the cap and install the dog shaft so that the dog is horizontal and the square on the end of the dog shaft has a corner on top. With the dog shaft in the position above, scribe a horizontal line on the end of the dog shaft. This line must be horizontal when the lifting gear is finally installed on the valve. Install the dog shaft O-ring in the dog shaft bearing and place the dog shaft bearing gasket on the dog shaft bearing. Screw the dog shaft bearing into the cap. Rotate the dog shaft so that the dog is pointing down and install the cap assembly onto the bonnet. Rotate the dog shaft so that the dog contacts the spindle nut. With the scribed line horizontal, remove the assembly and adjust the position of the spindle nut. Repeat the operation until the scribed line is horizontal when the dog contacts the spindle. Remove the assembly and install the spindle nut cotter pin.

Install the lifting gear assembly onto the bonnet and secure it with cap studs and nuts. For Type D lifting levers that have two part caps (cap and cap top) the above procedure is more easily accomplished. After the cap is screwed to the bonnet, the positioning of the dog shaft is the same as above except that the positioning of the spindle nut is performed last through the open end of the cap. With the dog in the horizontal position, screw the spindle nut onto the spindle until it contacts the dog. Install the spindle nut cotter, cap top gasket and screw the cap top into the cap.

- Type E

Assembly of Type E lifting lever is identical to Type D with the addition of the cap plug gasket and cap plug. The test rod is installed only during system hydrostatic testing. Never install the test rod unless performing system hydrostatic test.

- Type G and L

Install the cap studs to the bonnet top. Place the cap gasket onto the bonnet and the cap onto the cap studs. Install and tighten cap stud nuts.

- Type H and M

Assembly of Type H and M is identical to Type G and L with the addition of the cap plug gasket and cap plug. The test rod is installed only during system hydrostatic testing. Never install the test rod unless performing system hydrostatic test.

#### 6.8 Soft seat construction

Coat O-ring with Parker Super O-Lube and place a small amount of Loctite 242 (or equivalent removable thread lock) onto retainer screw before assembly. Securely tighten retainer screw(s).

- O-ring soft seats

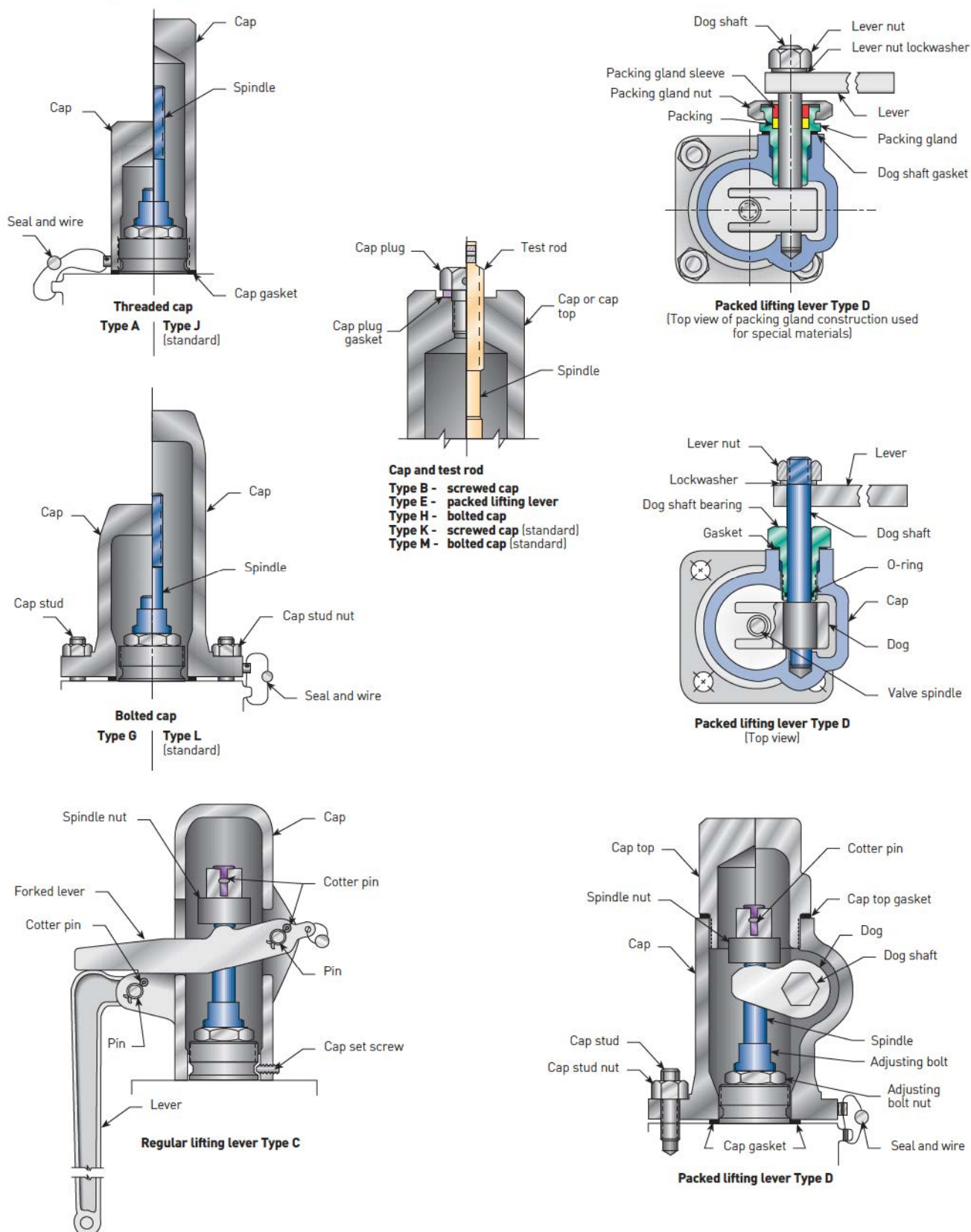
Crosby Style JOS-E/JBS-E metal-to-metal seated pressure relief valves may be converted to an O-ring soft seat by replacing the standard disc insert and nozzle with those parts designed to house the O-ring soft seat or vice versa.



# CROSBY STYLE JOS-E, JBS-E, JLT\*-JBS-E, JLT\*-JOS-E VALVES

## INSTALLATION AND MAINTENANCE INSTRUCTIONS

FIGURE 13 - Cap and lifting levers



# CROSBY STYLE JOS-E, JBS-E, JLT\*-JBS-E, JLT\*-JOS-E VALVES

## INSTALLATION AND MAINTENANCE INSTRUCTIONS

### 7 STYLE VARIATIONS

The Crosby Style JOS-E pressure relief valve was designed with flexibility and interchangeability in mind. Retrofitting from conventional to balanced bellows high performance liquid trim or soft seat design is accomplished with a minimum number of new parts. These style retrofits can be accomplished at lowest possible cost.

- **Balanced bellows**

A Crosby JOS-E conventional non-bellows pressure relief valve may be converted to a Style JBS-E balanced bellows valve simply by adding the bellows assembly and tailpiece gasket.

- **JLT Liquid Trim**

Crosby Style JOS-E/JBS-E pressure relief valves in D to N orifice sizes may be converted to high performance JLT liquid service design simply by replacing the standard disc holder with a JLT disc holder, or vice versa. For P to T orifice sizes, a new nozzle ring is also required.

- **O-ring soft seat design**

Crosby Style JOS-E and JBS-E pressure relief valves in all orifice sizes may be converted from the standard metal-to-metal seats to an exceptionally tight soft seat design. This style conversion can be accomplished by replacing the standard disc insert and nozzle with parts adapted to accommodate the soft seat design. The Crosby soft seat design uses standard size O-rings and is capable of handling pressures to 1480 psig. Standard O-ring materials include NBR, EPDM, FKM, Kalrez®, Silicone and PTFE. [See Figure 14 and Table 10].

### 8 SERVICE RECORDS

Service records should be completed before a valve is returned to service. These records are important and will provide guidance on establishing time intervals between repairs as well as providing the historical record of repairs and service conditions. Well kept records will be useful in predicting when to retire a valve and which spare parts should be maintained in inventory to ensure uninterrupted plant operation.

### 9 SPARE PARTS

When ordering spare parts, the valve shop number, assembly number, or serial number should be given together with set pressure, part name and item number, valve size and style. On the valve nameplate, the valve assembly number is shown as shop number. Spare parts may be ordered from any Pentair Valves & Controls Regional Sales Office or Representative.

### 10 TROUBLE SHOOTING PRESSURE RELIEF VALVES

Troubles encountered with pressure relief valves can vitally affect the life and performance of the valve and must be corrected at the first possible opportunity. Failure of a pressure relief valve to function properly could result in the rupture of a line or vessel jeopardizing the safety of personnel and causing damage to property and equipment. Some of the most common troubles and the recommended correction measures are discussed in the following paragraphs.

#### 10.1 Seat leakage

Of all the problems encountered with pressure relief valves, seat leakage is the most common and the most detrimental. A leaking valve allows fluids to circulate into the secondary pressure zone of the valve where it can cause corrosion of the guide and valve spring. When a leaking valve problem is not immediately addressed, the leakage itself will further contribute to seat damage through erosion (wire-drawing).

##### 10.1.1 Seats damaged by foreign matter

Seating surfaces may be damaged when hard foreign particles such as mill scale, welding spatter, coke and dirt are trapped between the seats. While this type of damage usually occurs while the valve is in service, it may also happen in the maintenance shop. Every precaution should be taken to clean the process system before installing a pressure relief valve and to test the valve using only clean fluids.

Damaged seating surfaces are generally reconditioned by lapping. Most often small pits and scratches may be removed by lapping alone. More extensive damage will also require remachining prior to lapping.

In some instances, valve construction can be changed to reduce the effects of seat leakage. The use of an O-ring soft seat when applicable will minimize leakage and thus eliminate the associated corrosion and erosion problems. If it is not possible to use a soft seated valve, or if the corrosive media is present in the exhaust system, conversion to a Style JBS bellows seated valve will isolate and protect the guides and valve spring from any corrosive fluids.

FIGURE 14

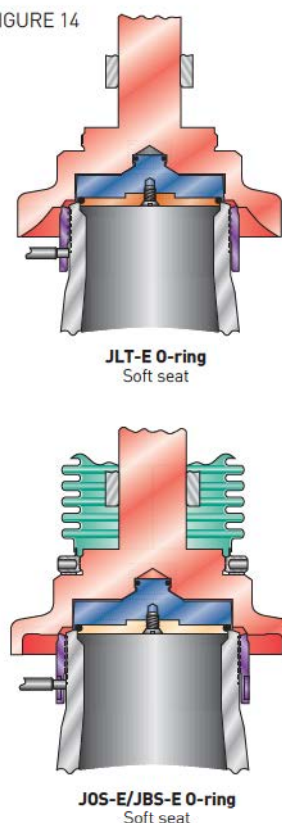


TABLE 10 - Soft seat O-ring sizes

Orifice	O-ring size
D, E	*2-013
	** 2-014
F	2-113
G	2-116
H	2-120
J	2-125
K	2-130
L	2-226
M	2-228
N	2-230
P	2-337
Q	2-346
R	2-352
T, T2	2-438

\* All elastomers

\*\* PTFE only



# CROSBY STYLE JOS-E, JBS-E, JLT\*-JBS-E, JLT\*-JOS-E VALVES

## INSTALLATION AND MAINTENANCE INSTRUCTIONS

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10.1.2 Distortion from piping strains  
Valve bodies can be distorted by excessive piping loads causing seat leakage. Both inlet and discharge piping must be properly supported and anchored so that high bending loads are not transmitted to the valve body.

10.1.3 Operating pressure too close to set pressure  
A carefully lapped metal-to-metal seated valve will be commercially tight at a pressure approximately ten percent under the set pressure or 5 psi, whichever is greater. Consequently, this minimum pressure differential should be maintained between set and operating pressure to avoid seat leakage problems.

10.1.4 Chatter  
Oversized valves, excessive pressure drop in the inlet lines, restrictions in the inlet line, too great a build up of back pressure or pulsating inlet pressure will cause instability to the pressure relief valve. In such installations, the pressure under the valve disc may be great enough to cause the valve to open, but as soon as flow is established, the pressure drops allowing the valve to immediately close. This cycle of opening and closing sometimes occurs at very high frequency causing severe seat damage, sometimes beyond repair. Proper valve selection and installation techniques are paramount to reliable valve performance.

10.1.5 Incorrectly adjusting lifting gear  
A space of  $\frac{1}{16}$  inch minimum should always be provided between the lifting device and the spindle lift nut. Failure to provide sufficient clearance may result in inadvertent contact causing a slight shift in the opening pressure.

10.1.6 Other causes of seat leakage  
Improper alignment of the spindle, too much clearance between the valve spring and the spring washers, or improper bearing contact between the adjusting bolt and the spring washers, spindle and disc holder or spindle and lower spring washer may cause seat leakage problems. Spindles should be checked for straightness and springs and spring washers should be properly fitted and kept together as a spring assembly.

10.1.7 Corrosion  
Corrosion may result in pitting of valve parts, failure of various valve parts, build up of corrosive products and general deterioration of the valve materials. Corrosive attack is generally controlled through selection of suitable materials or by employing a bellows seal to isolate the valve spring, adjusting bolt, spindle and guiding surfaces from the corrosive attack of the process fluid. Environmental corrosion attacks all exposed surfaces, including studs and nuts. In general, the materials required for a particular service are dictated by the temperature, pressure and the degree of corrosion resistance required.

### 11 PENTAIR VALVES & CONTROLS FIELD SERVICE AND REPAIR PROGRAMS FIELD SERVICE

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Pentair Valves & Controls field service provides on-site, in line testing and repair capability for all types of pressure relief devices.

#### 11.1 Parts

Pentair Valves & Controls will help you establish the right mix of on-site spares with Pentair Valves & Controls' own distribution and manufacturing support.

#### 11.2 Training

Crosby offers intensive factory or on-site seminars to improve maintenance and application skills.

#### 11.3 Testing

Pentair Valves & Controls has the capability to evaluate pressure relief valve operability either in the field or at various Pentair Valves & Controls facilities. Special qualifications programs may also be conducted in our laboratories.

#### 11.4 Contract management

Pentair Valves & Controls will combine a group of services to satisfy your special maintenance needs.

### WARNING

*The product is a safety related component intended for use in critical applications. The improper application, installation or maintenance of the product or the use of parts or components not manufactured by Crosby may result in failure of the product. The advice of a qualified engineer should be sought prior to any use of the product.*

*Any installation, maintenance, adjustment, repair or test performed on the product must be done in accordance with the requirements of all applicable codes and standards.*

*The information, specifications and technical data (the "Specifications") contained in this document are subject to change without notice. Crosby does not warrant that the specifications are current and assumes no responsibility for the use or misuse thereof.*

*The purchaser should verify that there have been no changes to the specifications prior to use.*



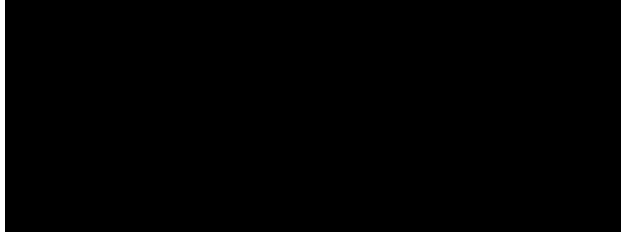
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# IMO - 209

Issue Date: 12/01

## INSTALLATION, MAINTENANCE, AND OPERATING INSTRUCTIONS



### SERIES 5H & 5HW VALUE-LINE® 1/4" – 2" (DN 6 – 50) 2-PIECE HIGH-PRESSURE BALL VALVES

Read entire instructions carefully before installation or servicing

## 1 GENERAL

This instruction manual contains important information regarding the installation, operation and troubleshooting of the Jamesbury Series 5H and 5HW *VALUE-LINE* 1/4" - 2" (DN 6 - 50) 2-Piece High Pressure Ball Valves. Please read these instructions carefully and save them for further reference.

### WARNING

FOR YOUR SAFETY AND PROTECTION, IT IS IMPORTANT THAT THE FOLLOWING PRECAUTIONS BE TAKEN PRIOR TO REMOVING THE VALVE FROM SERVICE OR BEFORE ANY DISASSEMBLY OF THE VALVE.

1. AT ALL TIMES DURING THIS ENTIRE PROCEDURE, KEEP HANDS OUT OF THE VALVE. A REMOTELY ACTUATED VALVE COULD CLOSE AT ANY TIME AND RESULT IN SERIOUS INJURY.
2. KNOW WHAT MEDIA IS IN THE LINE. IF THERE IS ANY DOUBT, CHECK WITH THE PROPER AUTHORITY.
3. WEAR ANY PROTECTIVE CLOTHING OR EQUIPMENT NORMALLY REQUIRED WHEN WORKING WITH THE MEDIA INVOLVED.
4. DEPRESSURIZE THE LINE AND VALVE AS FOLLOWS:
  - A. OPEN THE VALVE AND DRAIN THE LINE.
  - B. CLOSE AND OPEN THE VALVE TO RELIEVE ANY RESIDUAL PRESSURE THAT MAY BE IN THE VALVE PRIOR TO REMOVING THE VALVE FROM SERVICE. LEAVE THE VALVE IN THE OPEN POSITION.
  - C. AFTER REMOVAL AND PRIOR TO ANY DISASSEMBLY, DRAIN ANY REMAINING MEDIA BY PLACING THE VALVE IN THE VERTICAL POSITION AND CAREFULLY OPEN AND CLOSE THE VALVE SEVERAL TIMES.

5. SEAT AND BODY RATINGS - THE PRACTICAL AND SAFE USE OF THIS PRODUCT IS DETERMINED BY BOTH THE SEAT AND BODY RATINGS. READ THE NAME TAG AND CHECK BOTH RATINGS. THIS PRODUCT IS AVAILABLE WITH A VARIETY OF SEAT MATERIALS. SOME OF THE SEAT MATERIALS HAVE PRESSURE RATINGS THAT ARE LESS THAN THE BODY RATINGS. ALL OF THE BODY AND SEAT RATINGS ARE DEPENDENT ON VALVE TYPE AND SIZE, SEAT MATERIAL, BOLTING MATERIAL, AND TEMPERATURE. DO NOT EXCEED THESE RATINGS.

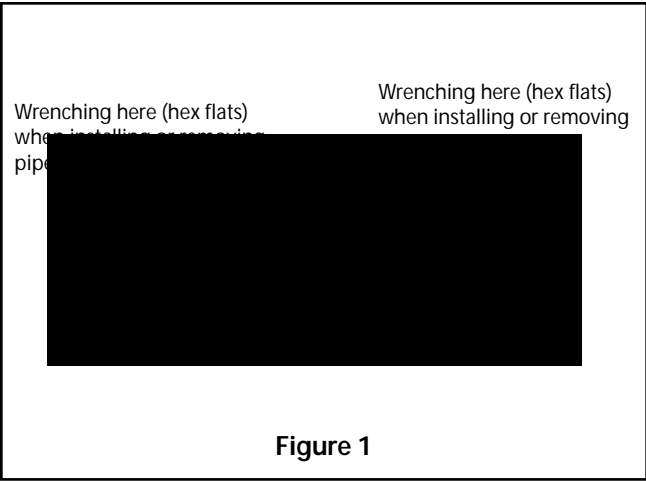
## 2 INSTALLATION

The valve may be installed for flow in either direction. It is recommended, however, that a screwed valve be installed with the body cap facing upstream. Screwed end valves have NPT threads. To insure a leaktight joint, liberal use of a compatible pipe joint compound is necessary. Figure 351 and 356 valves may be installed for flow in either direction. Use standard piping practices when installing valves with threaded parts. When tightening the valve to the pipe, apply the wrench to the end nearest the pipe being worked. Adjust packing prior to installation. See **MAINTENANCE** Section of this IMO. (See **Figure 1.**) Include compatible pipe fitting compound or PTFE tape.

## 3 MAINTENANCE

Periodically observe the valve to be sure of proper performance. More frequent observation is recommended under extreme operating conditions.

Routine maintenance consists of tightening the stem nut 1/4-turn periodically to compensate for the wear caused by the stem's turning against the resilient PTFE seal.

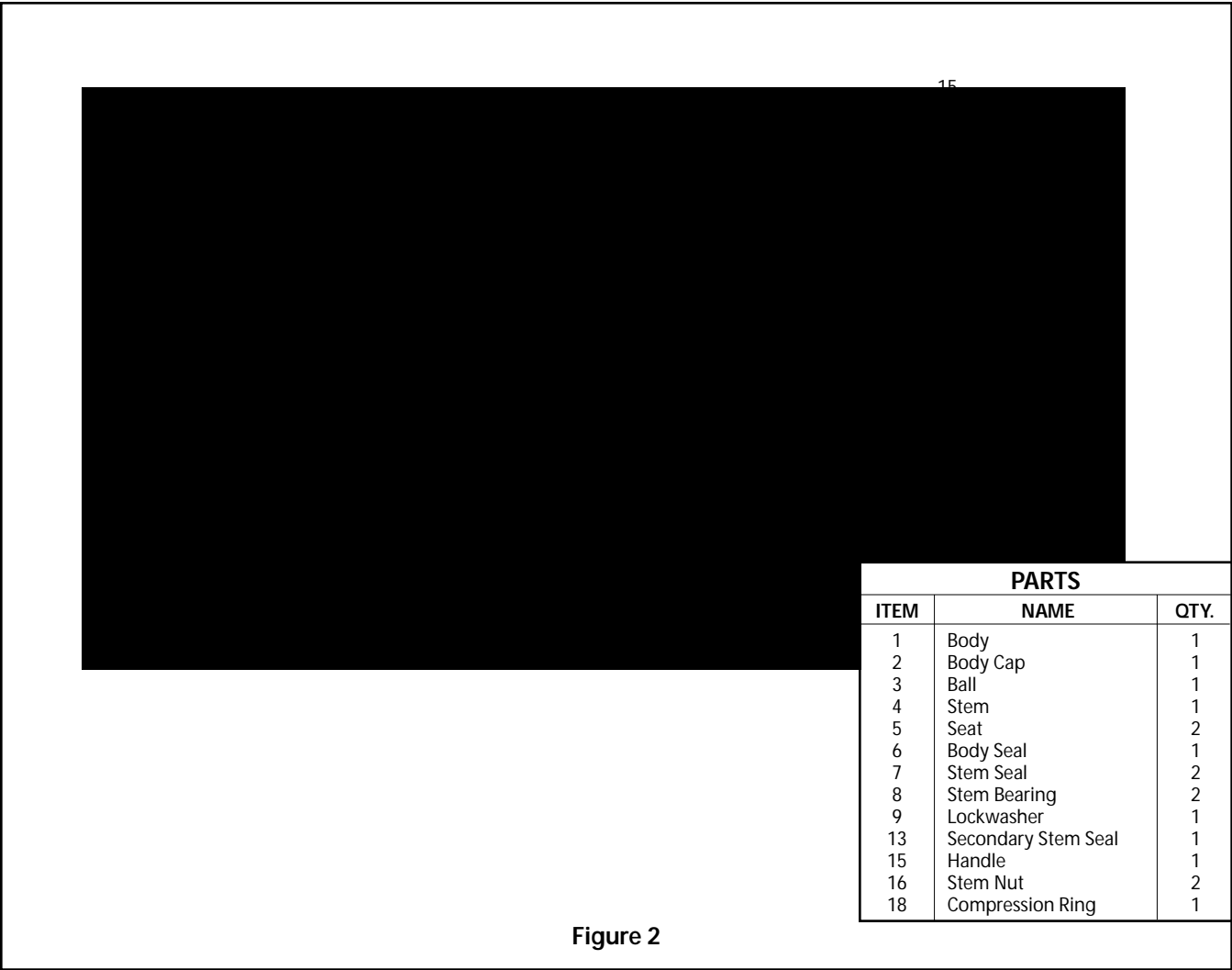


### 3.1 Disassembly

If complete disassembly becomes necessary, replacement of all seats and seals is recommended. Refer to Service Kit chart.

1. Remove the valve. Then remove the upper stem nut (16), lockwasher (9), handle (15), and lower stem nut (16). (See Figure 2.)

2. Remove the compression ring (18).
3. Unscrew and remove the body cap (2) and body seal (6). Heat may be required.
4. If the ball (3) and seats (5) do not fall from the body with the ball in the fully closed position, use a piece of wood or some other soft material to gently tap the ball (from the end opposite the body cap). This will unseat these parts without damaging the ball.
5. Press the stem (4) from the top into the valve body and remove it through the body cap end of the body.
6. Using a wire brush, clean the body cap thread and body threads to remove any excess thread lock.
7. Using a pointed instrument, pry out and discard the old stem seals (7), stem bearings (8), and *FIRE-TITE* bearing (13), if applicable. Be very careful not to scratch any sealing surfaces in the valve body (surfaces on which seats and seals rest).



### Figure 3

7. Insert second seat (5) into the body (1) so that the sealing surface of the seat is towards the ball. Insert the body seal (6).
8. Apply Loctite® 272 or equivalent, one bead 360° around the body cap (2) covering a minimum of two threads.
9. Insert the body cap (2), screw it down and tighten to the required torque, (**See Table 1 for Body Cap Torque specifications**).

<b>TABLE 1</b>		
<b>Service Data</b>		
<b>Valve Size</b>	<b>Body Cap Assembly Torque</b>	<b>Service Kit (DELFIN Seats)</b>
1/4" – 1/2" (DN 8 – 15)	100 lb.-ft. (136 Nm)	RKN-220-RT
3/4" (DN 20)	225 lb.-ft. (305 Nm)	RKN-221-RT
1" (DN 25)	225 lb.-ft. (305 Nm)	RKN-221-RT
1-1/4" (DN 30)	275 lb.-ft. (373 Nm)	RKN-222-RT
1-1/2" (DN 40)	350 lb.-ft. (475 Nm)	RKN-223-RT
2" (DN 50)	600 lb.-ft. (814 Nm)	RKN-224-RT

10. Place the handle (15), lockwasher (9), and stem nut (16) over the stem (4). Tighten the stem nut (16) until snug.
11. Cycle the valve slowly twice to ensure permanent position of the ball between the two seats.

## 4 SERVICE KITS

Service kits include two seats (5), two stem seals (7), two stem bearings (8), a secondary seal (13), and one body seal (6).

## 5 REPAIR KITS/SPARE PARTS

For further information on spare parts and service or assistance visit our web-site at [www.jamesbury.com](http://www.jamesbury.com)

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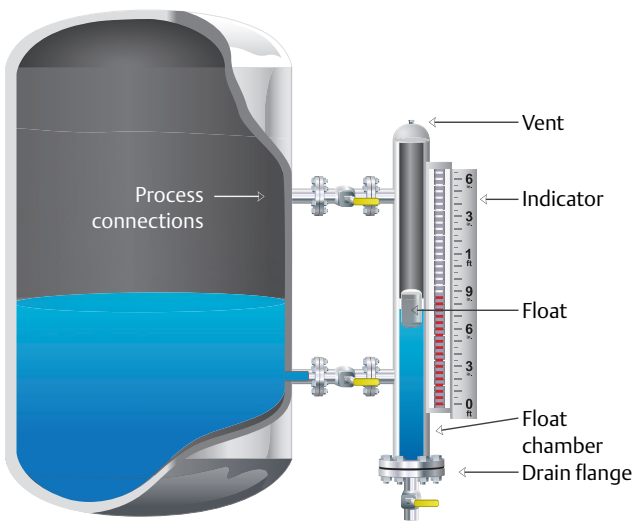
# Magtech™ Magnetic Level Indicators



- Visual level indication to 100 ft. (30 m)
- Designed to ASME B31.3 Process Piping Code. ASME B31.1 Power Piping Code is available upon request
- Minimal leak points as compared to sight glasses
- No process liquid in contact with indicator glass
- Designed for both gas/liquid (top level) and/or liquid/liquid (interface) measurements
- Optional construction is available for cryogenic, high-temperature, high-pressure, and corrosive applications
- Dual chamber design optimized for use with the Rosemount™ 5300, 3308, and 3300 Guided Wave Radars also available



# Overview



# Ordering Information

## Magtech Magnetic Level Indicator (MLI)



Specification and selection of product materials, options, or components must be made by the purchaser of the equipment, see Magtech Level Indicator [Quick Data Sheet](#). For more information on Material Selection see [page 15](#)

### Additional Information

Specifications: [page 15](#)

Dimensional Drawings: [page 17](#)

**Table 1. Magtech Magnetic Level Indicators Ordering Information**

Model	Product description					
L	Magnetic level indicator					
Measurement type <sup>(1)</sup>						
0	Liquid level (gas/liquid interface)					
2	Submerged interface (liquid/liquid interface)					
4	Flashing application (consult factory for model selection)					
Float selection						
Liquid level (gas/liquid interface) applications, measurement type code 0						
	Float material	Minimum SG	Float max. operating pressure in psig (bar) at 100 °F (37.8 °C)	Chamber size and schedule	“A” Dimension in inches (mm)	
76	316 Stainless steel	0.76	125 (8.6)	2-in. S10	12.0-in. (305 mm)	
78	316 Stainless steel	0.78	285 (19.7)	2-in. S10	12.0-in. (305 mm)	
81	316 Stainless steel	0.81	500 (34.5)	2-in. S10	12.0-in. (305 mm)	
58	316 Stainless steel	0.58	75 (5.2)	2½-in. S10	12.0-in. (305 mm)	
60	316 Stainless steel	0.60	135 (9.3)	2½-in. S10	12.0-in. (305 mm)	
62	316 Stainless steel	0.62	220 (15.2)	2½-in. S10	12.0-in. (305 mm)	
83	316 Stainless steel	0.83	285 (19.7)	2½-in. S10	12.0-in. (305 mm)	
86	316 Stainless steel	0.86	740 (51.0)	2½-in. S10	12.0-in. (305 mm)	
54	Titanium	0.54	125 (8.6)	2½-in. S10	12.0-in. (305 mm)	
59	Titanium	0.59	285 (19.7)	2½-in. S10	12.0-in. (305 mm)	
61	Titanium	0.61	740 (51.0)	2½-in. S10	12.0-in. (305 mm)	
68	316 Stainless steel	0.68	115 (7.9)	2½-in. S40	12.0-in. (305 mm)	
82	316 Stainless steel	0.82	175 (12.1)	2½-in. S40	12.0-in. (305 mm)	
87	316 Stainless steel	0.87	285 (19.7)	2½-in. S40	12.0-in. (305 mm)	
88	316 Stainless steel	0.88	740 (51.0)	2½-in. S40	12.0-in. (305 mm)	

Table 1. Magtech Magnetic Level Indicators Ordering Information

	Float material	Minimum SG	Float max. operating pressure in psig (bar)	Chamber size and schedule	"A" Dimension in inches (mm)	
40	316 Stainless steel	0.40	50 (3.5)	3-in. S10	18-in. (457 mm)	
69	Titanium	0.69	2300 (158.6)	2 1/2-in. S40	16-in. (406 mm)	
63	Titanium	0.63	2300 (158.6)	2 1/2-in. S40	20-in. (508 mm)	
45	Titanium	0.45	2100 (144.8)	3-in. S10	20-in. (508 mm)	
55	Titanium	0.55	2100 (144.8)	3-in. S40	14-in. (356 mm)	
49	Titanium	0.49	2100 (144.8)	3-in. S40	17-in. (432 mm)	
46	Titanium	0.46	2100 (144.8)	3-in. S40	20-in. (508 mm)	
41	Titanium	0.41	2100 (144.8)	3-in. S40	25-in. (635 mm)	
74	Titanium	0.74	3400 (234.4)	3-in. S80	20-in. (508 mm)	
67	Titanium	0.67	3400 (234.4)	3-in. S80	25-in. (635 mm)	
85	Titanium	0.85	3400 (234.4)	3-in. S160	16-in. (406 mm)	
73	Titanium	0.73	3400 (234.4)	3-in. S160	20-in. (508 mm)	
64	Alloy 400	0.64	90 (6.2)	3-in. S10	12-in. (305 mm)	
80	C-276	0.80	135 (9.3)	2-in. S10	12-in. (305 mm)	
89	C-276	0.89	425 (29.3)	2-in. S10	12-in. (305 mm)	
<b>Submerged interface (liquid/liquid interface) measurement type code 2</b>						
	Float material	Minimum delta SG	Float max. operating pressure in psig (bar) at 100 °F (37.8 °C)	Chamber diameter and schedule	"A" Dimension in inches (mm)	
37	316 Stainless steel	0.37	450 (31.0)	2-in. S10	12-in. (305 mm)	
21	316 Stainless steel	0.21	740 (51.0)	2 1/2-in. S10	12-in. (305 mm)	
23	316 Stainless steel	0.23	175 (12.1)	2 1/2-in. S40	12-in. (305 mm)	
10	316 Stainless steel	0.10	50 (3.5)	3-in. S10	12-in. (305 mm)	
28	Titanium	0.28	2300 (158.6)	2 1/2-in. S40	12-in. (305 mm)	
20	Titanium	0.20	2300 (158.6)	2 1/2-in. S40	12-in. (305 mm)	
15	Titanium	0.15	2100 (144.8)	3-in. S10	12-in. (305 mm)	
14	Titanium	0.14	2100 (144.8)	3-in. S40	12-in. (305 mm)	
11	Titanium	0.11	2100 (144.8)	3-in. S40	12-in. (305 mm)	
30	Titanium	0.30	3400 (234.4)	3-in. S80	12-in. (305 mm)	
29	Titanium	0.29	3400 (234.4)	3-in. S160	12-in. (305 mm)	
38	C-276	0.38	135 (9.3)	2-in. S10	12-in. (305 mm)	
13	Alloy 400	0.13	90 (6.2)	3-in. S10	12-in. (305 mm)	

Table 1. Magtech Magnetic Level Indicators Ordering Information

Mounting style (see <a href="#">Figure 1</a> for mounting options or consult factory for custom mounting)		
A	Style A - Flanged top and bottom, with stop plates, no side process connection	
B	Style B - Access flange on top and bottom with side process connections	
C	Style C - Access flange on bottom, flanged bottom with side(s) process connection	
D	Style D - Access flange on top, flanged top, closed bottom with side(s) process connection	
L	Style L - No float access flanges, with or without side(s) process connection	
Instrument rating		
AA	ANSI/ASME B16.5 Class 150	
AB	ANSI/ASME B16.5 Class 300	
AC	ANSI/ASME B16.5 Class 600	
AD	ANSI/ASME B16.5 Class 900	
AE	ANSI/ASME B16.5 Class 1500	
AF	ANSI/ASME B16.5 Class 2500	
Access flange type		
0	Not applicable (Style L only)	
1	Raised Face (RF) Weld Neck	
2	RF Slip-On	
3	RF Socket Weld	
4	Ring Type Joint (RTJ) Weld Neck	
5	RTJ Slip-ON	
6	RTJ Socket Weld	
Indicator scale unit of measure		
E	Imperial (English), inches	
M	Metric, millimeters	
Mounting dimension (center-to-center for style B, C, D, L and top-to-bottom for style A) <sup>(2)</sup>		
XXXXX	XXX.XX inches or XXXXX mm	04863 = 48.63 inches or 4863 mm
Chamber material		
S	316/316L Stainless steel (standard)	
1	317 Stainless steel	
2	321 Stainless steel	
7	347 Stainless steel	
X	Special (consult factory)	

Table 1. Magtech Magnetic Level Indicators Ordering Information

Side process connection design			
D	Drill (1/2-in. hole)		
F	Drill (full bore) <sup>(2)</sup>		
E	Extrusion (limited to chamber size S10 or S40 with 1 1/2-in. or 2-in. NPS process connection size) <sup>(2)</sup>		
T	Buttweld Tee (ASME B16.9)		
N	None (Style A)		
X	Special (consult factory)		
Process connection size (NPS)			
0	Same diameter as chamber (Style A only)		
8	1/2-in.		
9	3/4-in.		
1	1-in.		
5	1 1/4-in.		
6	1 1/2-in.		
2	2-in.		
7	2 1/2-in.		
3	3-in.		
4	4-in.		
X	Special (consult factory)		
Process connection rating		Process connection type	
ZZ	Same as instrument rating (Style A only)	Z	
AA	ANSI/ASME B16.5 Class 150	1, 2, 3, 4, Y	
AB	ANSI/ASME B16.5 Class 300	1, 2, 3, 4, Y	
AC	ANSI/ASME B16.5 Class 600	1, 2, 3, 4, Y	
AD	ANSI/ASME B16.5 Class 900	1, 2, 3, 4, Y	
AE	ANSI/ASME B16.5 Class 1500	1, 2, 3, 4, Y	
AF	ANSI/ASME B16.5 Class 2500	1, 2, 3, 4, Y	
FA	ANSI/ASME B16.11 Class 3000	A, C, E, G, H, K, L	
FB	ANSI/ASME B16.11 Class 6000	A, C, E, G, H, K, L	
FC	ANSI/ASME B16.11 Class 9000	A, C, E, G, H, K, L	
SA	ANSI/ASME B16.9 STD	M, P, N	
SB	ANSI/ASME B16.9 XS	M, P, N	
SC	ANSI/ASME B16.9 XXS	M, P, N	



Table 1. Magtech Magnetic Level Indicators Ordering Information

Process connection type		Process connection rating	
Z	Same as access flange (Style A only)	ZZ	
1	RF Weld neck	AA, AB, AC, AD, AE, AF	
2	RF Slip-on	AA, AB, AC, AD, AE, AF	
3	RF Socket weld	AA, AB, AC, AD, AE, AF	
4	RTJ Weld neck	AA, AB, AC, AD, AE, AF	
5	RTJ Slip-on	AA, AB, AC, AD, AE, AF	
6	RTJ Socket weld	AA, AB, AC, AD, AE, AF	
Y	Raised face lap joint (RFLJ)	AA, AB, AC, AD, AE, AF	
A	Nipple - Plain end	FA, FB, FC	
C	Nipple - Male NPT	FA, FB, FC	
E	Coupling - Female NPT	FA, FB, FC	
G	Coupling - SW	FA, FB, FC	
H	Fitting	FA, FB, FC	
K	Fitting	FA, FB, FC	
L	Fitting	FA, FB, FC	
M	Fitting - Plain End	SA, SB, SC	
P	Fitting - Beveled End (37.5°)	SA, SB, SC	
N	Fitting - Male NPT	SA, SB, SC	
Process connection schedule <sup>(3)</sup>			
0	Same schedule as chamber (Style A only)		
1	S10		
4	S40		
8	S80		
6	S160		
Process connection material			
0	Same Material as Chamber		
S	316/316L Stainless steel (standard)		
2	321 Stainless steel		
7	347 Stainless steel		
4	304/304L Stainless steel		
1	317 Stainless steel		
C	Carbon steel		
X	Special (consult factory)		

Table 1. Magtech Magnetic Level Indicators Ordering Information

Top of the chamber		
B	Blind flange	
D	Dome cap	
F	Flat cap	
Z	Open flange with stop plate	
X	Special (consult factory)	
Top vent size		
0	No top vent	
8	1/2-in.	
9	3/4-in.	
1	1-in.	
X	Special (consult factory)	
Top vent type		
Z	No top vent	
A	NPT tap only with Plug	
C	SW tap only	
D	Flanged	
F	Coupling - FNPT with Plug	
H	Coupling - SW	
K	Fitting - Plain End	
M	Fitting- Male NPT End	
X	Special (consult factory)	
Top vent schedule or rating		
Z <sup>(4)</sup>	No top vent	
1	S10	
4	S40	
8	S80	
6	S160	
3	Class 3000	
5	Class 6000	
Bottom of the chamber		
B	Blind flange	
D	Dome cap	
F	Flat cap	

**Table 1. Magtech Magnetic Level Indicators Ordering Information**

Z	Open flange with stop plate	
X	Special (Consult Factory)	
<b>Bottom drain size</b>		
0	No bottom drain	
8	1/2-in.	
9	3/4-in.	
1	1-in.	
<b>Bottom drain type</b>		
Z	No bottom drain	
A	NPT tap only with plug	
C	SW tap only	
D	Flanged	
F	Coupling - FNPT with plug	
H	Coupling - SW	
K	Fitting- Plain end	
M	Fitting- Male NPT end	
X	Special (consult factory)	
<b>Bottom drain schedule or rating</b>		
Z	No bottom drain	
1	S10	
4	S40	
8	S80	
6	S160	
3	Class 3000	
5	Class 6000	
<b>Indicator</b>		
F	Flag	
B	Follower (birdie/shuttle)	
<b>Measuring range<sup>(5)</sup></b>		
XXXXX	XXX.XX inches or XXXXX mm	04863 = 48.63 inches or 4863 mm
<b>Scale units</b>		
Z	Feet and inches (1/2-in. increments)	
A	Metric (5 mm increments)	
B	Percentage (custom increments)	

**Table 1. Magtech Magnetic Level Indicators Ordering Information**

C	Inches only (1/2-in. increments)	
D	+/- (custom increments)	
E	Dual (feet and inches, percent)	
F	Dual (metric, percent)	
<b>Indicator enclosure material</b>		
0	Anodized aluminum housing with glass	
1	Anodized aluminum housing with polycarbonate	
2	Anodized aluminum housing with acrylic frost extension	
3	Stainless steel housing with glass	
4	Stainless steel housing with polycarbonate	
5	Stainless steel channel with glass tube	
6	Stainless steel channel with polycarbonate tube	
<b>Indicator indicator color</b>		
Z	Red and silver flags	
A	Red and white flags	
C	Yellow and black flags	
B	Red follower	
D	Green follower	
<b>Indicator mounting (see <a href="#">Figure 2</a>)</b>		
Z	Standard orientation (180° from process connections)	
R	Right mount	
L	Left mount	
C	Customer specified	
<b>Typical model number: L 0 76 C AA 1 E 03600 S E 6 AA 1 1 S D 8 Z Z B 8 Z Z F 03600 Z 0 Z Z</b>		

1. For flashing applications please consult factory.
2. Maximum mounting dimension per single unit is 20 ft. (6 m) for Style A and 18 ft. (5.5 m) for Style B/C/D.
3. Process connection schedule needs to be equal or greater than the chamber schedule.
4. Must select for Top Vent type Z Option Z.
5. Should be equal to or smaller than the Mounting dimension. Please provide datum offset using Magtech Level Indicator [Quick Data Sheet](#).

## Order options - must be specified at time of order

### Test and inspection

- Hydrostatic pressure test
- Weld inspection
- NDE (non-destructive examination)

### Documentation

- Approval and as-built drawings
- Weld procedures and welder qualifications
- Quality control plans
- Material Traceability Record (MTR)
- Float curves

### Accessories

- Valves (vent and drain)
- Insulation blanket
- Steam trace
- Heat trace
- Hard shell cryogenic insulation with frost protection
- Chamber support clips

## Associated products

- Dual chamber unit with Guided Wave Radar
- Switches
- Magnetostrictive transmitter



Table 2. Process Connection Rating

	ANSI/ASME B16.5						ANSI/ASME B16.11			ANSI/ASME B16.9		
Process connection style	150	300	600	900	1500	2500	3000	6000	9000	STD	XS	XXS
RF Weld Neck	X	X	X	X	X	X						
RF Slip-on	X	X	X	X	X	X						
RF Socket Weld	X	X	X	X	X	X						
RTJ Weld Neck	X	X	X	X	X	X						
RF Lap Joint (RFLJ)	X	X	X	X	X	X						
Fitting - Plain End							X	X	X			
Fitting - Male NPT							X	X	X			
Coupling - Female NPT							X	X	X			
Coupling - SW							X	X	X			
Fitting							X	X	X			
Fitting							X	X	X			
Fitting							X	X	X			
Fitting - Plain End										X	X	X
Fitting - Beveled End (37.5)										X	X	X
Fitting - Male NPT										X	X	X

Figure 1. Mounting Styles

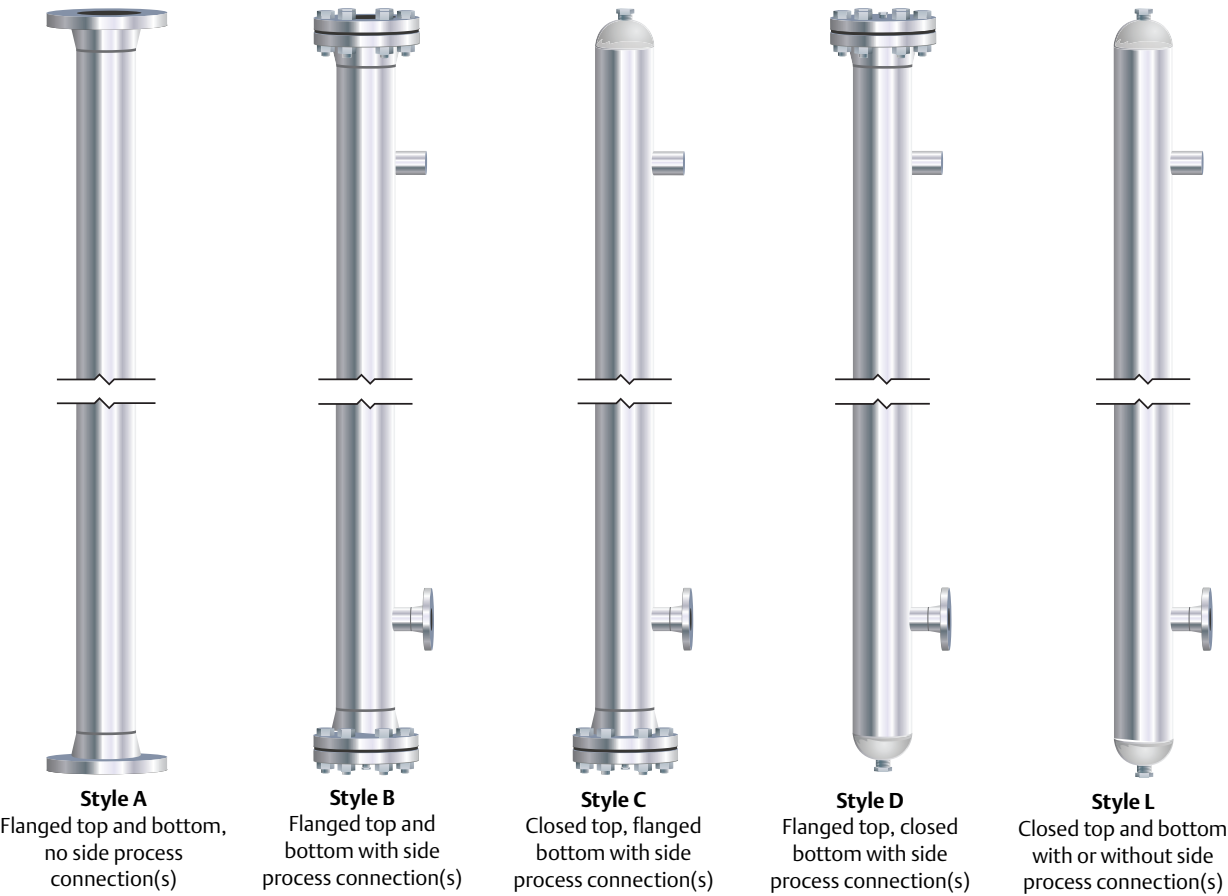
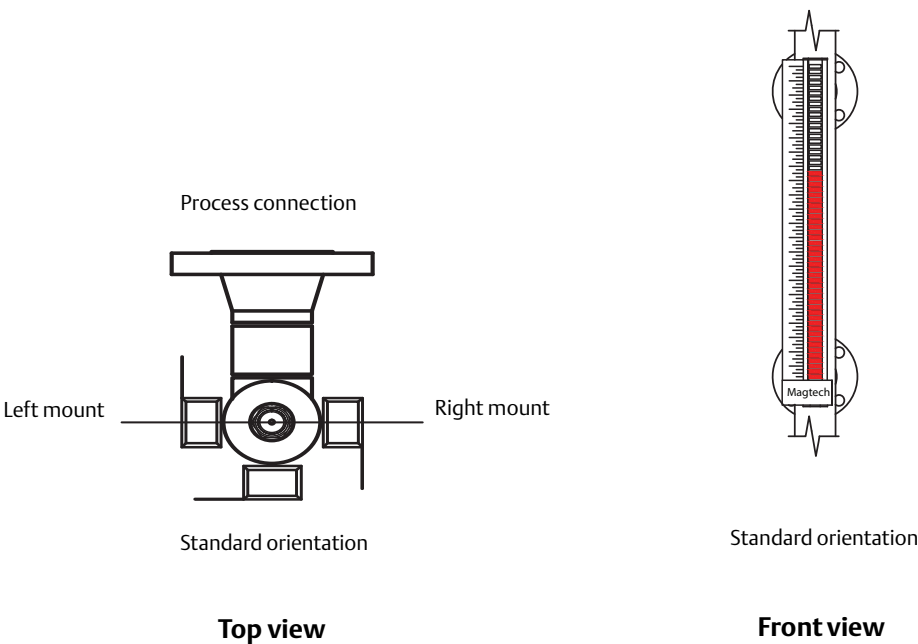


Figure 2. Indicator/Scale Orientation



# Specifications

## Performance specifications

### Resolution

Approximately 1/4 -inch resolution

### Measuring range

Maximum mounting dimension per single unit is 20 ft. (6 m) for Style A and 18 ft. (5.5 m) for Style B/C/D.

### Maximum viscosity

2000 cP

### Minimum Specific Gravity (SG)

0.40 (consult factory for lower specific gravities)

### Minimum delta SG

0.11

## Functional specifications

### Temperature rating

850 °F (454 °C)

### Float Pressure rating

Up to 4000 psig (275.8 bar) at 100 °F (38 °C)

### Visual indicator

Visible from 100 ft (30 m)

### Indicator options

- Flag (standard)
- Follower (optional)

## Physical specifications

### Material selection

Emerson™ provides a variety of products with various options and configurations including materials of construction that can be expected to perform well in a wide range of applications. The 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.

### Chamber design options

Designed to ASME B31.1 or B31.3, or CRN (all provinces). Welding and welder qualification in accordance with ASME Section IX.

- ASME B31.3
- ASME B31.1
- CRN Registration (all provinces)

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### Note

Welding and welder qualifications in accordance with ASME Section IX.

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### Process connection sizes

1/2-in. to 4-in.

### Materials of construction

#### Chamber

- 300 Series stainless steel (standard 316/316L)
- Optional: Other non-ferrous materials that do not exhibit ferro-magnetic properties such as Alloy C-276, CB20, Alloy 600, Alloy 400, T-321 stainless steel, CPVC, and Kynar.

#### Float

- 316 stainless steel
- Titanium
- Alloy 400
- Alloy C-276
- Special options: Kynar, CPVC, PTFE coating

#### Indicator viewing window

Glass or polycarbonate

#### Gasket

All gauges are shipped complete with 0.125-in. composition gaskets for protection of flanges. Customer is responsible for process compatible gaskets for protection of flanges.

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#### Note

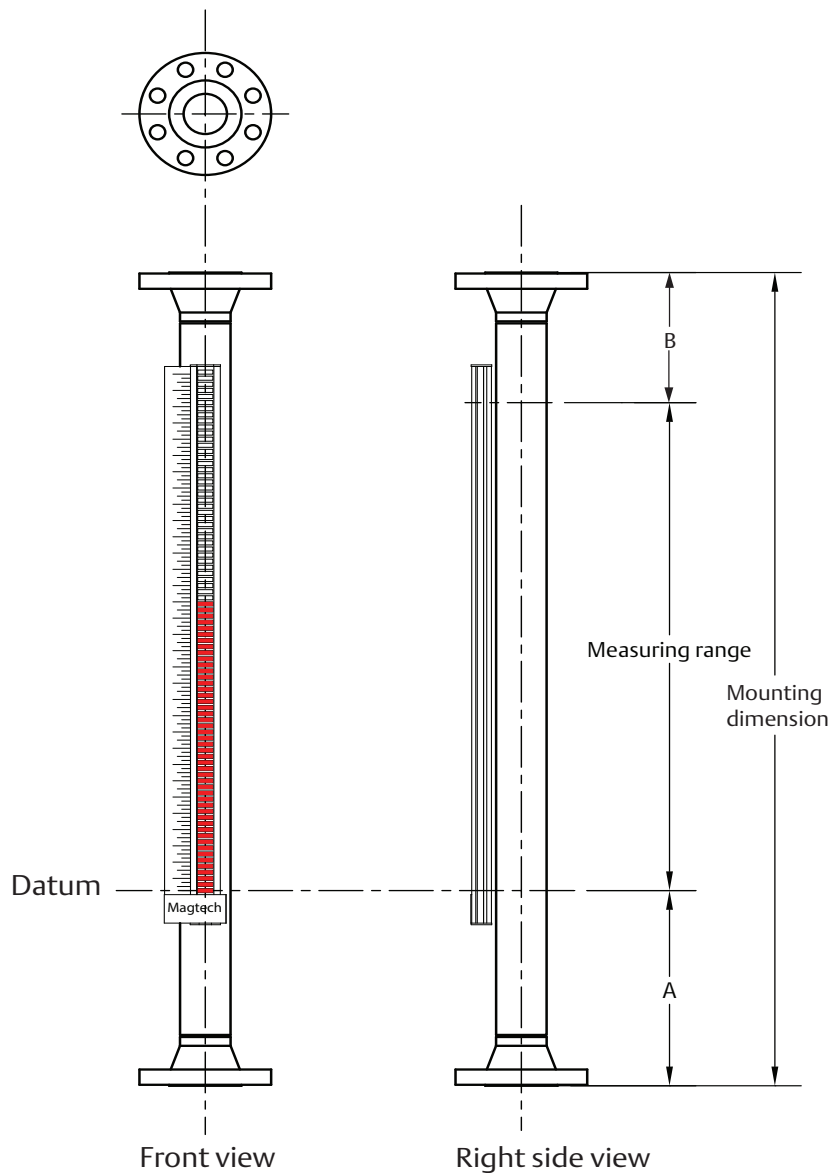
If composition gaskets are not compatible with your process conditions, appropriate gaskets should be used in place of those shipped with the gauge.

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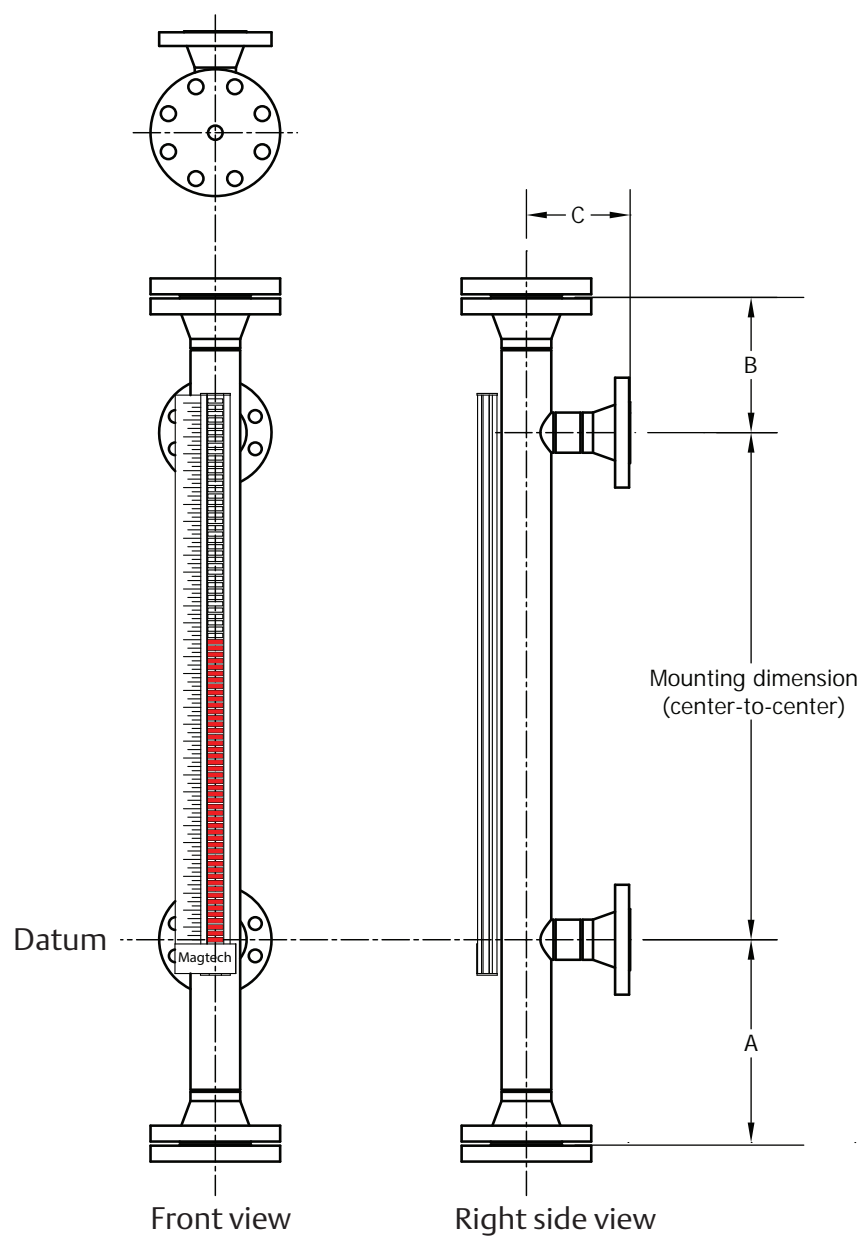
# Dimensional Drawings

Figure 3. Standard MLI - style A



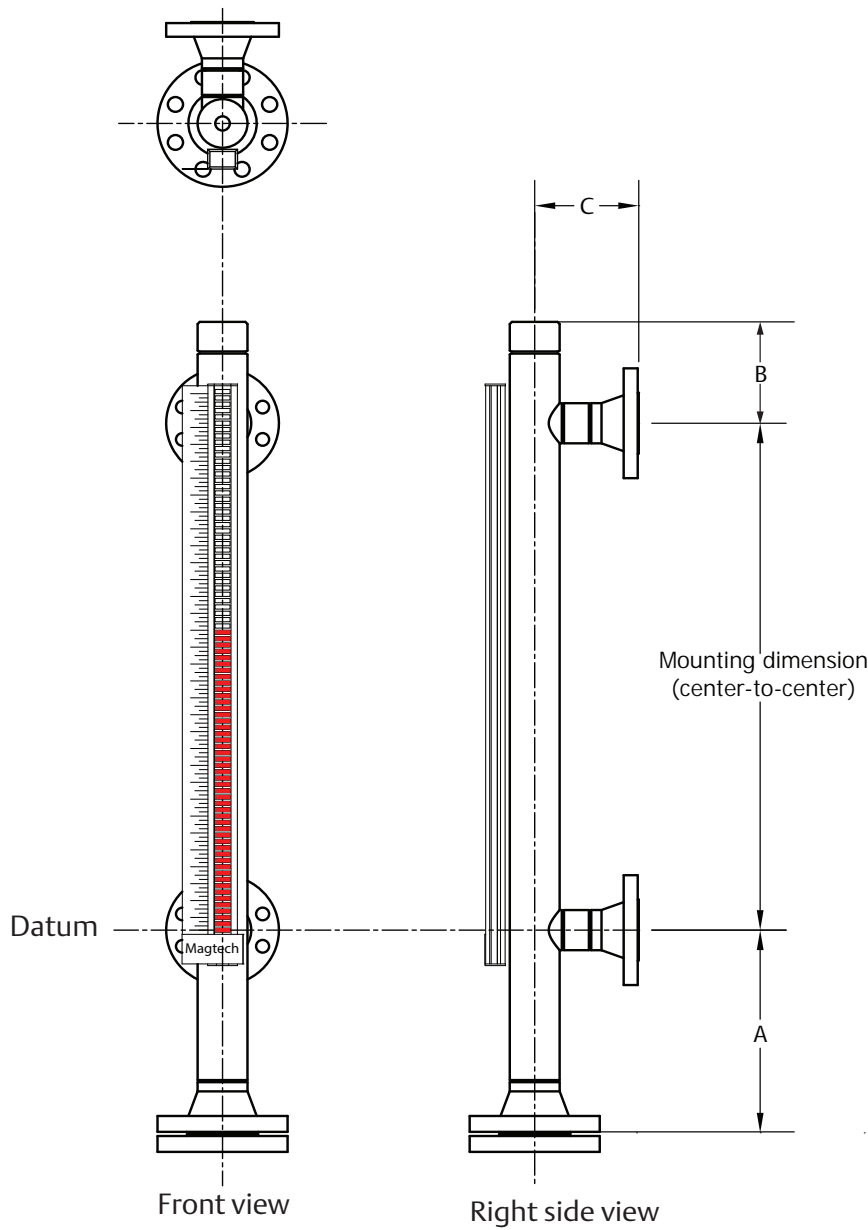
**Note**  
For reference use only. Do not use for construction purposes or as built unless certified by Magtech. Drawing is generic - see [Table 1](#) for detailed options.

Figure 4. Standard MLI - style B



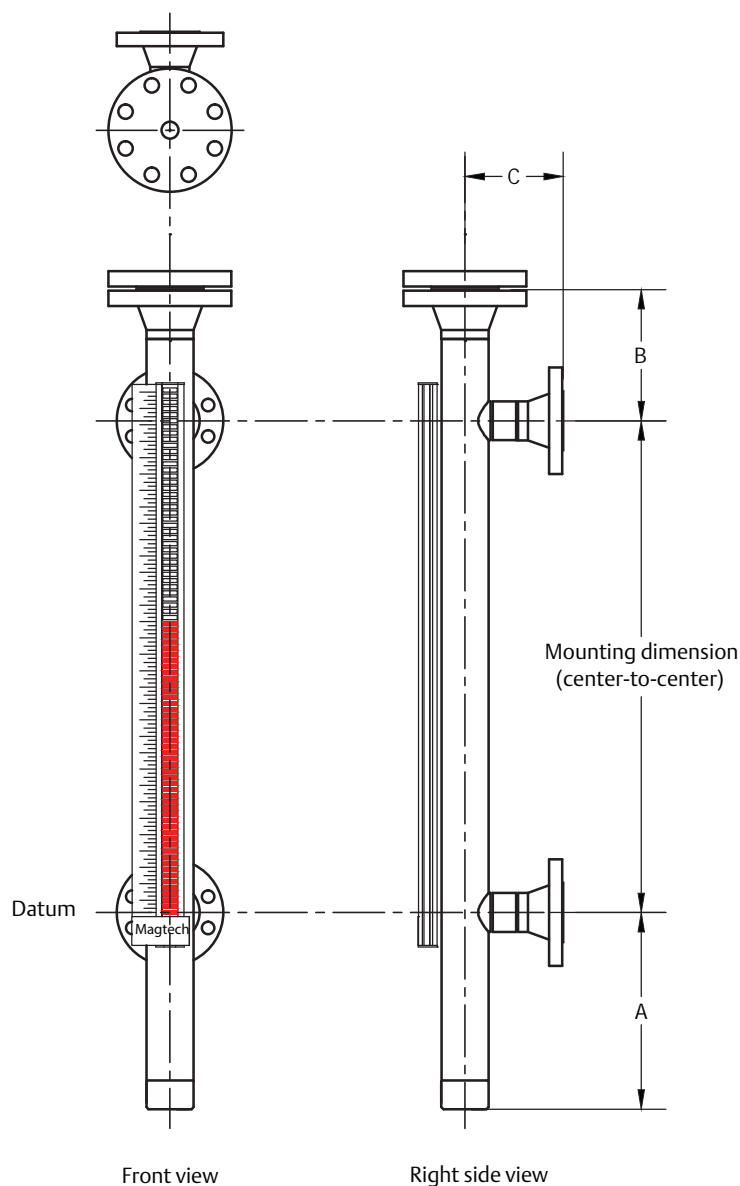
**Note**  
For reference use only. Do not use for construction purposes or as built unless certified by Magtech. Drawing is generic - see [Table 1](#) for detailed options.

Figure 5. Standard MLI - style C



**Note**  
For reference use only. Do not use for construction purposes or as built unless certified by Magtech. Drawing is generic - see [Table 1](#) for detailed options.

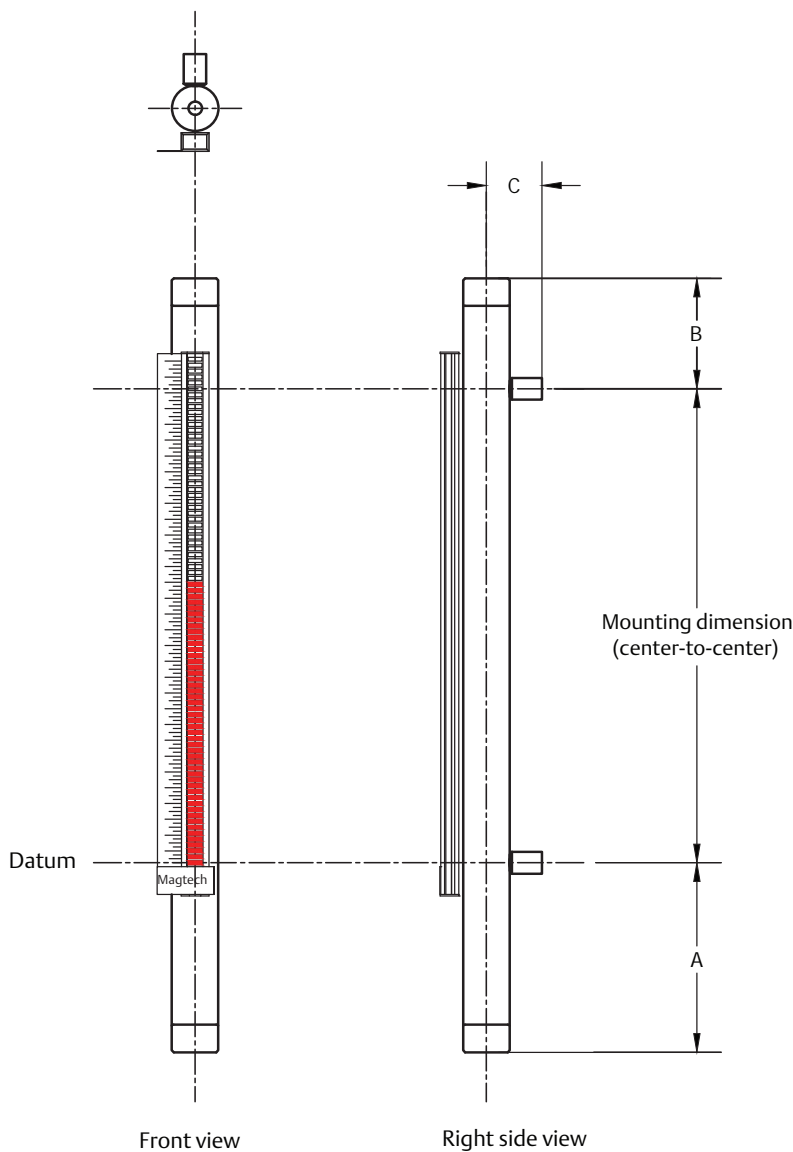
Figure 6. Standard MLI - style D



**Note**

For reference use only. Do not use for construction purposes or as built unless certified by Magtech. Drawing is generic - see [Table 1](#) for detailed options.

Figure 7. Standard MLI - style L



**Note**  
For reference use only. Do not use for construction purposes or as built unless certified by Magtech. Drawing is generic - see [Table 1](#) for detailed options.






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## LTM – Series

Models: LTM-250 and LTM-350  
Magnetostrictive Level Transmitters



# Instructions & Operation Manual

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## Icon Key



Warning/Caution Valuable Operation Information



Important Information to Know



Read Carefully these Tips are the “DON'Ts” of the instrument.

## Section

# 1

## Warranty

### 1.0 Warranty

All Magtech products are warranted against defects in materials and workmanship for a period of no less than one year from the date of shipment. The level gage chamber and process connections are guaranteed for the life of the tank or vessel to which it is attached. Floats are guaranteed for two years. **Magtech will repair or replace at its discretion those products that fail to perform as specified**, with the following exceptions:

1. Products repaired or modified by persons that are not authorized by Magtech.
2. Products subjected to misuse, negligence or accidents.
3. Products that are connected, installed, or otherwise used in such a way not in strict accordance with manufacturer's instructions.

This warranty is in lieu of any other warranty expressed or implied by any party other than Magtech. Repairs and/or replacements shall be at the sole discretion of Magtech based on the terms and conditions of this warranty. Defective products shall be returned to the factory prepaid by the buyer after obtaining a Return Authorization Number from Magtech. All warranty repairs or replacements will be performed at the factory in Pearland, Texas. Surface return freight will be paid by Magtech. Factory warranties do not include field service. Field service warranty repairs will be at the buyer's expense. Consult Magtech for field service rates.

Any modifications to terms and condition of this warranty will not be binding unless made in writing and signed by an authorized agent or official of Magtech.



**All Magtech gages and transmitters should be unpacked and thoroughly inspected upon receipt. Gages are shipped FOB factory and are fully protected against damage or loss during shipment. Any claims for parts damaged during shipment should be submitted within 15 days of receipt of goods by customer.**



**We value your opinion and want to better serve you. Please go our website: [www.isemagtech.com](http://www.isemagtech.com) and click the customer feedback survey option (on the left side of the screen). Some of the best suggestions for improvement come from our valued customers. Let us know how we are doing and what we can do better to improve your satisfaction with our product and service.**

## Transmitter Overview

## 2.0 General Description

The LTM-Series are 2-wire electronic field instruments, suitable for installation in hazardous and non-hazardous locations. Testing and certification has been obtained from different agencies for installation in such areas. This instrument is designed to measure and transmit an analog and/or digital signal proportional to liquid level in a tank. The complete assembly includes an explosion-proof enclosure and attached sensor tube and a magnetic float. The LTM-Series are available in a variety of lengths and wetted materials to accommodate many different applications.

## 2.1 Product Identification

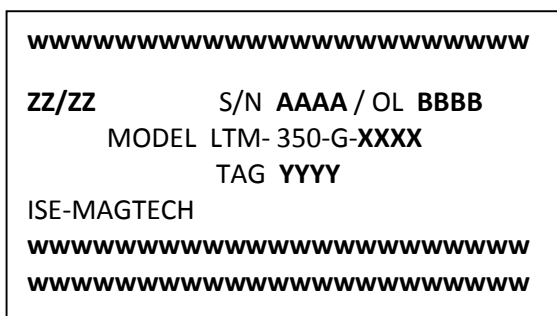


Figure 1. Example label/name plate

The product can be identified by the stainless steel label that is located on the side of the transmitter enclosure/housing.

The label can be read as follows:

**www** = Any hazardous location area classification markings that the instrument is approved for.

**ZZ/ZZ** = Born on date; the 2 digit month and 2 digit year the instrument was shipped to the customer.

**AAAA** = The specific serial number assigned by Magtech for complete traceability.

**BBBB** = The overall probe length of the instrument.

**Note:** THIS IS NOT THE MEASURING RANGE.

**XXXX** = The measuring range of the instrument.

The 0 and 100% (4/20mA) output range.

**YYYY** = The end user specified tag number (only when specified).

## 2.2 Transmitter Configurations

LTM-Series transmitters generally have two configurations:

1. **Gage Mounted:** Where the transmitter is mounted on the outside of a magnetic level gage and strategically located within a certain longitudinal distance from the transmitter sensor probe and a magnetic float is placed inside the level gage.
2. **Standalone (or Direction Insertion Type):** Where the transmitter has a magnetic float directly around the transmitter sensor probe and the probe is directly inserted into a tank/vessel.

In either configuration as the tank level changes, the float tracks the change and continuously activates the sensor probe. The electronics process the change in signal and output an analog and/or digital signal. This output is precisely the liquid level in the tank.



**Magtech is always willing to explore unique applications that require their own distinctive configurations. Please consult the factory for guidance.**



## 2.3 Gage Mounted Transmitter

The LTM-Series may be strapped to the outside of the Magtech LG series magnetic level gage. In such an installation, it is used as an accessory transmitter for the visual level gage. The same float used to activate the magnetic gage is also used to activate the magnetostrictive sensor of the LTM and transmit a directly proportional 4/20mA signal.

The depiction below shows the gage mount installation of the LTM-Series to a mag-gage. The transmitters may be calibrated for the same range as the visual indicator on the mag-gage, or for part of the range depending on the application.

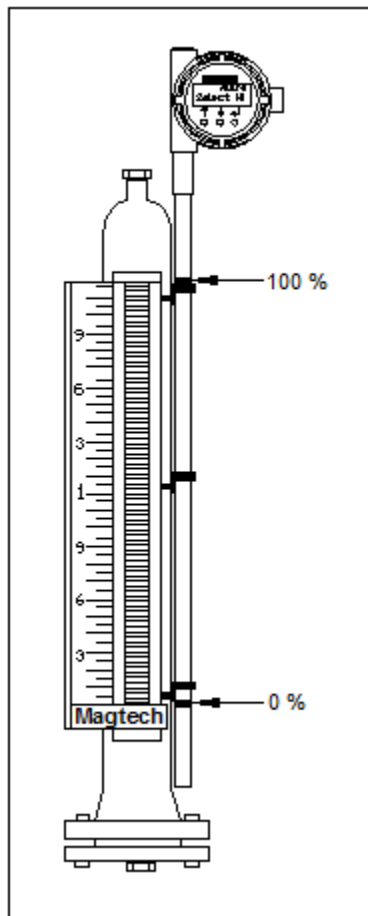


Figure 2. Gage mounted transmitter



Magtech transmitters may also be used in conjunction with other manufacturers' magnetic level gages. Full warranties will apply upon factory approval. Float and or Indicator replacement may be required.

## 2.4 Standalone Transmitter

When a magnetic level gage is not present, the LTM can be inserted into the tank/vessel with its own float mounted around the sensor tube.

The depictions below show the standalone version of the LTM-Series with various process connections and the standard float stop with centering ring.

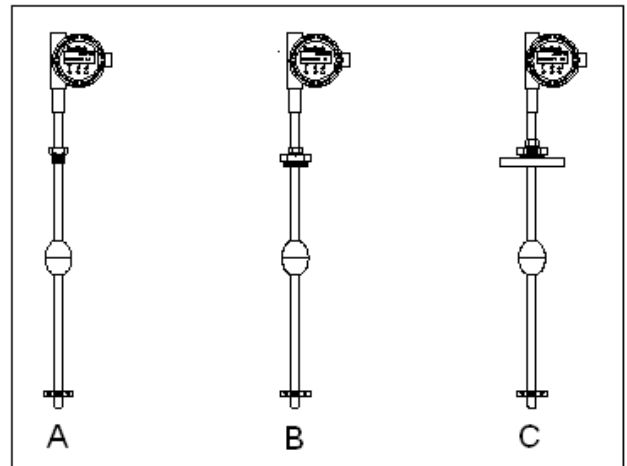


Figure 3. Transmitters with various process connections.

In Figure 3:

**Transmitter A** depicts a standard  $\frac{3}{4}$ " compression fitting that is on all standalone transmitters.

**Transmitter B** depicts a  $\frac{3}{4}$ " compression fitting and a hex plug. This option is highly recommended because the hex plug is selected based on the float's diameter (OD), so if the instrument ever needs to be removed or serviced for any reason it can be removed by the hex plug.

**Transmitter C** depicts a flanged option with a  $\frac{3}{4}$ " compression fitting and a hex plug.

A stilling well may be used along with the transmitter inside the tank. Stilling-well is a pipe external to the sensor probe and float encasing the entire assembly protecting it from surface agitation or from physical damage due to the length of the sensor probe. A depiction of a transmitter with a stilling well is provided below.

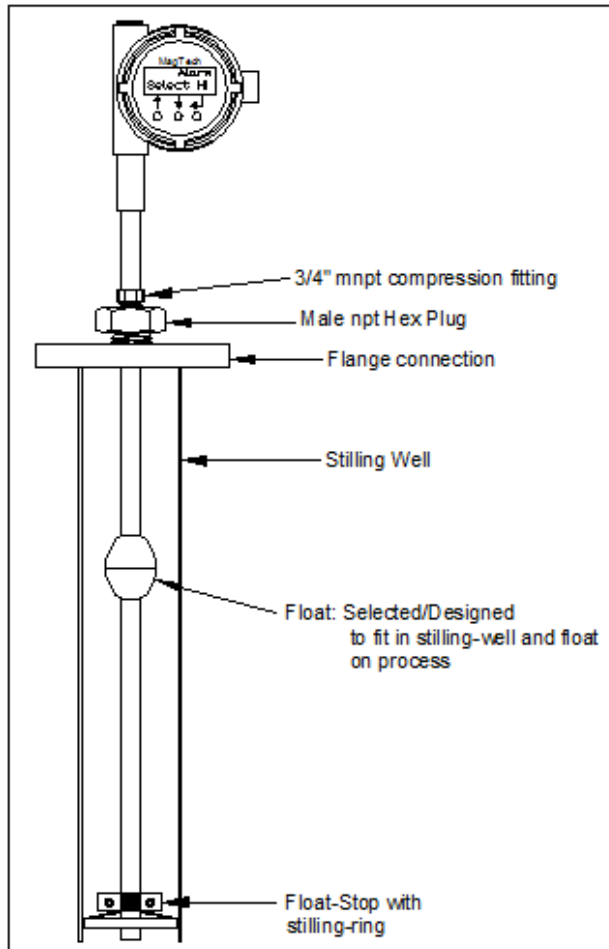


Figure 4. Transmitter with a Stilling-well



When a stilling well is used, care should be exercised when installing the tube to center it in the chamber so that the float can freely travel the entire length of the probe. **Stilling wells are required for transmitters over 10 feet or the instrument cannot be considered under warranty.**

Optional Features that are available with the LTM-350 but **NOT the LTM-250** are:

1. HART Protocol, which enables:
  - a. A second digital output proportional to an interface level (requires a second float of different specific gravity)
  - b. A digital temperature output that reflects the liquid temperature.
  - c. Advanced diagnostics and features highly beneficial for commissioning, troubleshooting or monitoring.

Up to two floats may be used with the LTM-350 only. The second float will typically sense the interface level (the heavier of the two fluids) in the tank. The specific gravity of the second float will be such that it can be totally immersed in the lighter fluid. The drawing below shows a transmitter with dual floats, one for total level and the other for interface level (also available with various process connections).

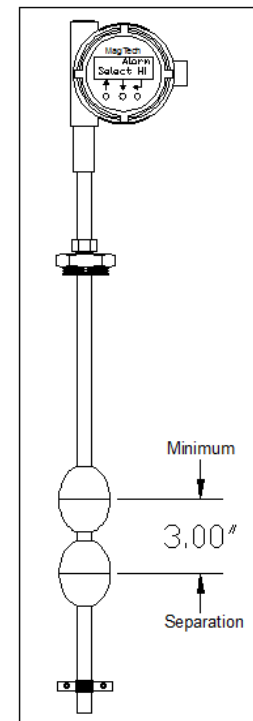


Figure 5. Dual Output Transmitter



**A dual output transmitter is also available in a gage mount configuration. Consult factory for further details.**

## Section 3

# Transmitter Description

### 3.0 Detailed Description

The LTM-Series is an assembly of two major components:

**The Sensor Tube Assembly:** This is a 5/8" diameter stainless steel probe, sealed on one end, with the magnetostrictive waveguide in its center. In addition to the magnetostrictive waveguide, the tube also houses the optional temperature sensor and the sensing elements. The tube is made to lengths of 2-30ft. in rigid construction.

**The Enclosure and Electronics:** The extruded aluminum housing has two compartments. The enclosure is rated NEMA 4X and 7. One side contains the microprocessor board assembly and calibration push buttons. The other side contains the field wiring termination board. The electronics module is connected to the detector board of the sensor tube assembly via a plug-in cable. The electronics module houses printed circuit boards (PCB) that encompass surface mount component construction utilizing the latest integrated circuit technology.



Magtech also has a stainless steel enclosure that can be utilized. Please contact factory for further details.

### 3.1 Technology – Theory of Operation

The LTM-250/350 series level transmitters are based on the principle of magnetostriction, first used for digital delay lines and later precision distance or displacement in the machine tool industry. This principle, if designed and applied properly, has potentially very high measurement resolution, typically better than 0.001 inch. In the machine tool industry such a high resolution is desirable. In the level measurement application, however, a resolution of 0.03 inch is more than adequate.

In a brief description, the magnetostrictive principle consists of a wire extruded and heat treated under carefully chosen conditions to retain desired magnetic properties, which is pulsed by a circuit with a relatively high current pulse. The high current pulse produces a circular magnetic field as it travels down the wire at the speed of sound. Another magnetic field generated by a permanent magnet (the float), placed near or around the wire at some distance from the point of entry of this pulse interferes with the magnetic field of the current pulse and a torsional force results at the collision point.

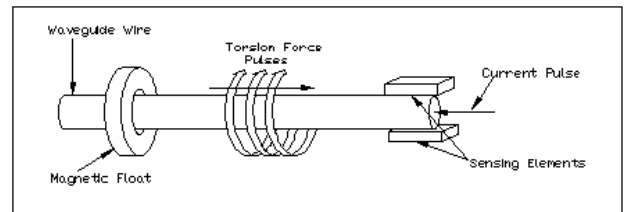


Figure 6. Principle of Operation

The effect of this torsion force is a twist to the wire at this point producing torsion wave traveling towards both ends of the wire. The propagation time (or time-of-flight) of this wave is measured precisely and if the wire properties remain stable, it is very repeatable at about 5-10 microseconds per inch, which is approximately the speed of sound in that medium. By measuring the exact number of microseconds it took the torsion wave to reach a designated termination point of the wire, the distance to the magnet from this termination point can be easily calculated.

A high-speed microcontroller is utilized in the design to process and calculate the elapsed time measurement. Accurate crystals are used for the time based to resolve sub-microsecond timing increments. The binary number, equivalent to the microseconds of the echo travel time is used to calculate the distance of the float and a corresponding digital signal is output. A basic block diagram describing the operation is shown below.

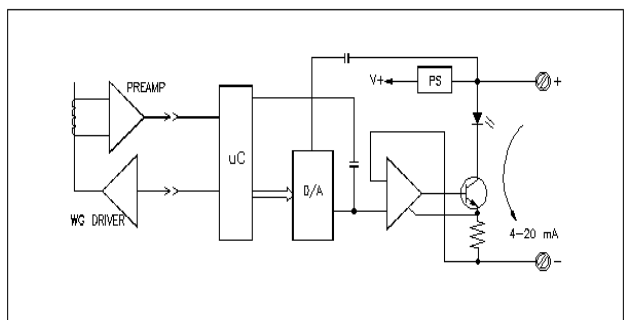


Figure 7. Basic Transmitter Block Diagram

Calibration routines are included in the software to the 0% and 100% points for any distance desired. Even reverse calibration is a simple task using the software routines. Reverse calibration is desirable if ullage instead of level is required, or when the probe is installed with bottom mount electronics.

The **LTM-350** transmitter has four output configurations.



**Configuration options must be chosen at quoting stage.**

- 1. Primary Level** – The most basic version of this transmitter is that it computes the distance between the float and the detector from the elapsed time measurement. A specific interrogation pulse is applied to the waveguide. Any feedback signal received before and after this window is rejected as noise. Even signals received during the active window are evaluated and filtered so that only high integrity data is accepted. The conditioned signal is converted to a percent of full-scale number and a number representing the distance and output as a digital signal. (LTM-250/350)



**LTM-350, via HART protocol only.**

- 2. Primary Level and Interface Level** – A second float may be added below the first, and the second output will be calibrated automatically. The second time interval is timed in the same manner as the first one and added to the first to derive the position of the heavier float. The two floats require a separation of approximately three inches. The float size, geometry, and magnetic strength all play a factor in how close the two floats can be without interfering with each other.
- 3. Primary Level and Temperature** – An optional temperature sensor is embedded inside the bottom tip of the probe, and it is configured to be the third digital output of the transmitter, and comes factory calibrated for the operating range of -50C to 149C (-58F to 300F)
- 4. Primary Level, Interface Level, and Temperature** – This options is called a ‘full-blown’ unit and offers all three possible outputs.



**A deadband of approximately three inches, next to the detector, is fixed in the software and the float is not permitted to enter this area. If this happens output readings maybe erratic or go to fail mode.**

## Section 4

# Installation

### 4.0 Gage Mount Installation

The LTM-Series can be mounted to the side of a Magtech LG series level gage using special mounting brackets and stainless steel hose clamps. When mounting the transmitter to an LG series gage the active sensor region of the probe should fall within the centerline of the process connections on the gage. If the transmitter's deadband region is inside the centerline of the process connections the transmitter will not output an accurate measurement because the active region of the probe is too short. When placing an order for a transmitter to accompany an existing gage it is important to indicate the style of the gage, the temperature, and the center-to-center dimension.

**Calibration of the probe is factory set to the center-to-center dimensions provided;** however a re-ranging may have to be performed to match the probe to the desired control room specifications. See Section 7.1 "Change Range" for more details.

### 4.1 Standalone Installation

The LTM-Series standalone transmitter comes equipped with a  $\frac{3}{4}$ " mnpt compression fitting, mounted approximately 3 to 6 inches below the electronics housing. The fitting is placed in this area to ensure the transmitter is calibrated in the sensor tubes active region. Refer to the standalone drawings for a visual description of the transmitter features. Optional configurations are available upon request (2" mnpt, flanges, etc...). The magnetic float used in the stand-alone unit is designed to travel up the sensor tube with the change in fluid level. If build-up of process or contaminates should restrict the movement of the float, the transmitter sensor tube will have to be cleaned or the float may have to be replaced with one that has a larger inside diameter. The floats are designed to match the pressure and specific gravity for the process being measured and come in various materials ranging from stainless to kynar. The magnetic float can be changed out at any time to accommodate the processes being measured. The float stop, located at the bottom of the

transmitters, can be removed to allow the float to slide off the sensor tube.

### 4.2 General Installation Guidelines

The basic steps to installing the LTMs are:

- 1. Inspection of equipment:** Inspect the parts that are listed on the packing slip. Make sure nothing appears to be damaged such as a broken glass from the level indicator assembly (flippers), damaged float, or a damaged transmitter. Please file a claim with the shipping company immediately if it is believed the shipment has arrived damaged and be prepared to provide pictures.



**The sensor probe of the transmitter SHOULD NOT BE BENT, BOWED, OR KINKED in any way or the transmitter will not work (will most likely go into fail mode).**

The following is a depiction of **damaged probes**:

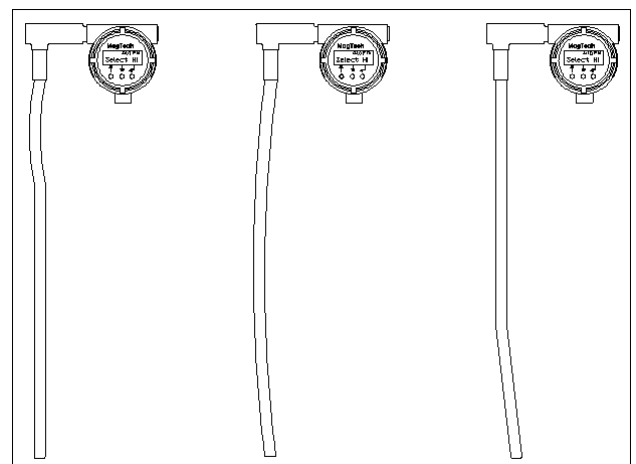


Figure 8. All damaged sensor probes

## 2. Identify Proper Orientation of Transmitter:

There are a few possible orientations of the LTM Series transmitters, they are:

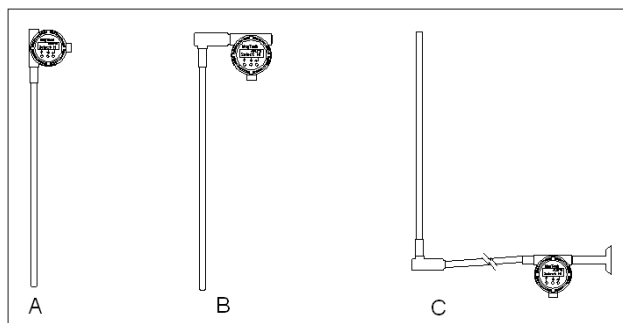


Figure 9. Possible transmitter configurations

**Transmitter A** is a standard top mount configuration.

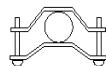
**Transmitter B** is a top mount with elbow, usually utilized when there are temperature or head room issues. There is also a bottom mount with elbow configuration which is not depicted.

**Transmitter C** is a bottom mount transmitter with remote electronics. This configuration is utilized in more extreme temperatures or for accessibility. There is also top mount with remote electronics which is not depicted.

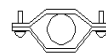
- 3. Mounting the Transmitter.** Align the 4/20 mA (or 0 and 100%) markings with the center of the top and bottom process connection. Mount the transmitter along the level gage and use a nut driver to tighten the clamps so the sensor probe of the transmitter is held securely (will not slip up and down). Keep the transmitter supported while the clamps are being tightened (this can require more than one person).



**Do not over tighten the clamps because they will bend and distort.**



A: Correct



B: Incorrect



C: Incorrect

Figure 10. Top view of mounting clamps and sensor probe

**A: Is the correct way to have clamps tightened.**



**The clamps do not have to meet.**

**B: Is incorrect** because the clamp is flipped around and will not grip the sensor probe.

**C: Is incorrect** because the clamp has been tightened too much and damaged/distorted.



Effects of high vibration can be minimized early on by notifying the factory at time of order. The electronics can be remote mounted and special insulators can be installed. Please see the depiction below.

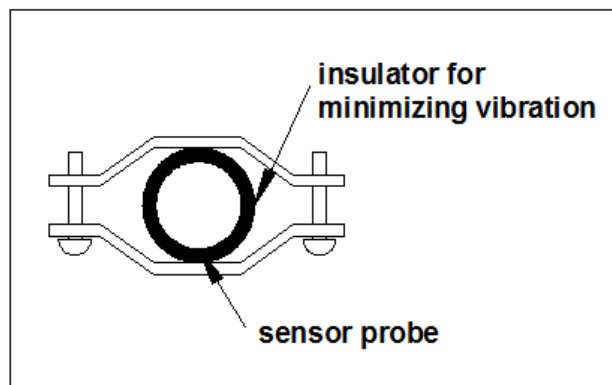


Figure 11. Insulator for high vibration



4. **Remote Mount Electronics Option.** Due to process temperature, vibration or accessibility the housing/electronics of the LTM transmitter can be remote mounted as far as 25 ft. The housing/electronics are supplied with a pipe-mount bracket that can be mounted most nearby posts or pipes with hose clamps. The drawing below depicts a gage mounted transmitter in the top mount remote electronics configuration.

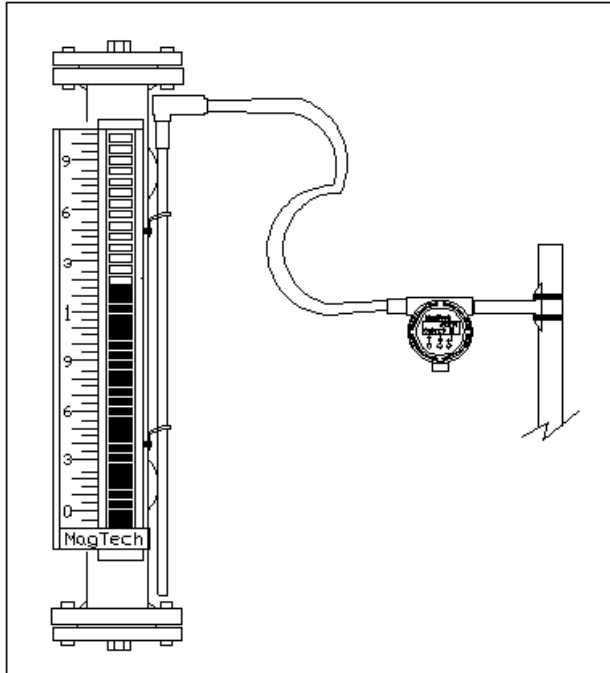


Figure 12. Gage mount transmitter in the top mount remote electronics configuration.



There are a variety of ways to install a standalone transmitters (i.e. crane, lift, etc...), the basic rule to remember when installing an LTM transmitter is **DO NOT DAMAGE the sensor probe**, this will void the warranty. If damage is suspected please contact the factory and be prepared to provide pictures.



In **REMOTE MOUNT** electronic options please support the sensor probe at the elbow/condulet and then every 3 feet (depending on length of cable). Support at every 2 feet may be required if explosion proof conduit is utilized by the end user.



**NEVER** install the sensor probe inside an insulation blanket that may be around the level gage. This will overheat the sensor probe and cause failure.



**NEVER** bend, bow or cause a kink in the sensor probe, this will damage the instrument and void the warranty. Do not attempt to straighten the sensor probe, this will not help the instrument work. If the shipment arrives damaged please file a claim with the shipping company and contact the factory to arrange for a replacement.

### 4.3 Insulation (against extreme heat/cold)

Magtech strongly recommends that an experienced Magtech Technician do insulation of the magnetic level gages at the factory 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.**



#### **(When insulating gages):**

Magtech level transmitters have a maximum operating temperature of 300 F. When insulating a mag-gage and transmitter assembly in HOT service, keep the transmitter **OUTSIDE** the insulating material. Special blankets for this type of insulation are available from Magtech, and recommended to guarantee proper insulation. For further information consult the factory.

If insulation is going to be done in the field, then the following guidelines **MUST** be followed:

1. Flexible type insulation jackets (NOT HARD SKIN) are required and must be installed around the mag-gage chamber only. **DO NOT** cover the LTM sensor tube, as this may burn up the sensor and possibly the electronics.
2. After the insulation jacket is installed, the LTM sensor tube must be remounted 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).
3. Make sure that the 0% and 100% (4/20mA) marking on the sensor tube are re-aligned at the centers of the process connections.

# Section 5

## Field Wiring

### 5.0 Recommended Loop Wiring

The following is the recommended loop wiring.

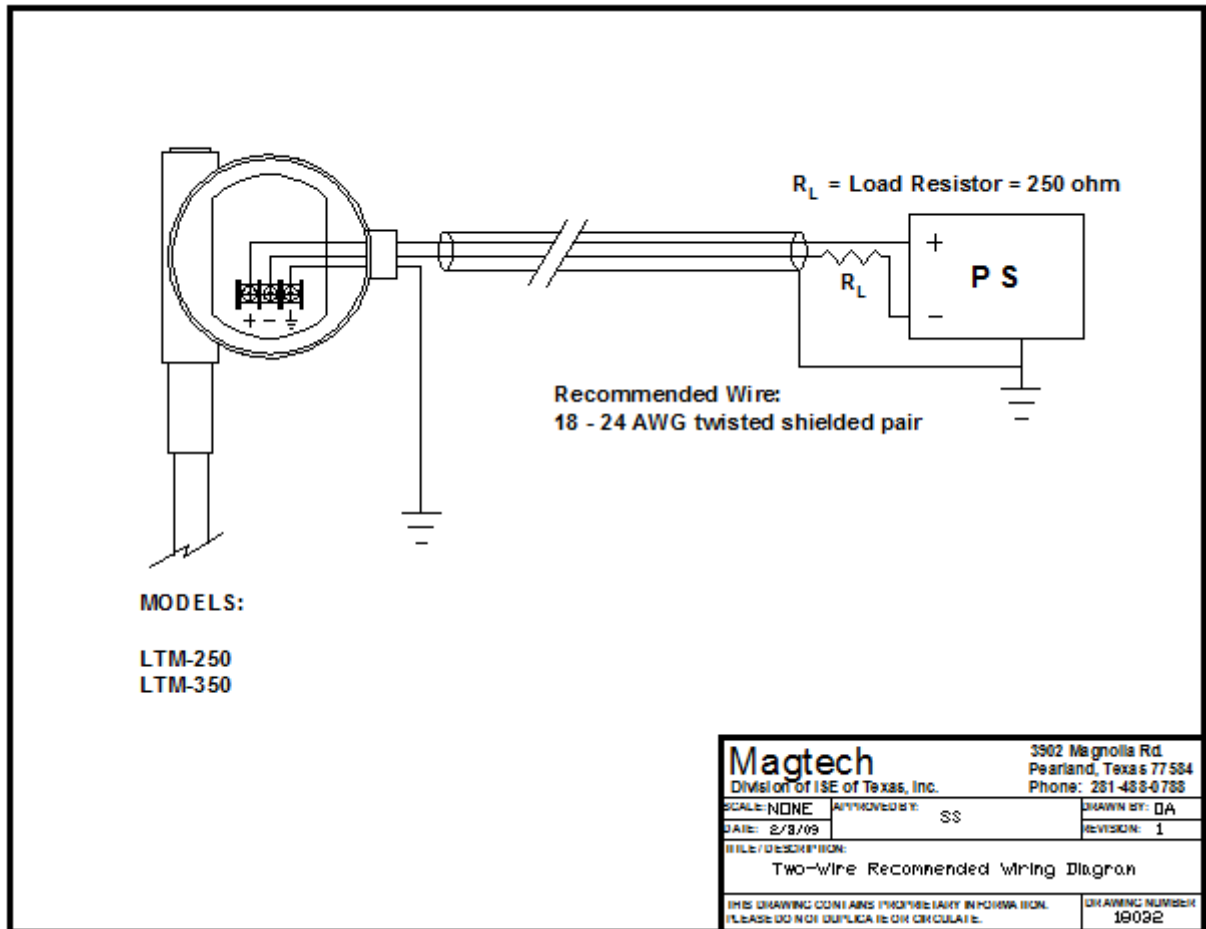


Figure 13. Recommended Loop Wiring

The following is the Hart Topology.

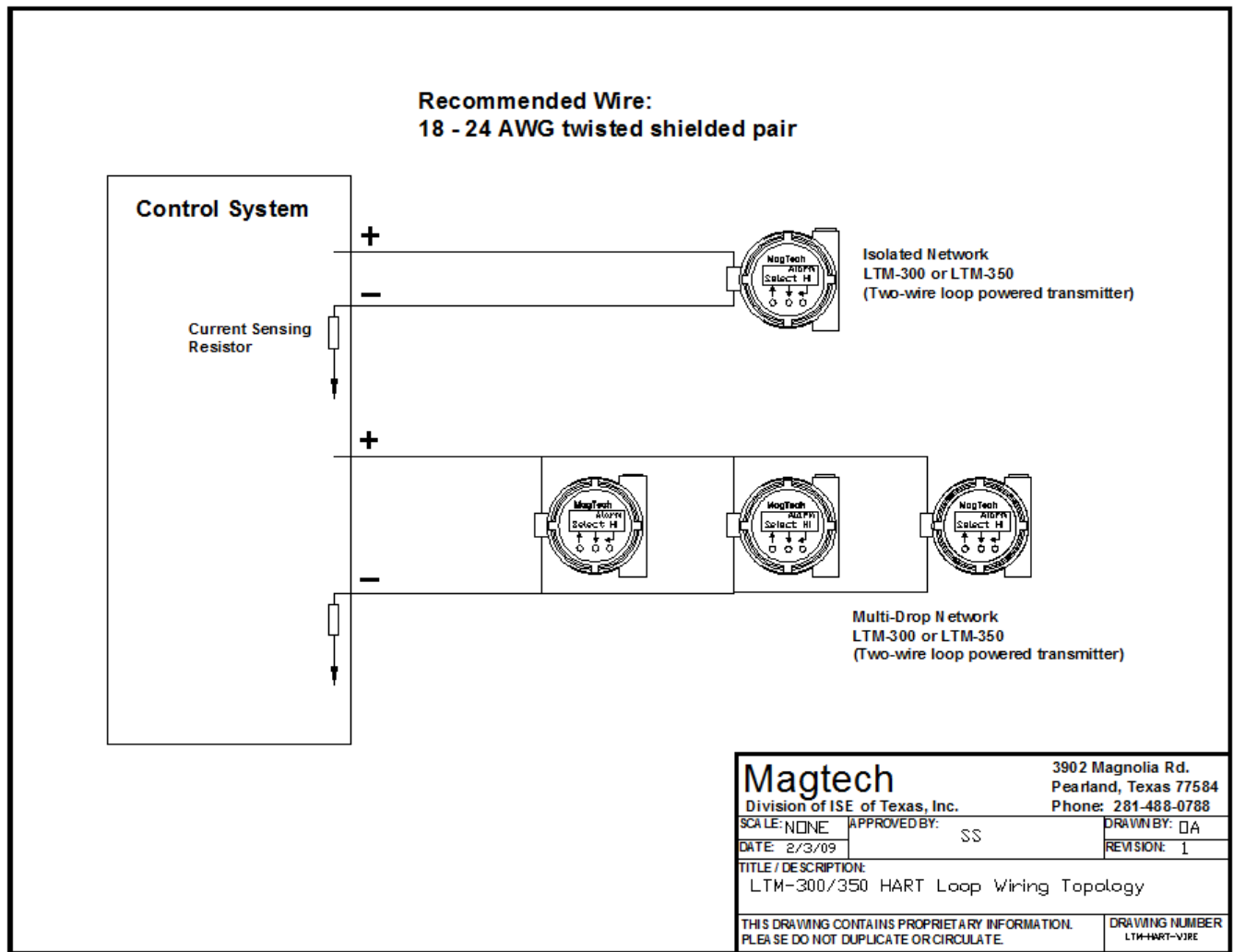


Figure 14. HART Loop Topology



Please visit [www.hartcomm2.org](http://www.hartcomm2.org) to learn more about HART Protocol.

## 5.1 Area Classification Installation Safety



If the instrument is used as an explosion proof (exp) device then exp conduit must be sealed within 18 inches of the termination point – at the instrument.



Power must be supplied by an isolated supply.



Caution-To reduce the risk of ignition of hazardous atmospheres, disconnect the device from the supply circuit, or area must be known to be non-hazardous, before opening.

# Section 6

## Transmitter Specifications

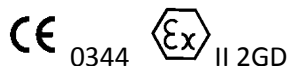
### 6.1 Hazardous Locations / General Ratings

#### CSA and CSAUS: Explosion Proof:

Class I Div. 1 or 2, Grps. B, C, D  
Class II, Grps. E, F, G  
Class III  
T<sub>amb</sub> -40°C to 85°C (-40°F to 185°F)

#### ATEX: Ex d:

Sira 10ATEX1308X  
Ex d IIC T5 Gb  
Ex tb IIIC T100°C IP66 Db  
T<sub>amb</sub> -40°C to 85°C (-40°F to 185°F)



#### IECEX: Ex d:

IECEX SIR 10.0150X  
Ex d IIC T5 Gb  
Ex tb IIC T100°C IP66 Db  
T<sub>amb</sub> -40°C to 85°C (-40°F to 185°F)

### 6.2 Electronic Specifications

**Supply Voltage:** 13 – 36 Vdc (13V @ 20mA)

**Repeatability:** .005% of full scale or .010", whichever is greater

**Non-Linearity:** .01% of full scale or .030", whichever is greater

**Sensor Accuracy:** .01% of full scale or .030", whichever is greater

**Damping:** 1 to 26 seconds

**Operating Temp:** -50 to 85 C  
(-58 to 185 F)

**Housing:** Explosion proof, dual compartment, ½" npt conduit, epoxy coated aluminum; NEMA 4X, 7

**Humidity Limits:** SAMA PMC 31.1-5.2

**Vibration Limits:** SAMA PMC 31.1-5.3

**RFI Limits:** SAMA PMC 31.1-  
20 to 1000 MHz  
Up to 30 V/m

### 6.3 Sensor Probe Specifications

**Material:** 5/8" 316ss standard, optional:  
Hastalloy, Monel, or Kynar sleeved

**Operating Temperature:** -50 to 149 C  
(-58 to 300 F)

**Maximum Pressure:** 2000psig @ 300F

**Range:** 12 in. to 30 ft.



# Section 7

## Menu Structure and Features

### 7.0 Pushbutton Operation

The menu structure and pushbutton operation of the LTM series transmitters is simple and user-friendly. The electronics module has 3 pushbuttons (from left to right):

↑ : This button is used to increment values and change “Yes” to “No” and “No” to “Yes”.

↓ : This button is used to decrement values and change “Yes” to “No” and “No” to “Yes”.

← : This is the enter button used to execute functions and enter/exit into or out of submenus.



The pushbuttons are timed **not** pressurized. It does not matter how hard/firm you press them. The buttons depend on the length of time they are pressed. The longer you hold the button the faster it will increment/decrement values. Hold the enter button down for 2 seconds to enter the configuration menus and 1 second for all subsequent menus.

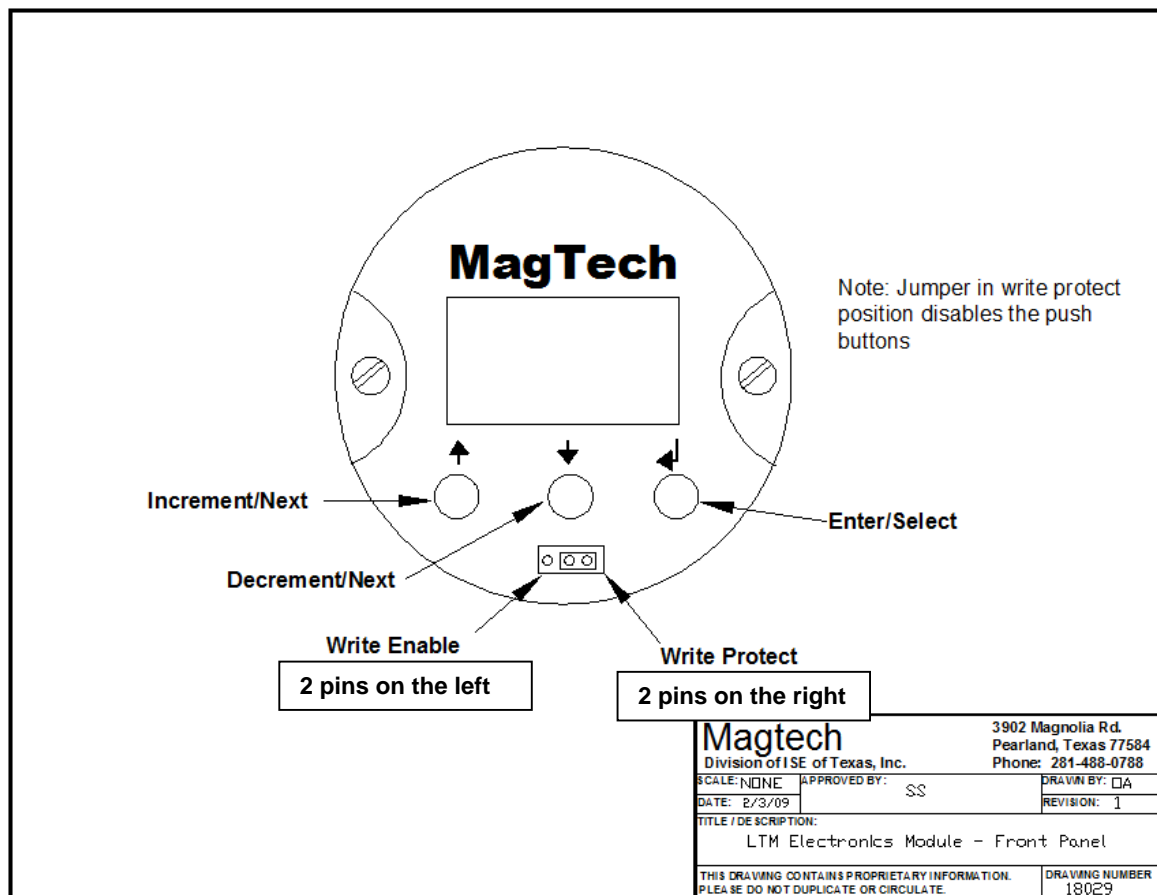


Figure 15. Front Panel of Electronics Module

## 7.1 Menu Structure

### Main Screen (scrolling):

The menu structure has been designed so the end user can make parameter changes relatively fast and easy. Below is a detailed description of these menus.

The LTM-250/350 LCD is a 2x8 character screen. The main screen scrolls between the following parameters:

1. Level (in selected engineering units)
2. Interface (when option is provided – in selected engineering units)-LTM-350 only
3. Temperature (when option is provided – in selected engineering units)-LTM-350 only
4. The analog current corresponding to level (in mA)
5. Percent of range corresponding to level (in %)

If the user desires to enter into the configuration menus simply press/hold the enter button for 2 seconds.



Make sure the electronics are not in write protect mode.



The menu order can change and new menus can be introduced based on transmitter output options and hardware or software revisions.

## The following is the LTM-250/350 LCD Menu Flowchart

Magtech  
LTM-250 or Magtech  
LTM-350

SW Rev  
1.00.00

HW Rev  
1.00.00

Display?  
Scroll > Level > Inrfce\* > Temp\*\* > mA Out > % Range

SelLngh  
30.00 in

Lvl Unit  
in > ft > mm > cm > m

Temp Unit\*\*  
C > F > R > K

Sel PV\*  
Level > Interface

Sel Alrm  
FailHigh > FailLow > HoldOut

ChgRnge? >>> Sel LRV >>> Sel URV  
Yes > No (yes) 0.00 in 24.00 in

SelDamp  
1 sec

ROC Fltr  
10.0in/s

TrmSnsr? >>> TrimZero >>> TrimZero >>> TrimSpan >>> TrimSpan >>> Span  
Yes > No (yes) -Busy- 24.00in -Busy- Error (if incorrect)

Offset  
0.00in

TrimDAC? >>> Trim 4mA >>> Trim20mA  
Yes > No (yes) 120 3860

TstLoop? >>> LoopTest  
Yes > No (yes) 4.00 mA

Exit?  
Yes > No

\* Only applies when Interface Float is included

\*\* Only applies when Temperature Sensor is included

## 7.1 Menu Structure Continued...

### Description

#### Manufacturer and Model:

#### Software Revision Status:

This is the current software revision.

#### Hardware Revision Status:

This is the current hardware revision.

#### Scrolling Option:

Allows the user to stop the main menu from scrolling and choose 1 of 5 possible parameters: Engineering Units (level, interface, and temp), Current (mA), or Percentage. Select the desired parameter and then press enter. "Scroll" is the default parameter this option keep the main menu scrolling. See section "7.2 Features" for more details.



Interface and Temperature options only appear if the option(s) are configured.

#### Select Length:

**Note:** THIS IS NOT THE MEASURING RANGE.

This parameter should only reflect the overall sensor length. It can be adjusted by incrementing and decrementing the value and then pressing enter.

#### Level Units:

This menu can be used to change the level engineering units. It can be changed by incrementing/decrementing to one of the following units: **in, ft, mm, cm, m** and then pressing **enter**.

#### Temperature Units:

This menu can be used to change the temperature engineering units. It can be changed by incrementing/decrementing to one of the following units: **F, C, R, K** and then pressing **enter**.



This menu only appears if the temperature option is provided.

### LCD Menu (example)

M	a	g	t	e	c	h
L	T	M	-	3	5	0

S	W		R	e	v	
	1	.	0	0	.	0 0

H	W		R	e	v	
	1	.	0	0	.	0 0

D	i	s	p	l	a	y ?
	S	c	r	o	l	l

S	e	l	L	n	g	t	h
	3	0	.	0	0	i	n

L	v	l	U	n	i	t	s
					i	n	

T	e	m	p	U	n	i	t
					°	C	

## 7.1 Menu Structure Continued...

### Description

#### Select PV:

This menu allows the user to select the measurement that controls the transmitter's current output (mA).



This menu only appears if the interface (2 floats) option is provided.

#### Select Alarm:

The following alarm settings can be chosen:

"FailHigh" = 21.00mA

"FailLow" = 3.50mA

"HoldOut" = holds last good reading until transmitter recovers.

#### Change Range:

This menu allows the user to change the measuring range or span. Enter the menu by changing the "No" to a "Yes" and press enter.

#### - Select Lower Range Value (LRV):

This is the 4.00mA (0.00%) point on the sensor. This value should only be incremented. For example if the value is changed from "0.00in" to "3.00in" the 4.00mA point will shift 3.00 inches higher than the original point. It is recommended to leave this at 0.00 most of the time unless a special circumstance arises. Press enter to go the next screen.

#### - Select Upper Range Value (URV):

This is the 20.00mA (100.00%) point on the sensor. This value should only be decremented. Changing this parameter will change the measuring range or span of the transmitter.

#### Select Damping:

This parameter is used to slow down the reaction of the instrument in order to ignore or average out any agitation on the process surface that may be causing an unsteady output. The units are fixed in seconds and values can be from 1 to 26 seconds.

### LCD Menu (examples)

S	e	l		P	V			
				L	e	v	e	l

S	e	l	A	l	a	r	m
F	a	i	l	H	i	g	h

C	h	g	R	n	g	e	?
						N	o

S	e	l		L	R	V		
			0	.	0	0	i	n

S	e	l		U	R	V			
			2	0	.	0	0	i	n

S	e	l		D	a	m	p
				1			s

## 7.1 Menu Structure Continued...

### Description

#### Rate of Change (RoC) Filter:

This parameter helps ignore erroneous readings from the transmitter's surroundings. If the user knows how fast the level can change in the vessel (i.e. inches per second) then this parameter should be set at a rate that the level in the vessel cannot suddenly jump to. See section "7.2 Features" for more details.

#### Trim Sensor:

This menu can be used to recalibrate the transmitter.



There is no need to recalibrate the instrument simply use the "Change Range" menu and change the LRV and URV as desired.



If the need arises to use this menu then level simulation will be required at 0 and 100 percent.

#### Offset:

This parameter simply adds a digital value to the measuring range or span it does NOT shift or move the measuring range. See section "7.2 Features" for more details.



The span will not change and the 4/20mA will not shift from its original calibrated points. This value also affects the reading for interface level when available.

### LCD Menus (examples)

R	o	C	F	l	t	r
1	0	.	0	i	n	/ s

T	r	m	S	n	s	r	?
						N	o

O	f	f	s	e	t
	0	.	0	0	i n



## 7.1 Menu Structure Continued...

### Description

#### Trim Digital-Analog-Converter (DAC):

These are factory set parameters used to provide an accurate 4.000mA and 20.000mA. This parameter should not be changed as Magtech uses NIST traceable equipment to calibrate our transmitters and only accredited laboratories for the annual calibration of our equipment. This menu will allow the user to change the accuracy of the transmitter output.



A current meter should be used to monitor the 4/20mA when this function is selected.

#### Test Loop:

This function allows for direct control of the Transmitter's current output (mA) capability. Simply enter into this menu and change the current (mA) output as desired. This option is excellent for plant startup verification.

#### Exit:

This signifies the last menu before the main screen. If the user desires go back through the configuration menus then change the "Yes" to "No" and review the configuration again else press enter while the screen shows "Yes" and return to the main screen.

### LCD Menu (examples)

T	r	i	m	D	A	C	?
						N	o

T	s	t	L	o	o	p	?
						N	o

E	x	i	t	?		
				Y	e	s

## 7.2 Features

This section will describe in more detail some of the LCD Menus and **new features** exclusive to models LTM-250/350.

**Scrolling Option:** When choosing not to scroll the main menu the following options can be chosen by pressing the up and down push buttons (**exclusively for models LTM-250/350**).

- |               |                   |                       |                  |                    |                     |
|---------------|-------------------|-----------------------|------------------|--------------------|---------------------|
| 1. Display?   | Display?          | Display?              | Display?         | Display?           | Display?            |
| <b>Scroll</b> | (or) <b>Level</b> | (or) <b>Interface</b> | (or) <b>Temp</b> | (or) <b>mA Out</b> | (or) <b>% Range</b> |



The “Scroll” option will vary depending on how many outputs are configured.

**Rate of Change (RoC) Filter:** The RoC filter is a continuous monitor of how fast (the rate) the level is rising and falling. It is also an excellent tool to help eliminate any temporary spontaneous noise that may be present in-field. For example if the level in a tank cannot rise or fall faster than 30.0 in/s then the setting for the RoC filter should be set to 15.0 in/s or less to help filter/ignore erroneous readings. Note: The engineering units will change according to units selected (i.e. cm/s) – (**exclusively for models LTM-250/350**).

**Offset:** The offset is a digital number that gets added to both the LRV and URV to account for any distance below the sensor probes measuring distance. For example if the offset is changed from “0.00in” to “2.00in” the ‘Level’ on the main screen will show “2.00in” at 4.00mA and the 20.00mA value will simply have 2.00 inches added to it.



The span will not change and the 4/20mA will not shift from its original calibrated points. This offset value will also add to the interface level when available.

## 7.2 Features (Exclusive to the LTM-250/350 models)



There is an “advance” menu incorporated into the LTM-250/350 models. To access this menu **press and hold** the increment (↑) button first then while holding the increment button **press and hold** the enter button for 3 seconds. A new menu will appear on the LCD screen.

The following is a flow chart of the “advanced” menus

[illegible]

## 7.2 Features (Exclusive to the LTM-250/350 models)

This section describes the “advance” menus in detail.

**ComPort:** This menu is currently only utilized at the factory and will not assist in any troubleshooting. When the menu first appears the “No” option is defaulted, simply press enter to bypass this option. If “Yes” is selected and this menu is accidentally entered into then the push buttons will be locked out. Simply cycle the power to the instrument to clear the effect of entering into this option.

---

**Default:** The next menu is the “Default Configurations” menu. This option allows the user to “load” the original factory settings or load settings saved in slots labeled “Sensor 1”, “Sensor 2” or “Sensor 3” (if utilized by end user). If desired one electronics module can save settings for 3 other sensor probes by calibrating the electronics module to a particular sensor probe then saving those settings into slots labeled sensor 1, 2, or 3. Change the menu screen from “load” to “save”. Then the user can save current setting into slots labeled sensor 1, 2 or 3 and load from these slots as desired.

- **Loading Factory Defaults:** Enter into the “Defaults” menu by changing the “no” to a “yes”. Then the option to “Load” will appear. Press enter and the “Factory” option will appear then press enter on more time to execute the load from defaults (settings can also be loaded from Sensor 1, 2, or 3 by using the up or down arrows on the “Factory” screen if the user has utilized the other slots).
- **Saving Settings:** Enter into the “Defaults” menu by changing the “no” to a “yes”. Then the option to “Load” will appear. Use the up or down arrow to change the “Load” to “Save” option. Press enter and the next menu will appear with “Sensor 1”. By pressing enter the current settings of the transmitter will be saved. At the “Sensor 1” menu screen if the up or down arrow is pressed the user has the option to save the transmitter settings into “Sensor 2” or “Sensor 3” slots. **Note:** One electronics module can potentially hold up to 3 other transmitter settings.



The factory settings can never be overwritten (or saved to), only loaded from.

---

**Deadzone:** This menu is mainly utilized at the factory to achieve optimal linearity near the deadband close to the electronics. This feature was released just in case in-field adjustments are necessary.



This option/feature only appears in software revisions 1.01.15 or higher.

---

## 7.2 Features (Exclusive to the LTM-250/350 models)



Please consult factory before attempting this procedure. Document transmitter's serial number for better assistance.

**1-point Calibration Procedure (1pt Cal):** The following menu is the 1 –point Calibration procedure. This procedure was designed to help the user get up and running in an emergency. If electronics have to be shared in an emergency the following procedure guides the user through a “quick” calibration procedure that does not require level simulation but instead works with the current level (1 point) in the vessel/tank.

1. Enter into the “1pt Cal” menu by changing the “no” to a “yes” and pressing enter.
2. The first menu is “SelLngh” or select length. **This is not the measuring range** but the overall probe length. This information can be found on the label of the instrument housing. (See Section 2.1 Product Identification). Enter the value in using the up or down arrows and press enter.
3. The second menu is “Sel LRV” or select lower range value. Most of the time this value is at 0.00in. It is recommended to leave this value at zero and press enter.
4. The next menu is “Sel URV” or select upper range value. Enter in the desired measuring range and press enter.
5. The “Energy” menu is next. This parameter controls the amount of energy being sent down the sensor probe. Longer sensor probes require more energy shorter sensor probes require less energy. Please contact the factory for guidance with this parameter.
6. The “DCOffset” menu is the signal to noise ration. Please contact the factory for guidance with this parameter.
7. The “HoldTime” menu is the amount of time the energy being sent down the probe is sustained. Note: a longer hold time can increase the deadband near the electronics. Please contact the factory for guidance with this parameter.
8. The last menu is the “CrntLvl” or current level menu. Enter the known current level in the vessel/tank (in engineering units) and press enter. The calibration should take place and the transmitter should be operational. If the next menu appears then the operation was successful. If the menu reverts back to the beginning of the “1pt Cal” menu then the operation was unsuccessful. Further troubleshooting may be necessary if the operation is unsuccessful. See **Section 8** for troubleshooting guide.



The 1-point calibration may not be within the published accuracy specification. Again this procedure was designed to get a critical application up and running. A recalibration (two point calibration) may be highly desirable as soon as the opportunity presents itself.

---

**Level Adjustment (LvlAdjst):** If the level gage indicator and level transmitter reading do not match or appear to be incorrect by a few inches then the “LvlAdjst” function can be utilized. Enter into the menu and simply use the up and down push buttons to enter the current level being displayed by the level gages visual indicator and then press enter. The transmitter will adjust the calibration and output accordingly. Note: Be careful make sure this is what is desired.

---

## 7.2 Features (Exclusive to the LTM-250/350 models)

**Field Reversible Transmitter (FlipPrb):** An important and key feature of the LTM-250 and LTM-350 Models is the ability to flip (rotate) the entire transmitter 180 degrees. This procedure is only for gage mount transmitters with an elbow connection on them. If the transmitter does not have an elbow connection please contact factory for assistance. If the need arises and a bottom mount transmitter is preferred over a top mount transmitter or vice versa then following these simple steps. **THIS PROCEDURE IS FOR GAGE MOUNT TRANSMITTERS ONLY.**

1. Physically flip (rotate) the entire transmitter (this includes the sensor probe) and mount it accordingly.



Be careful not to damage the sensor probe while rotating the transmitter.

2. Remove the front glass cover of the transmitter enclosure and then using needle nose pliers pull on the protection screws (snake-eye screws) to pull out the electronics module. Alternate pulling on the screws in order to prevent damage to the electronics module.
3. Rotate the electronics 180 degrees module and insert it back into the enclosure. The module should now be right side up.



Do not twist or rotate the transmitter housing to adjust the conduit entry. **The conduit entry must be left in the opposite position.**

4. There is a “special” configuration menu that is utilized to achieve this task. To access this menu **press and hold** the increment (↑) button then while holding the increment button **press and hold** the enter button for 3 seconds.
5. The “FlipPrb?” (Flip Probe) menu should appear. Use the up or down buttons to select “Yes” if rotating the sensor is what is desired else select no and exit the menu.
6. When “Yes” is selected the next menu is the “Config” (Configuration/Orientation) menu. This is where the “Top” or “Bottom” mount configuration is selected. This configuration/orientation is with reference to where the sensor probe “bulkhead” is located on top or bottom. Select the appropriate “Config” and press enter. If the original orientation is selection the menu will revert back to “FlipPrb?” menu.
7. The next menu is “Rerange?” (Change Range) menu. Select “Yes” if the measuring range (or span) is changing from the original span. Select “No” if the span is to able to remain the same. Selecting “Yes” will then go through change range procedure discussed in section 7.1 of this manual.
8. After the “Rerange?” menu is the “CrntLvl?” (current level) menu. Simply enter where the existing level is in the vessel and a one-point calibration will take place automatically and the next menu will appear. If the next menu appears then the operation was successful. If the menu reverts back to the beginning of the “FlipPrb” menu then the operation was unsuccessful. Further troubleshooting may be necessary if the operation is unsuccessful. See **Section 8** for troubleshooting guide.

## 7.2 Features (Exclusive to the LTM-250/350 models)

**Change Signal (ChngSgnl):** The next and final menu in the special features menu is “ChngSgnl” or change signal option. The feature allows the adjustment of the signal being sent down the sensor probe. It can be utilized when one electronics module is being utilized to save settings for various different length sensor probes.

This menu has 3 parameters that can be adjusted. The first is “Energy” [%], it is increased for a longer sensor probe and decreased for a shorter sensor probe. The second parameter is “DCOffset” or DC Offset [v], this parameter is decreased for longer sensor probes and increased for shorter sensor probes. The third (and final) parameter is the “HoldTime” or hold time [us], this parameter recommended to stay within a certain range.



There is purposely not much detail on this option as it is recommended that these parameters not be changed unless the electronics module is being utilized for more than one sensor probe. It is also recommended that the user be guided by the factory if this option is being utilized.



This option is also intended for mainly factory use. Changing these parameters can cause undesirable results. Please consult factory with any questions. The “factory” default configurations can be loaded if the parameters have been drastically changed.

**Pulse Width Filter (PW Filtr):** The pulse width filter can be utilized for dual output (level and interface) applications if there are any erroneous readings being transmitted or displayed. This feature can be adjusted so the unique signal from the magnetic float can be concentrated on and all other false signals are ignored.



This option/feature only appears in software revisions 1.01.15 or higher.

**Conversion from Gage Mount to Standalone:** When converting from a gage mount transmitter to a standalone transmitter or vice versa simply contact the factory to order appropriate parts. Please have the serial number of the transmitter documented so the factory can make traceable record changes and offer better assistance. Most conversions can now be done in-field with minor configurations and calibration.

**Converting from gage mount to standalone:** Remove the transmitter from the gage, then remove 4/20mA (or 0/100%) stickers from the sensor probe. Call factory with serial number and desired process connections (3/4”mnpt, 2”mnpt hex plug, flanges, etc...).

**Converting from standalone to gage mount:** Remove the transmitter from the vessel, then remove process connections and float. Call factory with serial number of transmitter and the level gage to which the transmitter is to be mounted.



Always be careful not to damage the sensor probe when removing/installing the transmitter to/from the gage or vessel.



## Section 8

# Transmitter Calibration and LTM Troubleshooting

### 8.0 Calibration



**There really is no need to re-calibrate this instrument. The LTM-Series arrive calibrated to specified measuring ranges at order placement.**

If the need arises and a recalibration is deemed necessary please follow these instructions carefully.



Level simulation will be required at 0% and 100% positions.

1. Verify the “probe length” is **not** the same as the “measuring range” desired. If so please change accordingly.  
See Sections 2.1 and 7.1.
2. Go to the “Change Range” menu and set the desired URV (measuring range).
3. Go to the “Trim Sensor” menu and enter.
4. At the “Trim Zero” screen place the level (or magnet/float) at 0% (4mA point) and then press enter.
5. At the “Trim Span” screen place the level (or magnet/float) at 100% (20mA point) and then press enter.
6. “Exit” the configuration menus and the instrument should be calibrated. If not begin to troubleshoot or consult factory for assistance.

**Error Preventative Calibration:** The LTM-250/350 transmitters are protected from incorrect calibration so if something is done incorrectly it will display “Span Error” on the LCD for 5 seconds and then return to the beginning of the “Trim Sensor” menu.

**Recommendation:** Again there is no need to recalibrate the instrument simply go to the “Change Range” menu and adjust the LRV or URV as desired.

### 8.1 Troubleshooting

Magtech manufactures custom built products so each transmitter has been specifically designed to fit on a magnetic level gage or be inserted into a tank/vessel and has been approved by the end user at some point during the ordering/purchasing process. Each transmitter has been factory calibrated to meet end user requirements so there is no need to recalibrate these transmitters unless the requirements have changed from the time of purchase/delivery to installation. If the need arises to calibrate these units to a new range please carefully read and follow the calibration procedure in the instruction and operation (I/O manual) or consult the factory. Always feel free to contact the factory if any questions or uncertainties arise. The following guide has been established to guide the end user through some troubleshooting procedures if the need arises.

There are 3 basic scenarios that can potentially cause issues. They are:

1. **Physical damage** to the sensor probe.  
Accidents can happen during the installation process and if the sensor is permanently bent, bowed, or kinked it will no longer work properly. Some symptoms of damage to the sensor probe are:
  - a. Erratic output, unit jumping to full scale (alarm mode) randomly, usually around the damage point.
  - b. Unit in constant alarm condition
  - c. Unit going into alarm condition after a certain point.



**If the unit arrives damaged please contact factory immediately.**

2. **Water damage** to the electronics module or sensor probe. This is potentially the most severe case the symptoms are unpredictable. If there is any suspicion that the transmitter may have incurred water damage please contact the factory to make arrangements to have the unit sent back for factory inspection.



**Physical and water damage are not covered under warranty.**

3. **Magnetic Indentation.** It is possible for any magnetostrictive instrument to have residual magnetic energy stored along the length of the waveguide. These magnetic anomalies can interfere with the output response signal. If this appears to be the case a level gage float (or a bar magnet preferably) may be run along the length of the sensor tube, past the head of the transmitter, in an even motion without stopping. This will usually clear all such magnetic anomalies.



**Never move a magnet in perpendicular motion away from the sensor tube. This will always leave a residual magnetic field in the waveguide which causes the transmitter output to be erroneous or unstable.**



**The LTM-350 is HART compatible, however HART communication will not work if the unit is not powering up.**

## 8.2 Power Supply Troubleshooting

The LTM-250/350 is designed to operate with a supply voltage of 13 – 36 Vdc (minimum 13V @ 20mA) across its terminal without affecting the analog current output. The most common supply voltage used is 24Vdc.

At times additional resistance in the loop is necessary, either in the form of a second load resistor or higher resistance safety barrier. This will appear to limit the maximum output of the transmitter to below 20mA. The transmitter will perform correctly up to a certain point. To resolve this problem, the voltage of the loop supply must be increased. Even a slight adjustment of 1Vdc may be sufficient.

All connections must be checked for improper wiring or polarity before power is applied. LTM-Series transmitters are polarity protected.

## 8.3 General Troubleshooting

Below are some troubleshooting procedures for the LTM transmitters that have been established overtime.

**Symptom: Transmitter is not powering up.  
The LCD is not turning on.**

**Resolutions:**

1. Make sure power is applied correctly (meaning plus and minus are not reversed). The transmitter is polarity protected.
2. Make sure the electronics module is seated properly. Open the front cover (where the LCD is) and firmly push on the “Magtech” text. A good way to tell if the electronics are not seated properly is by making sure the protection screws are not physically higher than the outside of the housing. Sometimes pulling the electronics module out and putting it back in can reseal the electronics correctly. Use cutters or needle nose pliers to grip the protection screw and lightly pull on each screw (alternate).

# Section 9

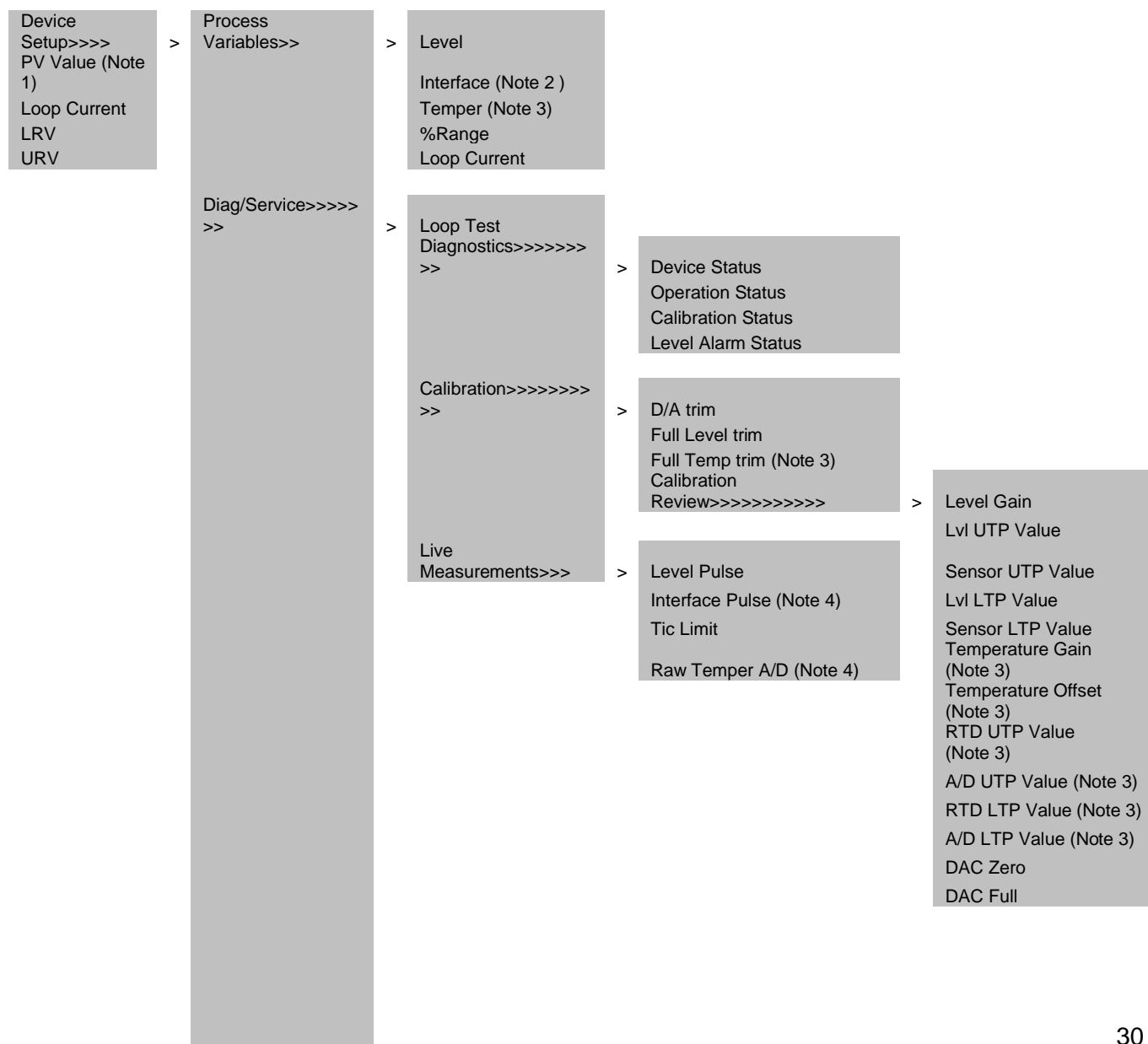
## LTM-350 has HART Protocol

### 9.0 Hart Protocol: General Information

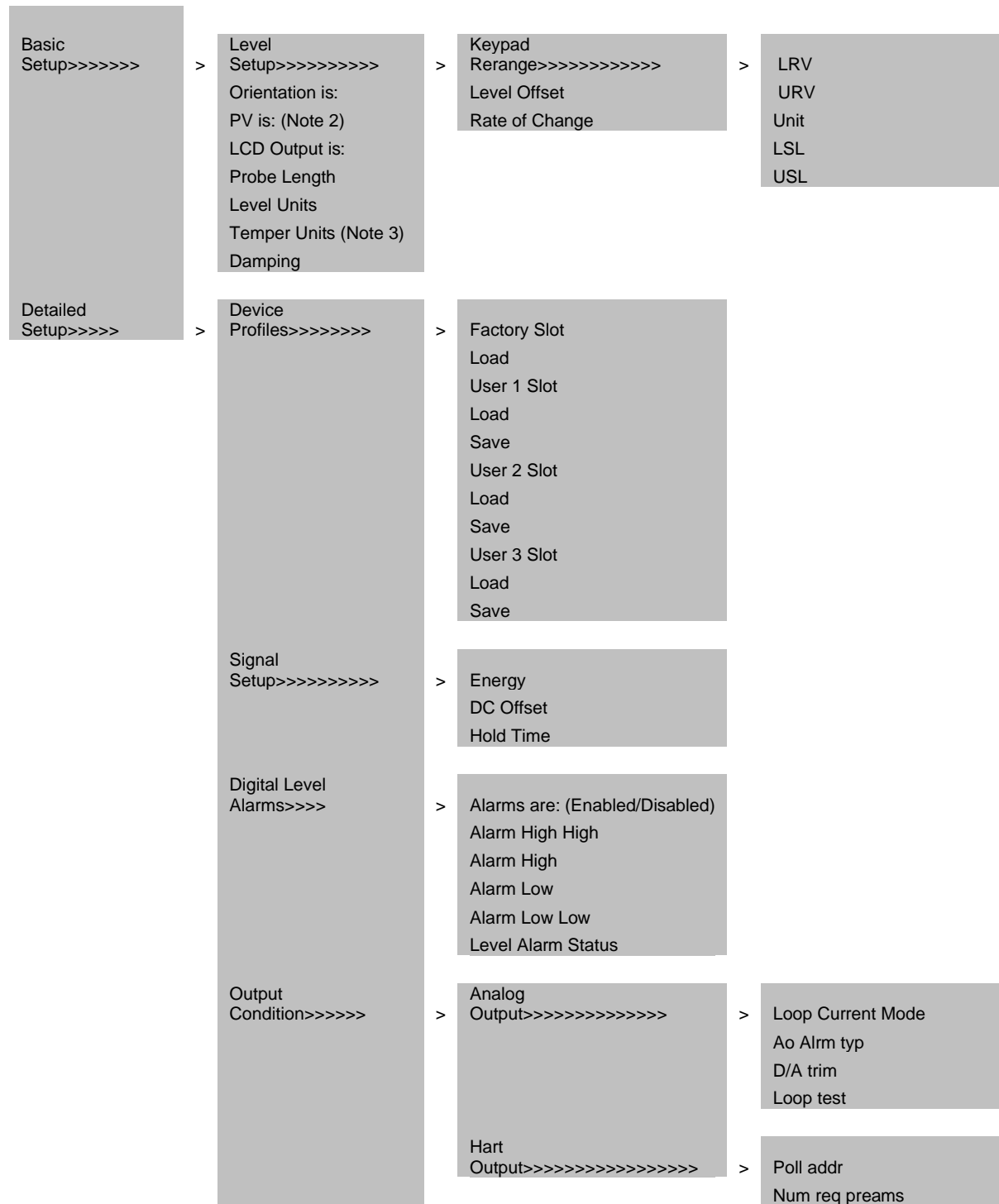
The LTM-350 is a HART registered and certified instrument. The section presents how the HART Communication Protocol has been utilized in the LTM-350. This section does not explain what HART Protocol is, please visit [www.hartcomm2.org](http://www.hartcomm2.org) to learn about HART.

The following is a flow chart of our HART menu structure. This flow chart can be utilized to access desired parameters and operations when using a handheld communicator or a HART enabled host system.

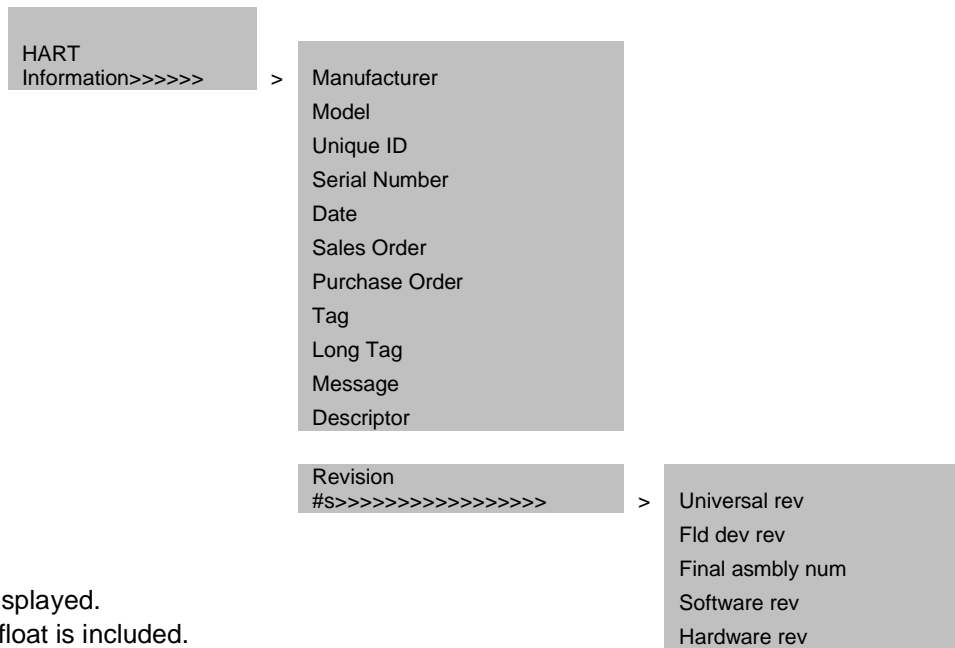
#### HART Menu Flowchart for LTM350 Transmitter



## 9.0 Hart Protocol: Menus and Flowchart (continued...)



## 9.0 Hart Protocol: Menus and Flowchart (continued...)



Note 1. When Interf is PV, Interf is displayed.

Note 2. Only applies when interface float is included.

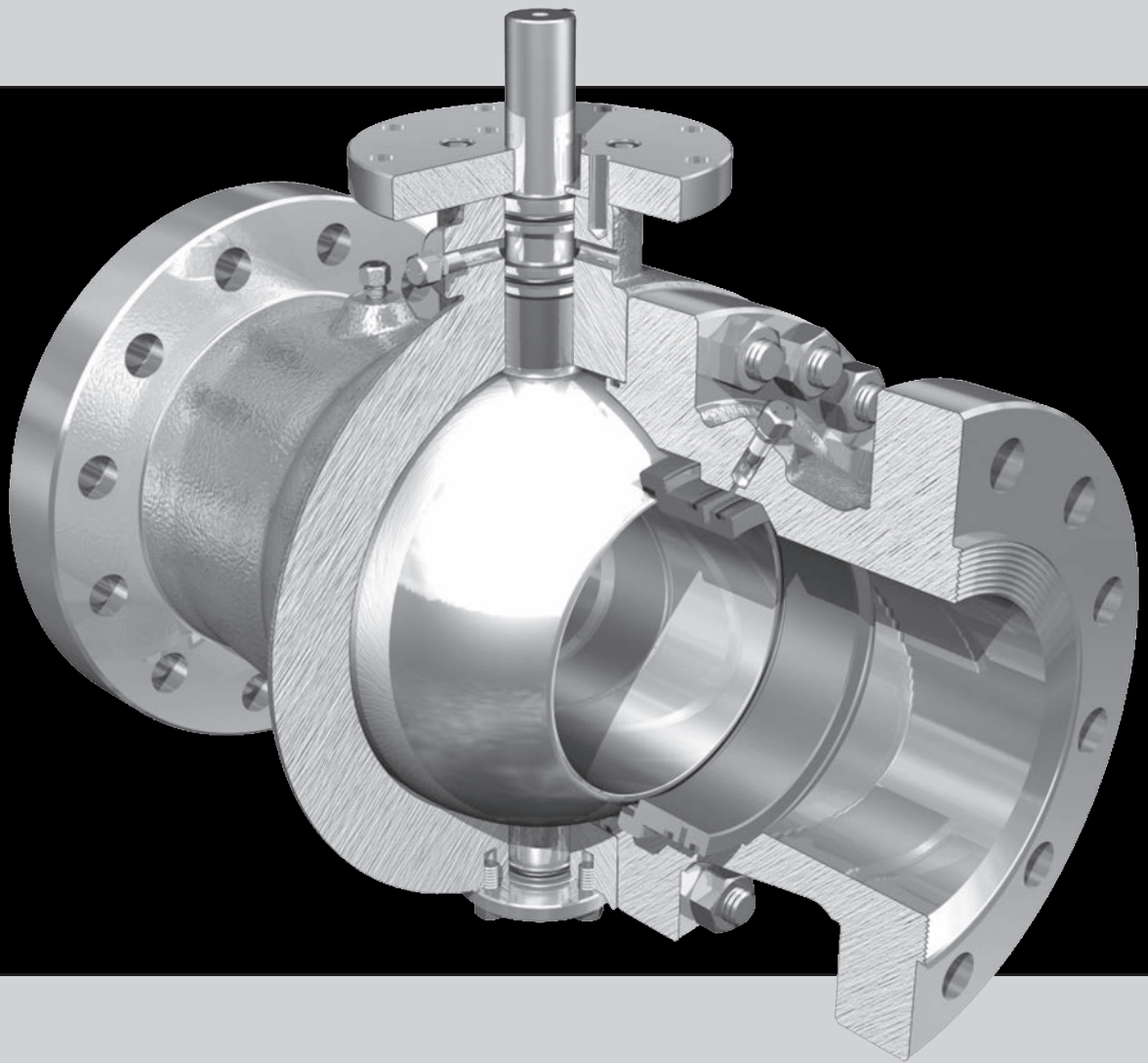
Note 3. Only applies when temperature sensor is included.

Note 4. Value displays 0 if interface float/temperature sensor is not present.

# WKM<sup>®</sup>

## DynaSeal<sup>™</sup> 370D4 Ball Valve

Installation, Operation and Maintenance Manual



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Initial Release 01  
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Revision 02  
May 2013

TC-003001-09 / Rev 01



## PREFACE

The procedures included in this book are to be performed in conjunction with the requirements and recommendations outlined in API Specifications. Any repairs to the equipment covered by this book should be done by an authorized Cameron service representative. Cameron will not be responsible for loss or expense resulting from any failure of equipment or any damage to any property or death or injury to any person resulting in whole or in part from repairs performed by other than authorized Cameron personnel. Such unauthorized repairs shall also serve to terminate any contractual or other warranty, if any, on the equipment and may also result in equipment no longer meeting applicable requirements.

File copies of this manual are maintained. Revisions and/or additions will be made as deemed necessary by Cameron. The drawings in this book are not drawn to scale, but the dimensions shown are accurate.

This book covers Cameron products.

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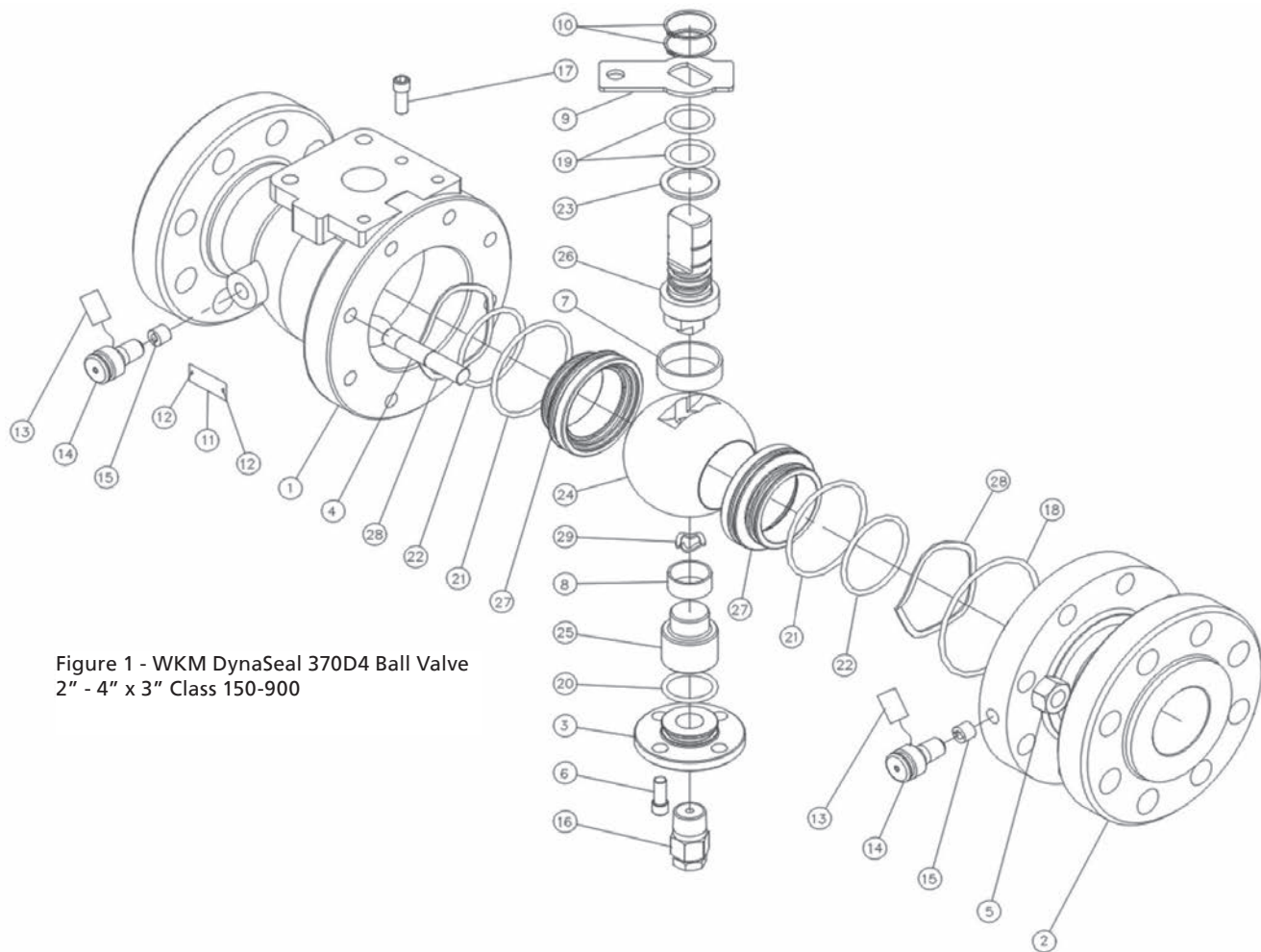


Figure 1 - WKM DynaSeal 370D4 Ball Valve  
2" - 4" x 3" Class 150-900

## BILL OF MATERIALS

### 2" - 4" X 3" CLASS 150-900

	Item	Qty	Description
	1	1	Body
	2	1	Tailpiece
	3	1	Lower Cover Plate
	4	*	Body Stud
	5	*	Body Nut
	6	4	Bolts (Lower Cover Plate)
	7	1	Bearings (Stem)
	8	1	Bearings (Trunnion)
	9	1	Stop Plate
	10	2	Retaining Ring
	11	1	Nameplate
	12	2	Drive Screw
	13	2	Caution Tag
	14	2	Grease Fitting
	15	2	Hidden Check Valve
	16	1	1/2" Vent Fitting
	17	1	Screw
	18	1	Tailpiece O-Ring
	19	2	Stem O-Ring
	20	1	Trunnion O-Ring
	21	2	Seat O-Ring
	22	2	Grease Seal Seat O-Ring
	23	1	Stem Seal
	24	1	Ball
	25	1	Trunnion
	26	1	Stem
	27	2	Seat Assembly
	28	2	Seat Wave Spring
	29	1	Wave Spring

 Body stud and nut qty. = 4 for 2" 150-300  
 8 for 2" 600-900 and 3" 150-900

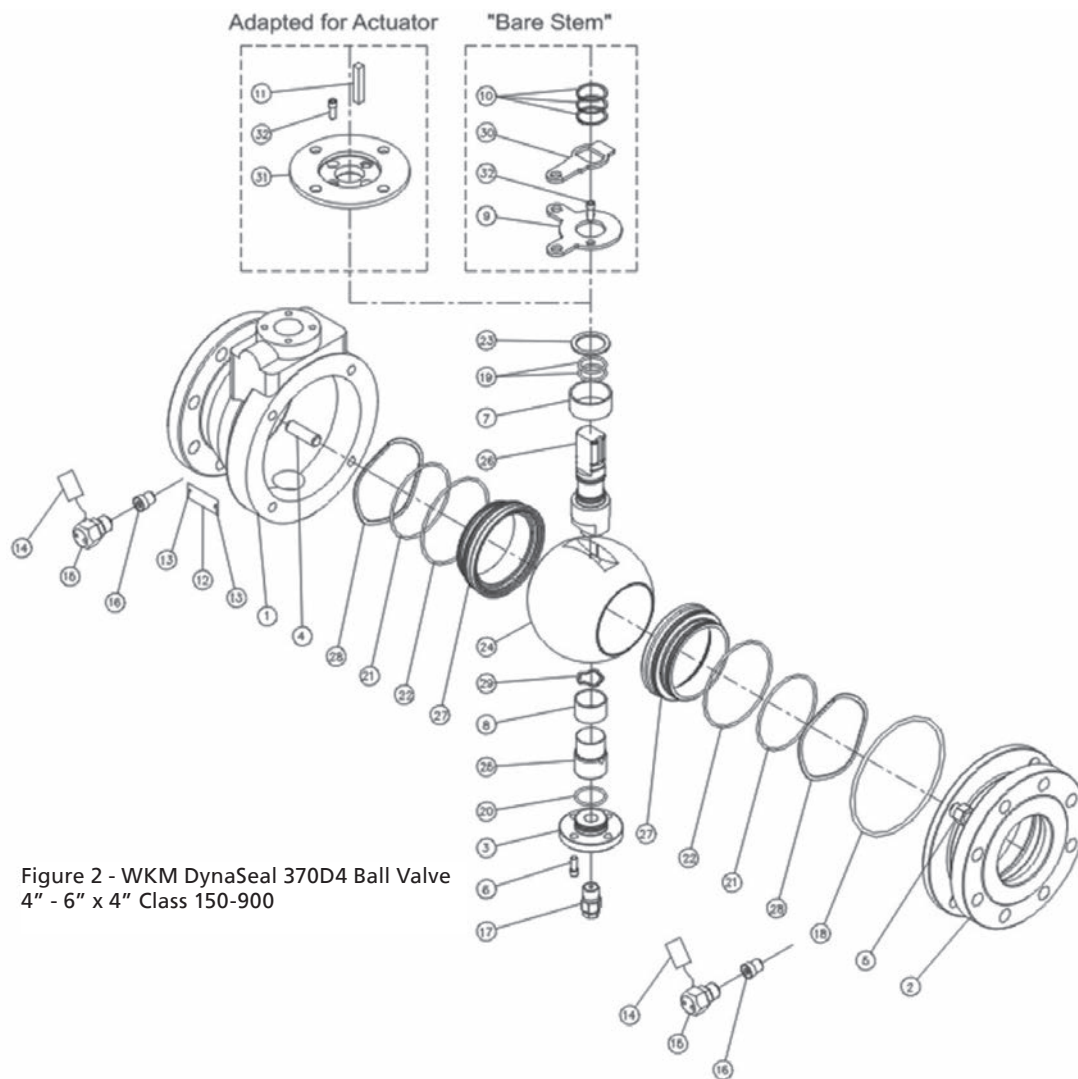











Figure 2 - WKM DynaSeal 370D4 Ball Valve  
4" - 6" x 4" Class 150-900

## BILL OF MATERIALS

### 4" - 6" X 4" CLASS 150-900

	Item	Qty	Description
	1	1	Body
	2	1	Tailpiece
	3	1	Lower Cover Plate
	4	*	Body Stud
	5	*	Body Nut
	6	4	Bolts (Lower Cover Plate)
	7	1	Bearings (Stem)
	8	1	Bearings (Trunnion)
	9	*	Stop Plate
	10	*	Retaining Ring
	11	*	Key
	12	1	Nameplate
	13	2	Drive Screw
	14	2	Caution Tag
	15	2	Grease Fitting
	16	2	Hidden Check Valve
	17	1	Drain Fitting
	18	1	Tailpiece O-Ring
	19	2	Stem O-Ring
	20	1	Trunnion O-Ring
	21	2	Seat O-Ring
	22	2	Grease Seal Seat O-Ring
	23	1	Stem Seal
	24	1	Ball
	25	1	Trunnion
	26	1	Stem
	27	2	Seat Assembly
	28	2	Seat Wave Spring
	29	1	Ground Wave Spring
	30	*	Lock Plate
	31	*	Adapter Plate
	32	*	Plate Bolts

- 1 Body stud and nut qty. = 4 for 4" 150  
8 for 4" 600-900
- 2 Parts required for "bare stem" valves = 1  
(0 required for valves adapted for actuators)
- 3 Parts required for valves adapted for actuators = 1  
(0 required for "bare stem" valves)
- 4 Plate bolts 2 for valves with "bare stem"  
4 For valves adapted for actuator
- 5 Drain fitting 4" = 1/2"  
6" x 4" = 3/4"



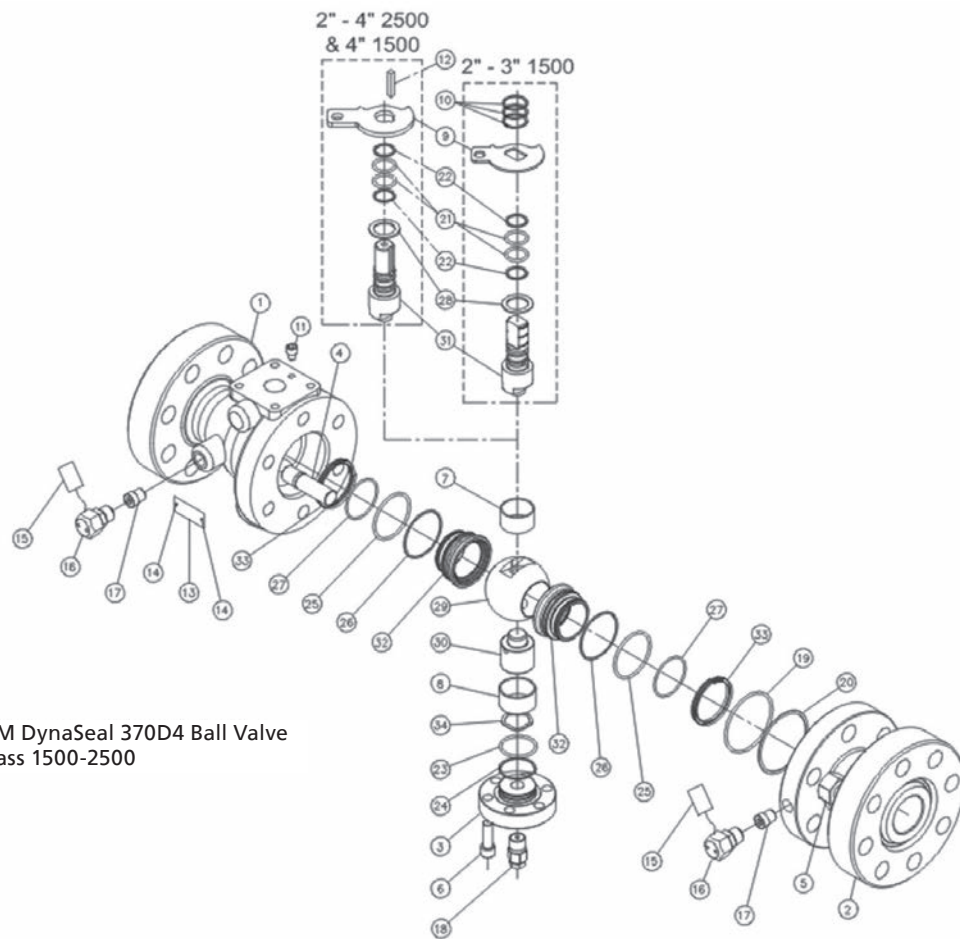





Figure 3 - WKM DynaSeal 370D4 Ball Valve  
2" - 6" x 4" Class 1500-2500

## BILL OF MATERIALS

### 2" - 6" X 4" CLASS 1500-2500

	Item	Qty	Description
	1	1	Body
	2	1	Tailpiece
	3	1	Lower Cover Plate
	4	*	Body Stud
	5	*	Body Nut
	6	6	Bolts (Lower Cover Plate)
	7	1	Bearings (Stem)
	8	1	Bearings (Trunnion)
	9	1	Stop Plate
	10	*	Retaining Ring
	11	1	Stop
	12	*	Key (Square)
	13	1	Nameplate
	14	2	Drive Screw
	15	2	Caution Tag
	16	2	Grease Fitting
	17	2	Hidden Check Valve
	18	1	Drain Fitting
	19	1	Tailpiece O-Ring
	20	1	Tailpiece Backup Ring
	21	2	Stem O-Ring
	22	2	Stem Backup Ring
	23	1	Trunnion O-Ring
	24	1	Trunnion Backup Ring
	25	2	Seat O-Ring
	26	2	Seat Backup Ring
	27	2	Grease Seal Seat O-Ring
	28	1	Stem Seal
	29	1	Ball
	30	1	Trunnion
	31	1	Stem
	32	2	Seat Assembly
	33	2	Seat Wave Spring
	34	1	Ground Wave Spring

1	Body stud and nut qty. =	6 for 2" 1500 8 for 2" 2500 and 3" - 4" 1500-2500 16 for 6" and 8" x 6" 1500
2	Retainer ring =	3 for 2" 1500 0 for 2", 3", 4" 2500 and 4" 1500 2 for 3" 1500 0 for 6" and 8" x 6" 1500
3	Stop =	Socket head screw for 2" - 4" 150 and 2" - 3" 2500 Pin for 4" 2500, 6" and 8" x 6" 1500
4	Key, square qty. =	0 for 2" - 3" 1500 1 for 2" - 4" 2500 and 4" 1500, 6" and 8" x 6" 1500
5	Drain fitting	2" through 4" = 1/2", 6" x 4" = 3/4"

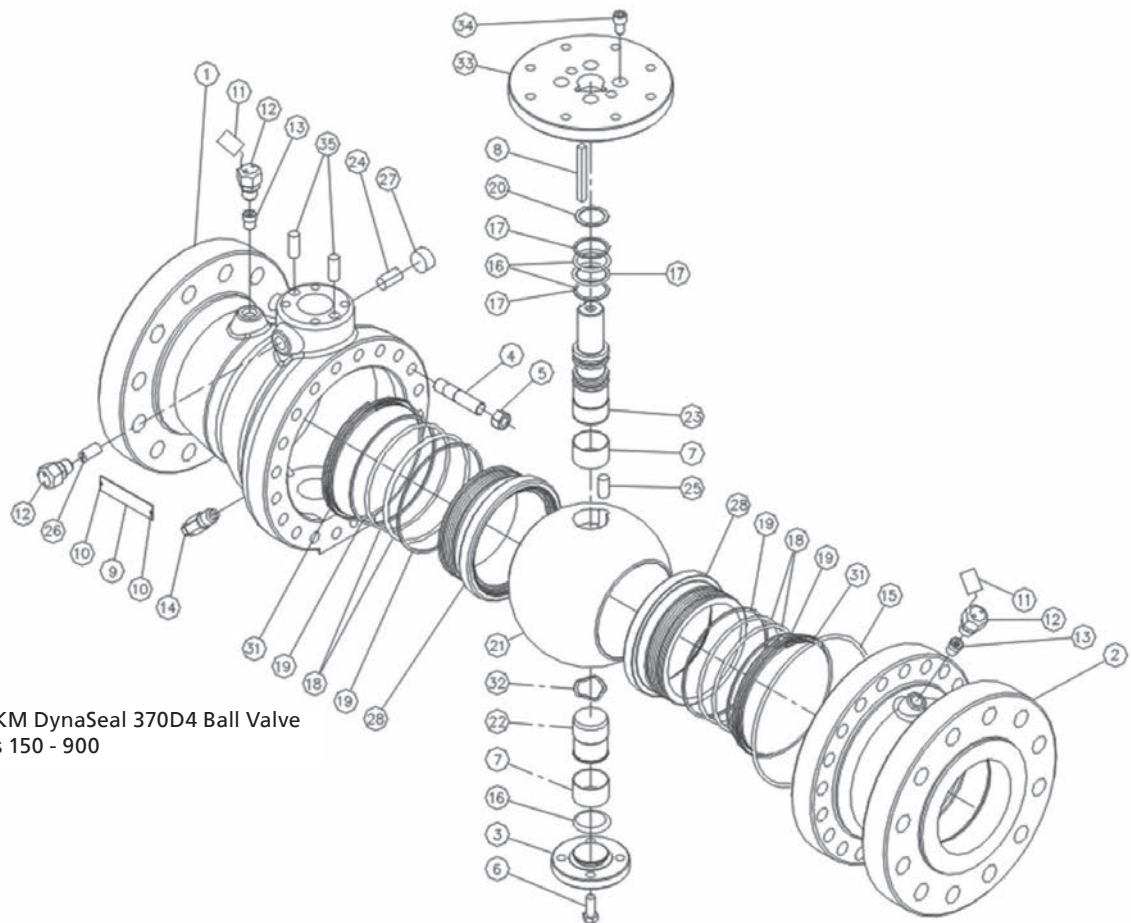


Figure 4 - WKM DynaSeal 370D4 Ball Valve  
6" - 16" Class 150 - 900

## BILL OF MATERIALS

### 6" - 16" CLASS 150 - 900

	Item	Qty	Description
	1	1	Body
	2	1	Tailpiece
	3	1	Lower Cover Plate
	4	*	Body Stud
	5	*	Body Nut
	6	4	Bolts (Lower Cover Plate)
	7	2	Bearings (Trunnion and Stem)
	8	1	Stem Key
	9	1	Nameplate
	10	2	Drive Screw
	11	2	Caution Tag for Check Valve
	12	3	1/2" Grease Fitting
	13	2	1/2" Check Valve
	14	1	Drain Fitting
	15	1	Tailpiece O-Ring
	16	3	Stem and Trunnion O-Ring
	17	2	Stem Backup Ring
	18	4	Seat O-Ring
	19	4	Seat Backup Ring
	20	1	Stem Thrust Washer
	21	1	Ball
	22	1	Trunnion
	23	1	Stem
	24	*	Stem Retainer
	25	1	Pin
	26	*	Grease Fitting Stem Retainer
	27	*	Pipe Plug
	28	2	Seat Assembly
	31	2	Seat Wave Spring
	32	1	Ground Wave Spring
	33	1	Adapter Plate
	34	4	Bolts (Adapter Plate)
	35	2	Pin (Adapter Plate)

- 1 Body stud and nut qty. =  
10 for 6" - 8" 150, 6" 300 and 10" 150  
12 for 8" 900 and 12" 150  
16 for 6" - 8" 900 and 10" - 12" 300 and 14" - 16" 150  
20 for 6" - 4" 600 and 10" - 12" 900 and 16" 300  
24 for 16" 600
- 2 Stem retainer and pipe plug qty. = 0 for 6" - 12" 150, 6" - 12" 300 and 6" - 8" 600  
1 for 10" - 16" 600 and 6" - 12" 900
- 3 Grease fitting retainer qty. = 1 for 6" - 12" 150, 6" - 12" 300, 6" - 8" 600 and  
8" - 10" 900  
0 for 10" - 16" 600, 6" 900 and 12" 900
- 4 Drain fitting = 6" and 8" = 3/4"  
10" and up = 1"

## NAMEPLATE INFORMATION

A nameplate is permanently affixed to each WKM DynaSeal 370D4 Ball Valve. The nameplate lists all the information necessary to identify the valve when making inquiries. Attaching the nameplate to the valve is the final step in a series of operations designed to provide you with quality service when ordering replacement parts, accessories, or making any inquiry about your valve's operation or maintenance.

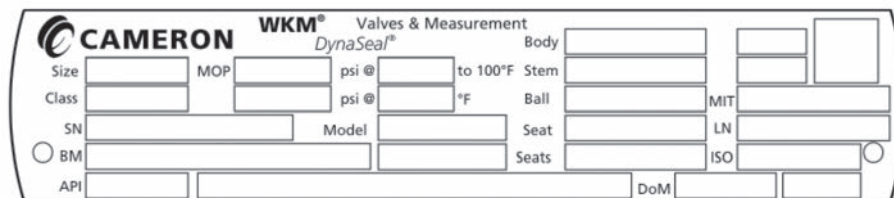


Figure 5 - WKM  
DynaSeal 370D4 Ball Valve Nameplate

Item		Stamp
1	Size	If full bore, size is nominal bore size. If reduced (regular or venturi port), size is nominal (end size) x bore through ball x nominal (end size)
2	Class	Pressure classification
3*	SN	Valve's unique serial number
4	B/M	Number of valve assembly bill of material
5	CWP	Cold working pressure; the working pressure of the valve in psi @ 100° F
6	Body	Body material
7	Temp	Operating temperature range
8	Model	Valve's model designations
9	Stem	Stem material
10	Ball	Ball material
11	Seat	Seat material
12	Seals	Seal material
13	6D	For 6D valves with special lengths, end-to-end length is stamped here
14	DOM	Date of manufacture
15	MIT	Maximum impact temperature
16	LN	API license number

\* Most important data for obtaining replacement parts.

## SCOPE

The WKM DynaSeal 370D4 end-entry, double block and bleed, trunnion ball valve is engineered for lengthy reliable performance. Manufactured in a variety of body and seal materials, this valve meets the requirements of the oil and gas pipeline industries, oil production industries as well as specialized pipeline and industrial process applications.



### Available Sizes

Sizes	150	300	600	900	1500	2500
2"	x	x	x	x	x	x
3x2"			x	x		
3"	x	x	x	x	x	x
4x3"			x	x		
4"	x	x	x	x	x	x
6x4"	x	x	x	x	x	x
6"	x	x	x	x	x	
8x6"	x	x	x	x	x	
8"	x	x	x	x		
10x8"	x	x	x	x		
10"	x	x	x	x		
12x10"	x	x	x	x		
12"	x	x	x	x		
14x12"	x	x	x	x		
14"	x	x	x			
16"	x	x	x			

## STORAGE

After WKM DynaSeal 370D4 Ball Valves are assembled and tested, the valves are left in the full open position, seats and bores are greased and end protectors are installed. These measures will provide protection for approximately six months. The following care should be taken when storing valves:

1. Make sure the valve end connection covers remain in place during storage.
2. If the valve does not have an operator and the valve will be stored outside, the exposed stem or the stem adapter should be covered to avoid accumulation of water and debris.

If long-term storage is required, the valve should be conditioned by following procedure X-150771-01 and ensure adequate end connection covers are in place. Request a copy of X-150771-01 from Cameron's Valves & Measurement group.

## INSTALLATION

DynaSeal 370D4 Ball Valves may be installed in most positions with flow from either direction. However, for best service life there is a preferred horizontal position to maximize sealing and minimize the accumulation of sediment. In horizontal piping it is preferable to have the stem lying horizontal (i.e. stem toward the viewer) with pressure from the right. During operation, flow will act as a siphon and minimize retention of sediment. When handling or installing a valve, keep the valve in the full open position whenever possible to prevent foreign object damage to the ball.

1. The valve should be lifted in such a way that the body supports the load.

**Caution:** The journal and the end connection necks are suitable places to attach lifting slings. Never use handwheels or other protruding parts of the valve, gearbox or actuator not designated for this purpose.

2. If the valve is equipped with lifting lugs, these should be used for handling.
3. The end protector covers should be kept in place on the end connections during all handling. Remove only during final installation of the valve.

**Caution:** During handling, protect the end connection faces and fittings against damage from the lifting devices. Failure to cover faces and fittings could cause damage to the valve.

Flanged-end valves may be bolted into the line using two open or boxed end wrenches.

1. Threads of flanged bolts and nuts should be lubricated to obtain proper loading of bolts.
2. Finger-tighten all nuts first.
3. When tightening bolts, use the crisscross method and torque each bolt to ASME or gasket manufacturer's specification.

Butt welded ends - To prevent seat and seal damage due to excessive heat or weld slag, the following procedure is recommended for welding DynaSeal 370D4 Ball Valves into a line:

1. Use solvent to clean grease or rust inhibitor from the ball and/or bore of the valve.
2. Electric welding equipment is preferred for all installations. However, if only oxygen-acetylene welding equipment is available, extreme caution should be taken regarding excess welding temperature.
3. Weld with the ball in the "Full Open" position.
4. Make sure the temperature of the body/seat area does not exceed 250° F. (Check with Tempil stick).
5. Avoid rapid application of excess welding material. Weld each end of valve with a continuous bead using a 1/8" maximum diameter electric welding rod.
6. Thoroughly clean (by pigging and/or flushing) weld slag from the valve bore and line before turning ball to the closed position.

If the ball must remain in the closed position during the installation of the valve, coat the exposed surfaces of the ball with grease. This will protect the ball from damage due to weld splatter.

**Caution:** A weld end valve without pup pipes should never be installed in the closed position.

After installation (of the valve in line) is complete and any desired testing is finished, the valve should be thoroughly drained to eliminate water or other test fluid from the body (see Draining Valve and Releasing Body Pressure, page 25). If the valve is equipped with seat injection, the seats should be charged with valve lubricant to displace any residual moisture in the seal areas (see Maintaining Seals, page 27).

**Caution:** Do not leave the valve in a partially open position for an extended period of time.

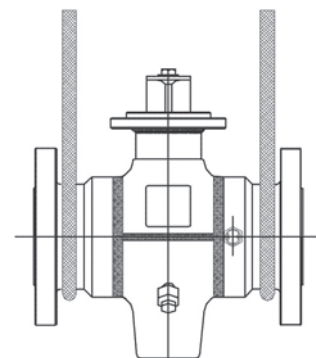


Figure 6 - Correct Valve Lifting Using End Connection Necks

## HYDROSTATIC TESTING

When WKM DynaSeal 370D4 Ball Valves are installed in a piping system that requires hydrostatic testing of the adjoining pipe, follow these procedures to minimize any damage that could occur to the sealing surface and seat seals inside the valve.

**Caution:** *Ensure that all test fluid contains corrosion inhibitors and that these are compatible with the valve seat and seal material.*

1. The valve should be in the fully open position when the injection of test fluid begins. This will allow any pipeline debris to be flushed through the valve bore and out of the piping.
2. Once the piping system has been purged of debris and the system has been filled completely with the test fluid, the ball should be placed in the partially open position (approximately 10 degrees from the fully open position). This allows test fluid into the body cavity of the valve.
3. The valve is now ready to be hydrostatic pressure tested.
4. Upon completion of hydrostatic testing, the valve should be returned to the fully open position before removing the test fluid from the piping system. The test fluid in the body cavity can be drained through the body drain port located on the lower portion of the valve body (see Draining Valve and Releasing Body Pressure, page 25).
5. Close the valve body bleed fitting and return the valve to required operating position, either fully open or fully closed.

## MOUNTING A GEAR/ACTUATOR

To mount a gear on a valve, use the following as guidelines:

**Note:** *The following information is for typical gear designs. Specific instructions for each design should be obtained from gear manufacturer.*

1. Make sure the valve is in the fully open or closed position and position the actuator to match.
2. Depending on the valve stem and the gear mounting kit, it is possible that the actuator may be installed in multiple positions. If this is the case, determine where the customer desires the handwheel and install it accordingly. A thin layer of anti-seize or grease on the valve stem is recommended.
3. Once the operator is mounted, secure it with the appropriate bolts. If the bolt holes do not line up, slightly operate to the open or closed to match the mounting flange.
4. It is now necessary to set the operator stops as outlined in the following section.

## SETTING STOPS

DynaSeal 370D4 Ball Valves do not have stops when mounting a gear or actuator on 2" through 4x3" class 150 through 2500 and 4" through 6x4" class 1500 and 2500. The stop plate (item 9) and stop (item 17, class 150 – 900 /item 11, class 1500 – 2500) are removed before

mounting an operator. The 4" and 6x4" class 150 through 900 also has no manual stop plate when specified for actuation. An adapter plate (item 31) is provided. All other DynaSeal 370D4 Ball Valves, 6" and larger, are equipped with a slot in the adapter plate (item 33 of figure 4). The key on the valve stem overlaps this slot and will indicate the stem location for full open and full closed.

**Caution:** *This slot is not designed to absorb the full operating torque of the valve. It is provided as a positive location to set the gear/actuator stops. Apply only enough torque or power to move the ball and stem to the open or closed position with no differential pressure across the valve.*

1. Make sure that operating the valve to the fully open and fully closed position will not disrupt current operation of the line.
2. Loosen the open and closed stop screw locknuts on the operator.
3. Partially back out the stop screw on the open side of the operator.
4. Operate the valve to the full open position. This is indicated when the flats on the stem are in line with the bore (2" through 6x4") or when the key touches the slot in the adapter plate (6" through 14x12"). If the ball stops short of the full open position, additionally back out the open stop screw on the operator and move the ball to the full open position.
5. Turn the open stop screw clockwise until it stops, then tighten the locknut.
6. To set the closed stop, partially back out the stop screw on the close side of the operator.
7. Operate the valve to the full close position. This is indicated when the flats on the stem are perpendicular to the bore (2" through 6x4") or when the key touches the slot in the adapter plate and the key is perpendicular to the bore (6" through 14x12"). If the ball stops short of the full close position, additionally back out the closed stop screw and move the valve to the full close position.
8. Turn the close stop screw clockwise until it stops, then tighten the locknut.
9. After mounting the operator, operate the valve three times to check for proper movement.
10. Perform a seat seal test on each side of the valve.

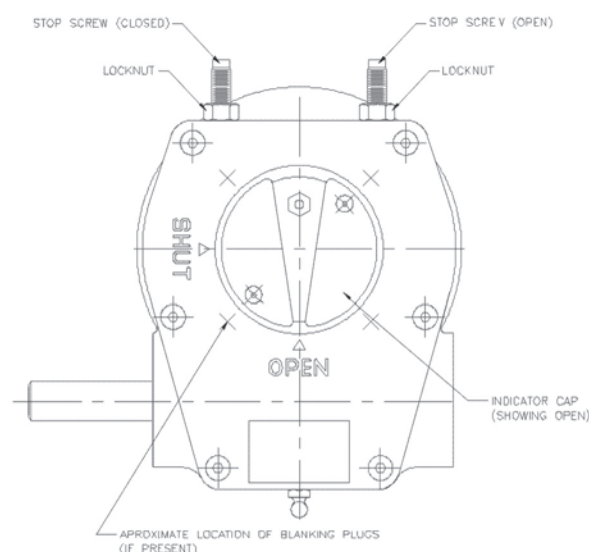


Figure 7 - Typical Gear Box with Stops

## OPERATION

DynaSeal 370D4 Ball Valves operate from fully open to fully closed by a 90 degree turn of the handle. The handle aligned with the pipe always means the valve is open. The handle perpendicular to the pipe means the valve is closed. Additionally, for stems with keys the bore of the

ball is in line with the key and for stems with two flats, double D configuration, the bore of the ball is in line with the flats.

Worm gear operators, available on all size valves, have an arrow on the top of the operator unit that indicates the "OPEN - CLOSE" position of the ball. The open and closed position of the valve is set or controlled by stops on the worm gear unit. Facing the handwheel, rotating the handwheel clockwise closes the valve while counterclockwise opens the valve. The handwheel should be turned until it contacts an open stop or closed stop depending on the desired valve position.

**Note:** *Handwheel movement in these directions is an accepted industry practice for opening and closing any valve with a worm gear operator.*

DynaSeal 370D4 Ball Valves may be power actuated. Pneumatic and hydraulic actuators, whether of the fail-open, fail-close, or fail-last position type, have "OPEN - CLOSED" indicators on the top of each unit. On a pneumatic actuator, make sure filters and lubricators (if recommended by the actuator manufacturer) are installed prior to the valve and actuator installation. Should any maintenance be necessary, obtain the part number from the unit's nameplate and contact Cameron's Valves & Measurement group or the nearest representative.

The body cavity of a DynaSeal 370D4 Ball Valve can be blown down or drained through the body vent port when the valve is closed with pressure on each side of the ball. Take the following steps when double block and bleeding the valve.

**Warning:** *Make sure proper safety garments are worn and follow all customer safety procedures. Failure to do so could injure you or others.*

1. Note the location of the body vent fitting. Check the direction the hole on the side of the vent fitting. Any debris in the valve or fitting will be exhausted at a high velocity.

**Warning:** *To avoid possibly being struck by liquid or foreign solid matter, position yourself so the hole of the bleed fitting is pointing safely away from you and backup the vent body so only the hex head on the top of the fitting is unscrewed.*

2. With the valve fully closed, open the body vent fitting all the way. A backup wrench on the body of the fitting should be used to prevent accidental loosening and removal of the body vent fitting.

For additional information on venting, see Draining Valve and Releasing Body Pressure on page 25.

**Warning:** *Never try to block and bleed the valve in the partially open position.*

## ROUTINE MAINTENANCE

Under normal working conditions, the WKM DynaSeal 370D4 Ball Valve is designed for lengthy, reliable service. The following recommended practices and procedures will ensure optimum performance of your valve.

**Caution:** *Verify compatibility of any sealant, lubricant, or antifreeze with the trim of the valve and product in the line.*

## Types of Fittings:

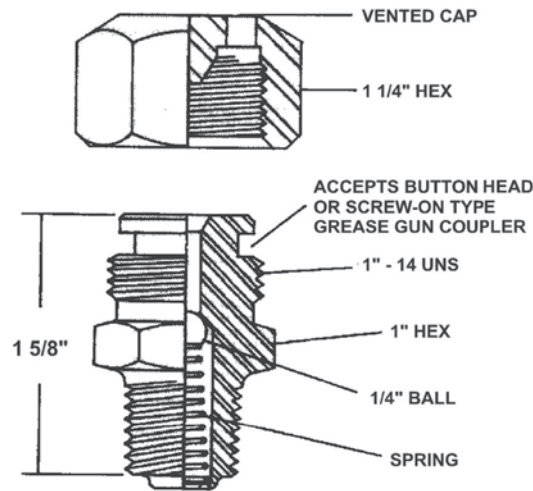


Figure 8 - Typical Injection Fitting

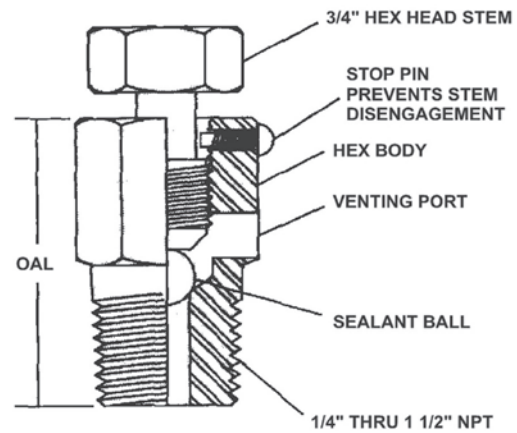


Figure 9 - Vent or Bleed Fitting

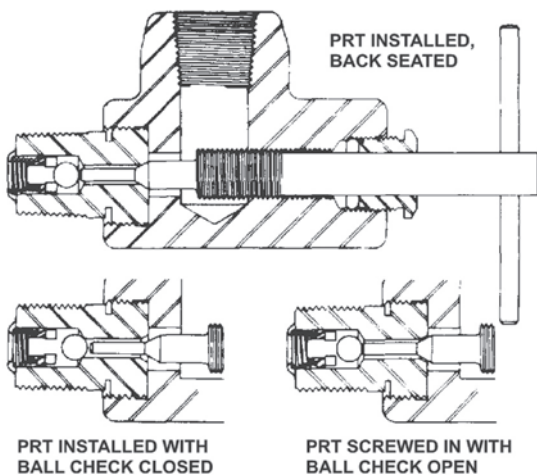


Figure 10 - Pressure Releasing Tool Shown on Injection Fitting

## DRAINING VALVE AND RELEASING BODY PRESSURE

After lengthy service, there is a possibility of water, line scale, sediment or other foreign matter collecting in the lower body cavity. It is advisable to periodically drain the valve to discourage development of conditions that can possibly lead to valve damage or impair the operation of your valve. If draining is not regularly scheduled, it is strongly recommended to drain the valve at these times:

1. After hydrostatic testing;
2. After cleaning the line;
3. When valve cannot be fully opened or closed (foreign matter in the bottom of valve cannot only prevent placing valve in a fully open or closed position, it can also cause permanent damage to the internal sealing surfaces).

If valve is equipped with a vent or bleed fitting in the lower drain (to release body pressure or drain the valve) first place ball in closed position.



**Warning:** To avoid possibly being struck by liquid or foreign solid matter, position yourself so relief port of vent or bleed (drain) fitting is pointing safely away from you and back up the vent or bleed (drain) fitting so only the stinger is unscrewed.

Carefully unscrew the stinger of the vent or bleed (drain) fitting to allow free flow of air, liquid or foreign solid matter to escape from body cavity. After body pressure is released or valve is drained, screw the stinger of the vent or bleed (drain) fitting back in to close the vent.

If valve is equipped with a grease fitting in the lower drain, a safety pressure releasing tool is required to simplify the procedure of releasing body pressure or draining the valve. To release body pressure or to drain valve, first place ball in closed position.

**Warning:** To avoid possibly being struck by liquid or foreign solid matter, position yourself so the outlet port of grease fitting is pointing safely away from you and back up the grease fitting so only the safety cap is unscrewed.

Carefully remove the safety cap of the lower drain grease fitting. Back out the stinger of the pressure releasing tool until it stops. Install the safety pressure releasing tool onto the uncapped grease fitting. Carefully screw the stinger of the releasing tool in (until the ball check in the grease fitting is pushed off its seat). This will allow the valve to drain or to release body pressure. After completion, back out the stinger of the pressure releasing tool to allow the ball check in the grease fitting to reseal and permit easy removal of the pressure releasing tool. Replace safety cap on the lower drain grease fitting.

## LOW TEMPERATURE PRECAUTIONS

Prior to exposure to freezing temperatures, it is highly recommended the valve be drained. Water that may be trapped in the body cavity could freeze and impair the operation of the valve or damage the valve. If the valve has a grease fitting in the lower drain, a sufficient amount of antifreeze injected into the body cavity via the lower drain grease fitting will prevent accumulated water from freezing.

It is also advisable to inject a sufficient amount of valve lubricant into the grease fittings of valve and operator (if present) prior to extended cold temperature exposure.

Trapped water should be drained from stem extensions. Some stem extensions in the field are equipped with plastic plugs that can be removed to drain trapped water from the piped extension.

## ROUTINE SEAT CLEANING

The seat pocket area is the primary area where any valve can be affected by contaminants in the lines. To ensure the seat's free movement, it is recommended that the valve seat pockets be cleaned routinely with an approved product. (The frequency of routine cleaning depends on the severity of service, but once a year is a good guideline). The following cleaning procedure can be used on valves equipped with seat injection fittings:

1. Locate the seat injection fittings on the valve.
2. Make sure the grease gun / pump is in working order and loaded with the appropriate product.

**Warning:** Back up the seat grease fitting so only the safety cap will be removed from the fitting. Carefully remove the safety cap from the seat grease fitting. NEVER remove the grease fitting when the valve is under pressure.

3. Remove the safety vent cap from each grease fitting. Attach grease gun connection onto grease fitting and inject the full seat capacity of valve flush into each seat.
4. Make sure it is safe to operate the valve. Fully operate the valve three times.
5. Remove grease gun and replace safety vent caps on the grease fittings.

If additional cleaning is desired, inject the full seat capacity of valve flush into each seat and allow to soak for one to six hours. Inject the full capacity of valve flush again and operate the valve (if safe to do so) three times. This additional cleaning may help break up buildup of contaminants.

## MAINTAINING SEALS

The WKM DynaSeal 370D4 Ball Valve is non-lubricated. Unlike a typical plug valve the DynaSeal 370D4 does not depend upon the injection of sealant to activate seals. However, occasionally injecting valve lubricant into seat and stem grease fittings will ensure optimum performance of the seat and stem seals and can help maintain long reliable service.

## TEMPORARY SEAL RESTORATION

If your valve seats or stem seal fail, normally it is possible to restore the seal or minimize any seat or stem leakage for an extended period of time (until it is convenient to remove the valve from service and replace the seals) with the injection of a sufficient amount of valve sealant into grease fitting (see chart for list of sealants). The valve must be equipped with the seat and/or stem injection feature.

WKM 103 Sealant is viscous grease with a consistency of peanut butter. It consists of synthetic oils, a suspending agent, friction-reducing filler, plastic, and an antioxidant. WKM 103 Sealant may be used in valves with a temperature range of -50° F through 250° F. This sealant is suitable in lines transporting hydrocarbon liquids and gases where water, dilute acids, alkalies or salt solutions may be present as well as where sweet or sour produced gas with water or organic condensate, LPG and aqueous solutions are being transported. The gallon containers are for use with bucket-type high-pressure grease guns. Gun cartridges are poly bags sized to fit screw/prime high pressure handguns.

Temporary seat seal restoration with the valve under line pressure for valves equipped with seat injection:

1. Fill the WKM high pressure grease gun with valve sealant.
2. Place the valve in a fully closed position.

**Warning:** *Back up the seat grease fitting so only the safety cap will be removed from the fitting. Carefully remove the safety cap from the seat grease fitting. NEVER remove the grease fitting when the valve is under pressure.*

3. Remove safety vent cap from grease fitting. Attach grease gun connection onto grease fitting and inject sealant.
4. Repeat process for the second seat grease fitting. If injection of the sealant is difficult, flush the valve seats and attempt to inject sealant again. Replace safety caps on seat grease fittings.

Temporary seat seal restoration with the valve out of line:



**Note:** Before removing the valve from the line, all pressure must be relieved from the valve and line.

1. Fill the high pressure grease gun with valve sealant.
2. Back up the seat grease fitting so only the cap will be removed from the fitting.
3. Carefully remove the safety cap from the seat grease fitting.
4. With the valve out of line, you should be able to view the bore interior.
5. Attach the high pressure grease gun connection onto the grease fitting and inject sealant until sealant enters the valve bore.
6. Repeat process for the second seat grease fitting. Replace safety caps on seat grease fittings.
7. Excess sealant should be removed from the valve bore before valve is put back in service.

Temporary stem seal restoration for valves equipped with stem injection fittings:

1. Fill the WKM high pressure grease gun with valve sealant.

**Warning:** Back up the stem grease fitting so only the safety cap will be removed from the fitting.

2. Carefully remove the safety cap from the stem grease fitting.
3. Attach grease gun connection onto grease fitting and inject sealant in stem grease fitting.
4. Replace safety cap on stem grease fitting.

Sealant, Lubricant, and Flush Volumes for Valves with Individual Seat Injection		
Nominal Size (Inches)	Sealant or Lubricant per Seat (Ounces)	Valve Flush per Seat (Ounces)
2	3	5
3	4	7
4	5	9
6	7	13
8	9	17
10	12	21
12	14	26

WKM Sealant and Lubricant		
Sealant No. 103 Part Number		Valve Lubricant 58G Part Number
Gun Cartridge	K155812	Gun Cartridge K154208
1 gal - 10 lbs	K155849	
3 gal - 30 lbs	K155853	
5 gal - 50 lbs	K155857	
16 gal - 150 lbs	K155866	
55 gal - 551 lbs	K155869	

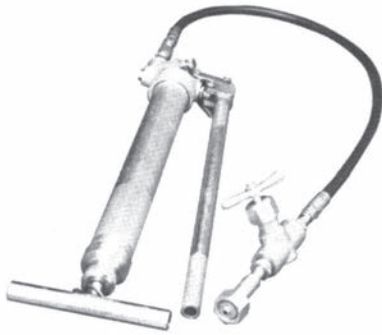


Figure 11 - Screw/Prime Hand Gun  
Part No. 2122495-01  
(Exact configuration may vary from  
photograph.)



Figure 12 - Bucket-Type Gun  
Part No. K065189  
(Exact configuration may vary  
from photograph.)



Figure 13 - Air Over Hydraulic Foot Pump  
Part No. 2330398-01

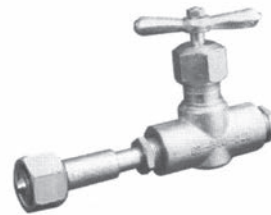


Figure 14 - Adapter Fitting  
Part No. K296434

### Approved Flush/Sealant

The following products are recommended by the cleaner/sealant manufacturers for the indicated service and condition. Contact your Cameron Valves & Measurement group's representative for availability.

Service Conditions	Product	Cleaner / Sealant Manufacturer			
		WKM	Val-Tex	Sealweld	Lubchem
Natural Gas	Flush		Valve Flush	Valve Cleaner	Valve Saver
	Standard Valve Lubricant	WKM 58G	2000 Light Lube	EQ 80	Lubchem "50-400"
	Standard Sealant	WKM 103	80 bulk/80-Hs stick	Total Lube 911*	Everlast No. 1
	Standard Low Temp		750 bulk/stick	Winterlub 7030*	Everlast No. 1 AG
	Severe Leak Sealant		80+FTFE bulk/stick*	Sealweld #5050*	Formasil RS
Sour Gas	Flush		Valve Flush	Valve Cleaner	Valve Saver
	Standard Valve Lubricant	WKM 58G	2000 Ligh Lube	EQ 80	Lubchem "50-400"
	Standard Sealant	WKM 103	700 bulk/stick	Total Lube 911*	Lubchem "50-400"
	Standard Low Temp		750 bulk/stick	Winterlub 7030*	Lubchem "50-300"
	Severe Leak Sealant		700+FTFE bulk/stick*	Sealweld #5050*	Formasil RS
Dry CO2	Flush		Valve Flush	Valve Cleaner	Valve Saver
	Standard Valve Lubricant	WKM 58G	2000 Light Lube	Sealweld Silicone Lubricant	Everlast WR
	Standard Sealant	WKM 103	700 bulk /stick	Sealweld Silicone Lubricant	Everlast WR
	Standard Low Temp		750 bulk/stick	Sealweld Silicone Lubricant	Everlast WR
	Severe Leak Sealant		700+FTFE bulk/stick*	Sealweld Silicone Sealant	Formasil CO2
Crude Oil	Flush		Valve Flush	Valve Cleaner	Valve Saver
	Standard Valve Lubricant	WKM 58G	2000 Light Lube	EQ80	Lubchem "50-400"
	Standard Sealant	WKM 103	700 bulk/stick	Total Lube 911*	Lubchem "50-400"
	Standard Low Temp		750 bulk/stick	Winterlub 7030*	Lubchem "50-300"
	Severe Leak Sealant		700+FTFE bulk/stick*	Sealweld #5050*	Formasil WR

\* Contains PTFE

## VALVE CLEANER / SEALANT MANUFACTURERS

### Headquarters

Cameron Valves & Measurement  
3250 Briarpark Drive, Suite 300  
Houston, TX 77042  
281/499-8511  
800/323-9160  
281/261- 3588 Fax  
www.c-a-m.com

### Val - Tex

Valves Incorporated of Texas  
10600 Fallstone Rd.  
Houston, TX 77099  
281/530-484  
800/627-9771

### Sealweld

7240 Brittmore Suite 120  
Houston, TX 77041  
713/937-9222  
800/237-0564

### Lubchem Inc.

P.O. Box 2626  
Spring, TX 77383  
281/350-9600

## TROUBLESHOOTING

Trouble	Probable Cause	Remedy
The valve is hard to operate	Actuator Unit	Refer to actuator maintenance manual or remove actuator cover and check stem adaptation and linkage for damage.
	Infrequent operation - lack of lubrication	Lubricate seats with valve lubricant and actuator with suitable industrial grease.
	Ice in valve operator	Apply heat or inject antifreeze solution into valve, but consult with authorized dealer prior to using remedy on operators.
	Buildup in the seat area due to line contaminants	Clean the seat area as outlined in Routine Seat Cleaning.
Ball is not properly aligned with bores of seats	Restrictions in bore of valve or stop not set properly	Remove bore restrictions or check stop in worm gear actuator and/or actuator limit switches.
Erratic Operation	Damaged actuator unit	Replace broken or damaged parts.
	Restriction of pneumatic actuator vent	Remove restriction.
	Faulty power supply	Check power supply.
	Infrequent operation - lack of lubrication	Lubricate seats with valve lubricant and actuator with suitable industrial grease.
Valve is leaking between tailpiece and body	Damaged O-ring seal	Disassemble and replace O-rings.
Leakage around valve stem	Damaged O-ring seal	Inject valve sealant into stem fitting (if present) or replace stem O-ring.
Valve will not fully close	Ice in body of valve	Apply heat or inject antifreeze solution into body of valve. Drain periodically to eliminate water accumulation.
	Improper setting of actuator limit switches or stops in worm gear	Reset actuator limit switches or stops for proper closing.
	Infrequent operation - lack of lubrication	Lubricate seats with valve lubricant and actuator with suitable industrial grease.
Grease fitting leaking	Damaged fitting	Tighten safety cap or replace safety cap if damaged. <b>WARNING:</b> Never remove entire grease fitting when valve is under pressure.
	Trash in fitting	Inject a small amount of cleaner into fitting to dislodge trash.

Trouble	Probable Cause	Remedy
Valve will not seal	Contamination around seat area due to service	Clean the seat area as outlined in Routine Seat Cleaning.
	Damaged seat face or seat O-ring	Inject seat sealant for temporary seal or replace seats.
	Valve not fully closed	Check that operator or limit-switches do not stop the rotation of ball prior to reaching the fully closed position.
	Valve stops incorrectly set	Adjust stops on actuator.
Gear operator hard to operate or stuck	Water in gear	Drain water and lubricate if possible. Replace weather seal if applicable.
Pneumatic operators excessive chatter during operation	Low air flow	Increase air flow and operation speed.
	Dried operator seals	Lubricate operator cylinder and seals with approved lubricant.
	Restriction in vent	Clear restriction.
	Actuator was undersized for service conditions	Check torque requirements of valve for service conditions.
	Service conditions require routine maintenance and/or lubrication	Refer to operator maintenance manual.



## VALVES & MEASUREMENT

3250 Briarpark Drive, Suite 300

Houston, Texas 77042

Tel 281.499.8511

For more information on WKM ball valves:

[www.c-a-m.com/WKM/ball](http://www.c-a-m.com/WKM/ball)

[WKMball@c-a-m.com](mailto:WKMball@c-a-m.com)



### **HSE Policy Statement**

At Cameron, we are committed ethically, financially and personally to a working environment where no one gets hurt, nothing gets harmed.

## **12.0 APPENDIX**



## **12.1 SERVICE AND ASSISTANCE**

GasTech Engineering LLC offers commissioning assistance and service. For a quotation of fees concerning such service contact the following.

**GasTech Engineering LLC**  
2110 Industrial Road  
Sapulpa, Oklahoma 74066

Telephone (918) 663-8383  
Fax (918) 663-8460

## **12.2 WARRANTY**

Regardless of any implication or expression of function or process warranty in this manual, the only warranty in effect is that stated specifically in the original offering quotation # **17-8579R3**.


### **12.3 CODES AND STANDARDS**


All equipment, material, design and fabrication procedures will be in accordance with applicable codes listed below:

Pressure Vessel:	ASME B&PV Code, Section VIII, Division I
Structural Welding:	ASME B&PV Code, Section IX
Process Piping:	ASME B31.3
Flanged Connections:	ASME B16.5 and ASME B16.47 Series A
Valve Dimensions:	ASME B16.10
Fasteners - Studs:	ASTM A193 Class 2A Grade B7
Fasteners - Nuts:	ASTM A194 Class 2B Grade 2H
Electrical:	Class 1 Division II, Group D

## **13.0 PSV CALCULATIONS**

<div style="display: flex; align-items: center;"> <div> <b>Gastech Engineering, LLC</b>  1007 e admiral blvd  tulsa ok 74120  United States of America  9186638383  dnorris@gastecheng.com </div> </div>					<b>Pressure Relief Valve Sizing &amp; Selection Report</b>						
					25-Oct-2017						
Quote Number:					No	Prpd.	Chk.	Appr.	Date	Revision	
Client: My Company Location: Project: 11048											
<div style="display: flex; justify-content: space-between;"> <div> End-User Ref. No.:  Project Ref. No.: </div> </div>											
1	<b>Valve ID</b>					41	<b>SIZING DATA</b>				
2	Tag No.	11048-PSV-1414				42	Design Code	ASME Section VIII		Sizing Std.	API 520
3	Service	NATURAL GAS				43	Sizing Basis	Fire Case			
4	PID No.	11046-100				44	Fluid State at Inlet	Gas / Vapor			
5	Line No.		Quantity			45	Relieving Case	Pressure Relief			
6			1			46	<b>Fluid Properties</b>				
7	<b>GENERAL</b>					47	Fluid Name		Natural Gas (SG=0.6)		
8	Valve Type	Conventional, DSO, O-ring Seat				48	Molecular Weight, M		17.400		
9	Safety / Relief	Safety	Balanced	No		49	Compressibility, Z		1.000		
10	Nozzle	Semi	Bonnet	Closed		50	Ratio of Sp. Heats, k (Cp / Cv)		1.31		
11	<b>CONNECTIONS</b>					51	Gas Constant, C		347.9		
12	Inlet	1 1/2"	Flngd.	600#	RF	52					
13	Outlet	3"	Flngd.	150#	RF	53					
14	<b>MATERIALS OF CONSTRUCTION</b>					54					
15	Body	CS SA216-WCB				55					
16	Inlet Bushing	N/A				56					
17	Bonnet	CS A105 (Zinc Cobalt Plated)				57					
18	Cap	CS A108-12L 14				58					
19	Nozzle	SS A479-316				59					
20	Seat					60	<b>Sizing Coefficients</b>		Unit	-	
21	Seals					61	K, Gas	Kd, Gas	0.816	0.907	
22	Spindle	SS A479-316				62	Kb	Kc	1	1	
23	Guide	SS A479-316				63					
24	Spring	STL 1060-1075 Aluminized				64					
25	Cap Type					65	<b>Required Capacity</b>		Unit	lb/hr	
26	NACE MR0175 (2002)	No				66	Total		28132.239		
27	Accessories					67	<b>Pressures</b>		Unit	psig	
28						68	MAWP	Operating	860	642	
29						69	Set	CDTP	860	860	
30						70	Over Pressure		180.6	21%	
31	<b>SIZING / SELECTION SUMMARY</b>					71	Back Pressure	Constant Superimposed		0	
32	Valve Model No.	83S1U12C24A-H_				72		Variable Superimposed		0	
33	Brand	Anderson Greenwood				73		Built-Up		6	
34	Area	Calculated	Selected	0.662	0.785	74		Total		6	
35	(in²)	Data Set	Orifice	ASME	H	75	Inlet Loss		17.2	2%	
36	Flow	Unit	Required	lb/hr	28132.239	76	Atmospheric (Barometric)		14.696	psia	
37		Rated	Actual	33362.836	37069.818	77	<b>Temperatures</b>		Unit	°F	
38						78	Normal System			90	
39	Estimated Reaction Force					79	Operating	Relieving	70	377.625	
40	Estimated Noise Level (db)		120.7 at 100-ft			80	Design Min	Design Max	-20	200	
Tag Notes						Valve Dimensions	A				
							B				
							C				
							Weight				

 <b>Gastech Engineering, LLC</b> 1007 e admiral blvd tulsa ok 74120 United States of America 9186638383 dnorris@gastecheng.com				<b>Pressure Relief Valve Calculation Report</b> 25-Oct-2017					
<b>Quote Number:</b>				No	Prpd.	Chk.	Appr.	Date	Revision
Client: My Company Location: Project: 11048									
End-User Ref. No.: Project Ref. No.:									
1	<b>VALVE ID</b>				11	<b>CALCULATION NOTES</b>			
2	Tag No.	11048-PSV-1414			12				
3	Valve Model No.	83S1U12C24A-H		Qty. 1	13				
4	<b>SIZING DATA</b>				14				
5	Design Code	ASME Section VIII		Sizing Std.	15	API 520			
6	Fluid State at Inlet	Gas / Vapor			16				
7	<b>CALCULATION SUMMARY</b>								
8	Flow	Required	28132.239 lb/hr		18	Area	Required	0.662 in²	
9		Rated	33362.836 lb/hr		19		Selected	0.785 in²	
10	Estimated Reaction Force				20	Estimated Noise Level (db) 120.7 at 100 ft			
<b>Variable Type</b>	<b>Variable Name</b>	<b>Symbol</b>	<b>Input Value</b>		<b>Equation Value</b>				
Fluid Properties	Molecular Weight	M	17.400		17.400				
	Ratio of Specific Heats	k	1.31		1.31				
	Compressibility	Z	1.000		1.000				
Process Cond.	Required Mass Flow	Wreq	28132.239 lb/hr		28132.239 lb/hr				
	Set Pressure	Pset	860 psig		860 psig				
	Over Pressure	Pover	180.6 psig		180.6 psig				
	Inlet Line Loss	Ploss	17.2 psig		17.2 psig				
	Back Pressure	Pback	6 psig		6 psig				
	Atmospheric Pressure	Patm	14.696 psia		14.696 psia				
	Relieving Temperature	T	377.625 °F		837.295 °R				
	Distance from Valve (noise)	r	100 ft		100 ft				
	Rupture Disc CCF	Kc	1		1				
Valve Data	Discharge Coefficient (actual)	Kd	0.907		0.907				
	Discharge Coefficient (derated)	K	0.816		0.816				
	Orifice Area	A	0.785 in²		0.785 in²				
	Back Press. Correction Factor	Kb	1		1				
	Outlet Diameter	Do							
<b>Calculate Inlet Relieving Pressure, Outlet Pressure, Absolute Pressure Ratio</b> $P1 = Pset + Pover - Ploss + Patm$ <b>P1</b> 1038.096 psia $P2 = Pback + Patm$ <b>P2</b> 20.696 psia $PR = P2 / P1$ <b>PR</b> 0.02									
<b>Calculate Gas Constant</b> <b>C</b> 347.9 $C = 520 * \{k * [2 / (k + 1)]^{(k + 1) / (k - 1)}\}^{0.5}$									
<b>Calculate Mass Critical Flow</b> <b>W</b> 33362.836 lb/hr $W = A * C * K * P1 * Kb * Kc * [M / (T * Z)]^{0.5}$									
<b>Calculate Required Orifice Area</b> <b>Areq</b> 0.662 in² $Areq = A * Wreq / W$									
<b>Calculate Mass Critical Flow (for Noise Calc)</b> <b>W</b> 37069.818 lb/hr $W = A * C * Kd * P1 * Kb * Kc * [M / (T * Z)]^{0.5}$									
<b>Calculate Noise Level at 100-ft (30-m)</b> <b>L100</b> 120.7 db $L100 = [6.5 * \log(1/PR) + 51.28] + [10 * \log(0.29354 * W * k * T / M)]$									

 <b>Gastech Engineering, LLC</b> 1007 e admiral blvd tulsa ok 74120 United States of America 9186638383 dnorris@gastecheng.com		<b>Pressure Relief Valve Calculation Report</b>						
						25-Oct-2017		
<b>Quote Number:</b>		<b>No</b>	<b>Prpd.</b>	<b>Chk.</b>	<b>Appr.</b>	<b>Date</b>	<b>Revision</b>	
Client: <i>My Company</i> Location: Project: 11048								
End-User Ref. No.: Project Ref. No.:								
1	<b>VALVE ID</b>				11	<b>CALCULATION NOTES</b>		
2	Tag No.	11048-PSV-1414			12			
3	Valve Model No.	83S1U12C24A-H	Qty. 1		13			
4	<b>SIZING DATA</b>				14			
5	Design Code	ASME Section VIII	Sizing Std.	API 520	15			
6	Fluid State at Inlet	Gas / Vapor			16			
7	<b>CALCULATION SUMMARY</b>							
8	Flow	Required	28132.239 lb/hr		18	Area	Required	0.662 in <sup>2</sup>
9		Rated	33362.836 lb/hr		19		Selected	0.785 in <sup>2</sup>
10	Estimated Reaction Force				20	Estimated Noise Level (db)		120.7 at 100 ft
<b>Calculate Noise Level at Distance, r</b> <span style="float: right;"><b>Lp</b></span> $Lp = L100 - 20 * \log(r / 100)$ <span style="float: right;">120.7 db</span>								
<b>Calculate Outlet Static Pressure</b> <span style="float: right;"><b>Po</b></span> $Po = [(0.00245 * A * C * Kd * P1 * Kc) / (Do^2 * (k * Z)^{0.5})] - Patm$								
<b>Calculate Reaction Force for Open Discharge</b> <span style="float: right;"><b>Fr</b></span> $Ao = (\pi * Do^2) / 4$ $Fr = (A * C * Kd * P1 * Kc / 366) * \{k / [(k + 1) * Z]\}^{0.5} + (Ao * Po)$								



Gastech Engineering, LLC  
1007 e admiral blvd  
tulsa ok 74120  
United States of America  
9186638383  
dnorris@gastecheng.com

# Pressure Relief Valve Dimensional Drawing

25-Oct-2017

Quote Number:

No	Prpd.	Chk.	Appr.	Date	Revision

Client: My Company

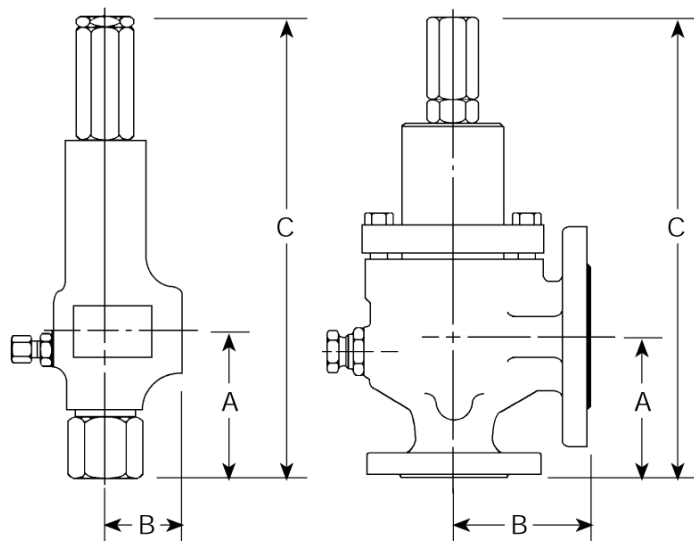
Location:

Project: 11048

End-User Ref. No.:

Project Ref. No.:

1	Valve ID			7	SELECTION SUMMARY					
2	Tag No.	11048-PSV-1414		8	Valve Model No.		83S1U12C24A-H_			
3	Service	NATURAL GAS		9	Brand		Anderson Greenwood			
4	PID No.	11046-100		10	CONNECTIONS					
5	Line No.		Quantity	11	Inlet	1 1/2"	Flngd.	600#	RF	Standard
6			1	12	Outlet	3"	Flngd.	150#	RF	ASME B16.5



Wt.= =

A= =

B= =

C= =

D= =

E= =

F= =

G= =

H= =

Tag Notes

Dimension Notes

- Accessories not shown.
- Weight and dimensions shown are approximate.
- Actual valve may vary from image.



## Summary Report

### Project Information

Company: My Company  
Location:

Project: 11048  
Project Ref. No.:

### Tag Information

Tag Number: 11048-PSV-1414

Revision:

Last Modified: 10/26/2017 10:35:45 AM

Prepared By:

Checked By:

Approved By:

### Specific Tank Data

Sized Using User Defined Flow

Pressure Fluid: Natural Gas (SG=0.6)  
Pressure Set Point: 860 psig  
Allowed Over Pressure: 180.6 psig  
Pressure Flow Rate: 28132.239

### Valve Sizing Information

Valve Type: 83, H  
Part Number: 83S1U12C24A-H\_  
Max Pressure Flow Capacity: 33362.836 lb/hr

Quantity to Order: 1

### Selected Valve Description

Code	Category	Description
N	Teflon Cap Seal	Standard Without Teflon Cap Seal
N	Test Gag	None
1	Code Case	No code case
AH	Internals Range	20 - 2580
C_	Body Selection	Carbon Steel
JH	Set Range	765.5 - 1150.5
ZZ	Valve Support	N/A
	Seat Range	
H	Max Operating Pressure	95% of Set Pressure
Z	Body Type	N/A
AH	Seal Range	20 - 2580
83	Valve Type	DSO PRV, O-ring Seated, Air/Gas Service
GS	Valve Service	Gas other than "Air"
H	Orifice	H Orifice
C	Body Material	Carbon Steel
12	Inlet Size	1 1/2 Inch
C	Inlet Flange Rating	600#
24	Outlet Size	3 Inch
A	Outlet Flange Rating	150#
1	Flange Facing In x Out	RF x RF
U	Port Type In x Out	Weldneck Flange x Standard Cast Flange
Z	NACE	Standard (without NACE)
	Seat Material	
	Seal Material	
	Lift Lever	
UH	Group PT - OR - 2	UH



Gastech Engineering, LLC  
1007 e admiral blvd  
tulsa ok 74120  
United States of America  
9186638383  
dnorris@gastecheng.com

# API 521 Fire Sizing Calculation

25-Oct-2017

Quote Number:

No	Prpd.	Chk.	Appr.	Date	Revision

Client: My Company

Location:

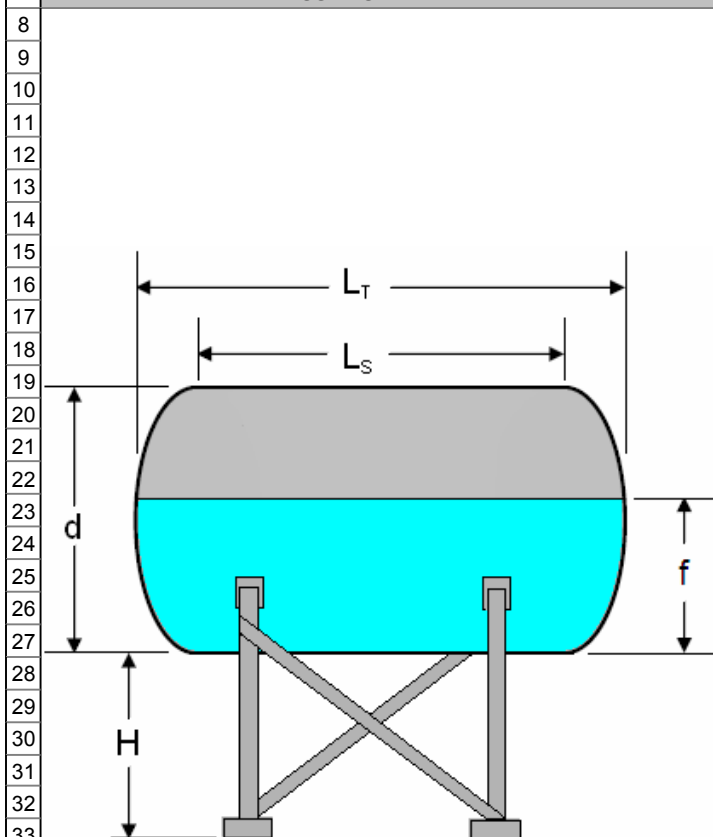
Project: 11048

End-User Ref. No.:

Project Ref. No.:

1	Valve ID	
2	Tag No.	11048-PSV-1414
3	Service	NATURAL GAS
4	PID No.	11046-100
5	Line No.	Quantity
6		1

## VESSEL SCHEMATIC



41	SIZING DATA			
42	Design Code	ASME Section VIII	Sizing Std.	API 520
43	Sizing Basis	Fire Sizing - API 521		
44	Method	Wetted (Liquid Filled) Vessel		
45				
46				

## VESSEL DATA

47	Surface Area Determination	Calculated		
48	Prompt-Fire Fighting Efforts and Adequate Drainage	No		
49	Geometry	Cylindrical		
50	Orientation	Horizontal		
51	End Types	2:1 Elliptical		
52	Diameter	d	12	in
53	Height	h		
54	Liquid Depth	f	12	in
55	Elevation	H	18	in
56	Seam-to-Seam Length	Ls	120	in
57	End-to-End Length	Lt	126	in
58	Wetted Surface Area	Awet	33.58	ft²
59	Environmental Factor	F	1.0	

$$Q = 34500 * F * Awet^{0.82}$$

where Q=BTU/hr, Awet=ft²

60	Heat Input from Fire Exposure	Q		
61	Latent Heat of Vaporization	Hvap	50	BTU/lb

$$W = Q / Hvap$$

where W=lb/hr, Q=BTU/hr, Hvap=BTU/lb

62	Required Capacity	W	28132.239	lb/hr
63				
64				
65				
66				
67				
68				
69				
70				
71				
72				
73				
74				
75				
76				
77				

## SIZING / SELECTION SUMMARY

78	Valve Model No.	83S1U12C24A-H_
79	Brand	Anderson Greenwood

Tag Notes

W CALCULATION IS:  
 $W = (A_{req}) (C * K * P1 * Kb * [M / (T * Z)]^{0.5}) / (A_{sel})$   
 EQ is equivalent to API 521 EQ 13 pg 43.  
 F=1 F is the environmental factor used in the tank sizing data.



Required Flow Rate Data

Fire Sizing Method Wetted

Wetted Area 33.58 ft²

☐ Prompt Fire-Fighting Efforts and Adequate Drainage Exists

Additional Capacity (for Pressure) 15821.714 lb/hr

Latent Heat of Vaporization 50 BTU/lb

Required Pressure Flow 28132.239 lb/hr

Environmental Factor 1.0

Enter Tank Data

Tank Data

Tank Shape Cylindrical

Orientation

- ☒ Horizontal
- ☐ Vertical

Ends

- ☐ Flat Ends
- ☒ 2:1 Elliptical Ends
- ☐ Hemispherical Ends

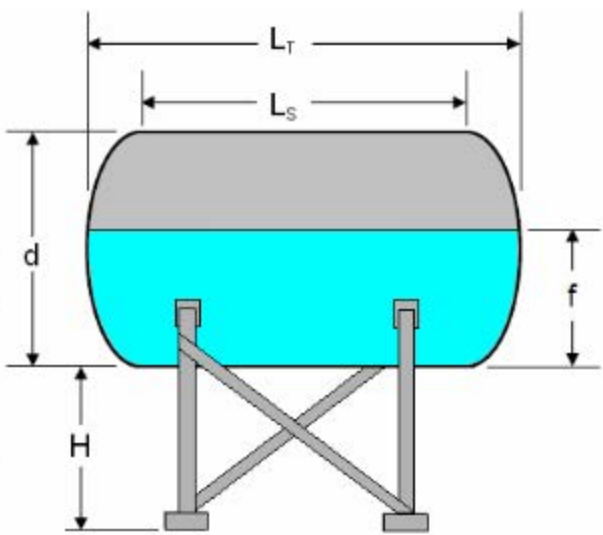
Diameter (d) 12 in

Elevation (H) 18 in

Liquid Depth (f) 12 in

☐ Length (End-to-End) (Lt) 126 in

☒ Length (Seam-to-Seam) (Ls) 120 in



OK

Cancel

## Required Flow Rate Data

Fire Sizing Method UnwettedSurface Area 266.54ft<sup>2</sup>☒ Calculate Fire Sizing Factor

Additional Capacity (for Pressure)

0.0

lb/hr

Environmental Factor 1.0Wall Temp. 1100

°F


Operating 70

°F

Operating Pressure 642

psig

Note: In order to continue Required Flow Capacity calculations, please fill out all required fields and return to the main worksheet by closing this dialog. Required Flow Capacity will be calculated for each candidate valve.

 Enter Tank Data

## Tank Data

Tank Shape Cylindrical

## Orientation

☒ Horizontal☐ Vertical

## Ends

☐ Flat Ends☒ 2:1 Elliptical Ends☐ Hemispherical EndsDiameter (d) 72

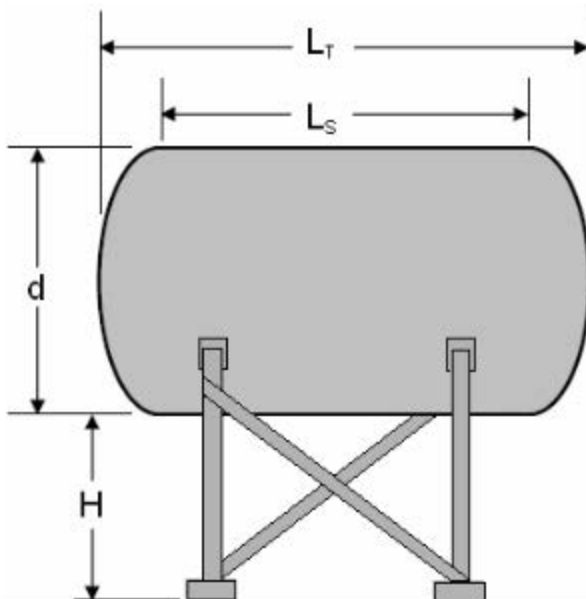
in

☐ Length (End-to-End) (Lt)156

in

☒ Length (Seam-to-Seam) (Ls)120

in



OK

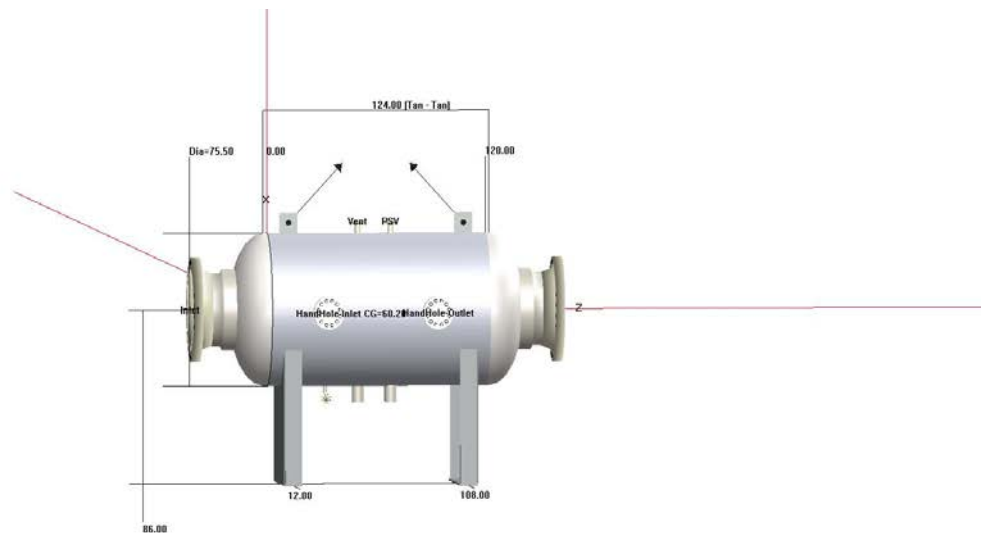
Cancel

## **14.0 PRESSURE VESSEL DESIGN CALCULATIONS**

# GasTech Engineering LLC

2110 Industrial Road

Sapulpa, OK, 74066



## GTE 11048 Upper Barrel Design Calculations

**Item:** Horizontal Cyclone Separator

**Vessel No:** V-1414

**Customer:** Williams Gas Pipe Line

**Contract:** 676280

**Designer:** Kamyar Najmi

**Date:** Wednesday, May 09, 2018

**Location:** Chester County, PA

**Purchaser:** Transcontinental Gas Pipe Line

**Name:** 11048-CC Upper Barrel REV 0

**P.O. Number:** 676280

**Tag Number:** V-1414

**Revision:** 0

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## Deficiencies Summary

***No deficiencies found.***

## Nozzle Schedule

Specifications									
Nozzle mark	Identifier	Size	Materials		Impact Tested	Normalized	Fine Grain	Flange	Blind
<a href="#">Downcomer - Inlet</a>	Downcomer - Inlet	NPS 6 XXS	Nozzle	SA-106 C Smls pipe	No	No	No	N/A	No
<a href="#">Downcomer - Outlet</a>	Downcomer - Outlet	NPS 6 XXS	Nozzle	SA-106 C Smls pipe	No	No	No	N/A	No
<a href="#">Drain</a>	Drain	NPS 2 Sch 160	Nozzle	SA-106 B Smls pipe	No	No	No	N/A	No
	<a href="#">Elbow (Drain)</a>	NPS 2 Sch 160	B16.9 Elbow	SA-234 WPB	No	No	No	N/A	No
	<a href="#">Elbow Pipe (Drain)</a>	NPS 2 Sch 160	Nozzle Piping	SA-106 B Smls pipe	No	No	No	NPS 2 Class 600 LWN A105 N	No
<a href="#">HandHole-Inlet</a>	HandHole-Inlet	8 ID x 1.375	Nozzle	SA-105	No	Yes	No	NPS 8 Class 600 LWN A105 N	NPS 8 Class 600 A105 N
<a href="#">HandHole-Outlet</a>	HandHole-Outlet	8 ID x 1.375	Nozzle	SA-105	No	Yes	No	NPS 8 Class 600 LWN A105 N	NPS 8 Class 600 A105 N
<a href="#">Inlet</a>	Inlet	34 ID x 3	Nozzle	SA-350 LF2 Cl 1	No	Yes	No	NPS 36 Class 600 WN A350 LF2 Cl.1 N	No
<a href="#">Outlet</a>	Outlet	34 ID x 3	Nozzle	SA-350 LF2 Cl 1	No	Yes	No	NPS 36 Class 600 WN A350 LF2 Cl.1 N	No
<a href="#">Plugged Connection 1</a>	Plugged Connection 1	NPS 1 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
<a href="#">Plugged Connection 2</a>	Plugged Connection 2	NPS 1 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
<a href="#">PSV</a>	PSV	2 ID x 0.655	Nozzle	SA-105	No	Yes	No	NPS 2 Class 600 LWN A105 N	No
<a href="#">Vent</a>	Vent	2 ID x 0.655	Nozzle	SA-105	No	Yes	No	NPS 2 Class 600 LWN A105 N	No

## Nozzle Summary

Dimensions										
Nozzle Identifier	OD (in)	t <sub>n</sub> (in)	Req t <sub>n</sub> (in)	Shell			Reinforcement Pad		Corr (in)	Gov. Stress Ratio (%)
				Nom t (in)	Design t (in)	User t (in)	Width (in)	t <sub>pad</sub> (in)		
<a href="#">Downcomer - Inlet</a>	6.625	0.864	0.4229	1.75	N/A		N/A	N/A	0.125	101.0
<a href="#">Downcomer - Outlet</a>	6.625	0.864	0.4229	1.75	N/A		N/A	N/A	0.125	101.0
<a href="#">Drain</a>	2.375	0.344	0.2969	1.75	N/A		N/A	N/A	0.125	Exempt
<a href="#">HandHole-Inlet</a>	10.75	1.375	0.4444	1.75	N/A		N/A	N/A	0.125	100.4
<a href="#">HandHole-Outlet</a>	10.75	1.375	0.4444	1.75	N/A		N/A	N/A	0.125	100.4
<a href="#">Inlet</a>	40	3	0.8774	1.625*	N/A		N/A	N/A	0.125	107.1
<a href="#">Outlet</a>	40	3	0.8774	1.625*	N/A		N/A	N/A	0.125	107.1
<a href="#">Plugged Connection 1</a>	2.25	0.4675	0.1875	1.75	N/A		N/A	N/A	0.125	Exempt
<a href="#">Plugged Connection 2</a>	2.25	0.4675	0.1875	1.75	N/A		N/A	N/A	0.125	Exempt
<a href="#">PSV</a>	3.31	0.655	0.314	1.75	N/A		N/A	N/A	0.125	Exempt
<a href="#">Vent</a>	3.31	0.655	0.314	1.75	N/A		N/A	N/A	0.125	Exempt
*Head minimum thickness after forming										

Definitions	
tn	Nozzle thickness
Req tn	Nozzle thickness required per 4.5.4.1 Increased for pipe to account for 12.5% pipe thickness tolerance
Nom t	Vessel wall thickness
Design t	Required vessel wall thickness due to pressure + corrosion allowance per 4.5.17
User t	Local vessel wall thickness (near opening)
Gov. Stress Ratio	Minimum stress ratio, $S_{allow} / P_L$ , $S / \tau$ , $S / \tau_n$
Corr	Corrosion allowance on nozzle wall

## Pressure Summary

Component Summary					
Identifier	P Design (psi)	T Design (° F)	MDMT (° F)	MDMT Exemption	Impact Tested
<a href="#">Inlet Head</a>	860	200	-26.1	Note 1	Yes
<a href="#">Straight Flange on Inlet Head</a>	860	200	-22.3	Note 2	Yes
<a href="#">Shell</a>	860	200	-21.9	Note 3	Yes
<a href="#">Straight Flange on Outlet Head</a>	860	200	-22.3	Note 2	Yes
<a href="#">Outlet Head</a>	860	200	-26.1	Note 1	Yes
<a href="#">Saddle #1</a>	860	200	N/A	N/A	N/A
<a href="#">Downcomer - Inlet (Downcomer - Inlet)</a>	860	200	-155	Note 4	No
<a href="#">Downcomer - Outlet (Downcomer - Outlet)</a>	860	200	-155	Note 4	No
<a href="#">Drain (Drain)</a>	860	200	-155	Note 5	No
<a href="#">Elbow (Drain)</a>	860	200	-155	Note 6	No
<a href="#">Elbow Pipe (Drain)</a>	860	200	-155	Note 6	No
<a href="#">HandHole-Inlet (HandHole-Inlet)</a>	860	200	-55	Note 7	No
<a href="#">HandHole-Outlet (HandHole-Outlet)</a>	860	200	-55	Note 7	No
<a href="#">Inlet (Inlet)</a>	860	200	-55	Note 8	No
<a href="#">Outlet (Outlet)</a>	860	200	-55	Note 8	No
<a href="#">PSV (PSV)</a>	860	200	-55	Note 9	No
<a href="#">Plugged Connection 1 (Plugged Connection 1)</a>	860	200	-155	Note 10	No
<a href="#">Plugged Connection 2 (Plugged Connection 2)</a>	860	200	-155	Note 10	No
<a href="#">Vent (Vent)</a>	860	200	-55	Note 9	No

Chamber Summary	
Design MDMT	-20 ° F
Rated MDMT	-21.9 ° F @ 860 psi
MAWP hot & corroded	860 psi
(1) This pressure chamber is not designed for external pressure.	

Notes for Maximum Pressure Rating	
Note #	Details
1.	Option to calculate MAP was not selected. See the Calculation->General tab of the Set Mode dialog.
2.	Option to calculate MAWP was not selected. See the Calculation->General tab of the Set Mode dialog.

Notes for MDMT Rating		
Note #	Exemption	Details
1.	Material is impact tested per UG-84 to -20° F.	UCS-66(i) reduction of 6.1° F applied (ratio = 0.939).
2.	Material is impact tested per UG-84 to -20° F.	UCS-66(i) reduction of 2.3° F applied (ratio = 0.9768).
3.	Material is impact tested per UG-84 to -20° F.	UCS-66(i) reduction of 1.9° F applied (ratio = 0.9812).
4.	Material is impact test exempt to -155° F per UCS-66(b)(3) (coincident ratio = 0.1792)	
5.	Nozzle is impact test exempt to -155° F per UCS-66(b)(3) (coincident ratio = 0.2854).	
6.	Material is impact test exempt to -155° F per UCS-66(b)(3) (coincident ratio = 0.2854)	
7.	Material LWN rated MDMT per UCS-66(c)(4) Flange rated MDMT per UCS-66(b)(1)(b) = -85° F (UCS-68(c) applies, coincident ratio = 0.5811)	Bolts rated MDMT per Fig UCS-66 note (c) = -55° F
8.	Material Flange rating governs: Flange is impact tested per material specification to -50° F. UCS-66(i) reduction of 44.5° F applied (ratio = 0.5811).	Bolts rated MDMT per Fig UCS-66 note (c) = -55° F
9.	LWN rated MDMT per UCS-66(c)(4) Flange rated MDMT per UCS-66(b)(1)(b) = -55° F (Coincident ratio = 0.5811) Bolts rated MDMT per Fig UCS-66 note (c) = -55° F	
10.	Nozzle is impact test exempt to -155° F per UCS-66(b)(3) (coincident ratio = 0.1008).	

### Revision History

Revisions			
No.	Date	Operator	Notes
0	12/ 6/2017	knajmi	New vessel created ASME Section VIII Division 1 [COMPRESS 2017 Build 7710]

## Settings Summary

COMPRESS 2018 Build 7800	
ASME Section VIII Division 1, 2015 Edition	
Units	U.S. Customary
Datum Line Location	0.00" from left seam
Vessel Design Mode	Design Mode
Minimum thickness	0.0625" per UG-16(b)
Design for cold shut down only	No
Design for lethal service (full radiography required)	No
Design nozzles for	Design P only
Corrosion weight loss	100% of theoretical loss
UG-23 Stress Increase	1.20
Skirt/legs stress increase	1.0
Minimum nozzle projection	3"
Juncture calculations for $\alpha > 30$ only	Yes
Preheat P-No 1 Materials > 1.25" and <= 1.50" thick	No
UG-37(a) shell tr calculation considers longitudinal stress	No
Cylindrical shells made from pipe are entered as minimum thickness	No
Nozzles made from pipe are entered as minimum thickness	No
ASME B16.9 fittings are entered as minimum thickness	No
Butt welds	Tapered per Figure UCS-66.3(a)
Disallow Appendix 1-5, 1-8 calculations under 15 psi	No
Hydro/Pneumatic Test	
Shop Hydrotest at user defined pressure	1,315 psi
Test liquid specific gravity	1.00
Maximum stress during test	90% of yield
Required Marking - UG-116	
UG-116(e) Radiography	RT1
UG-116(f) Postweld heat treatment	HT
Code Cases\Interpretations	
Use Code Case 2547	No
Use Code Case 2695	Yes
Apply interpretation VIII-1-83-66	Yes
Apply interpretation VIII-1-86-175	Yes



Apply interpretation VIII-1-01-37	Yes
Apply interpretation VIII-1-01-150	Yes
Apply interpretation VIII-1-07-50	Yes
Apply interpretation VIII-1-16-85	Yes
No UCS-66.1 MDMT reduction	No
No UCS-68(c) MDMT reduction	No
Disallow UG-20(f) exemptions	No
<b>UG-22 Loadings</b>	
UG-22(a) Internal or External Design Pressure	Yes
UG-22(b) Weight of the vessel and normal contents under operating or test conditions	Yes
UG-22(c) Superimposed static reactions from weight of attached equipment (external loads)	Yes
UG-22(d)(2) Vessel supports such as lugs, rings, skirts, saddles and legs	Yes
UG-22(f) Wind reactions	Yes
UG-22(f) Seismic reactions	Yes
UG-22(j) Test pressure and coincident static head acting during the test:	No
Note: UG-22(b),(c) and (f) loads only considered when supports are present.	

License Information	
Company Name	GasTech Engineering LLC
License	Commercial
License Key ID	23449
Support Expires	June 01, 2018

## Radiography Summary

UG-116 Radiography							
Component	Longitudinal Seam		Left Circumferential Seam		Right Circumferential Seam		Mark
	Category (Fig UW-3)	Radiography / Joint Type	Category (Fig UW-3)	Radiography / Joint Type	Category (Fig UW-3)	Radiography / Joint Type	
<a href="#">Inlet Head</a>	N/A	Seamless No RT	N/A	N/A	B	Full UW-11(a) / Type 1	RT1
<a href="#">Shell</a>	A	Full UW-11(a) / Type 1	B	Full UW-11(a) / Type 1	B	Full UW-11(a) / Type 1	RT1
<a href="#">Outlet Head</a>	N/A	Seamless No RT	B	Full UW-11(a) / Type 1	N/A	N/A	RT1
Nozzle	Longitudinal Seam		Nozzle to Vessel Circumferential Seam		Nozzle free end Circumferential Seam		
<a href="#">Inlet (Inlet)</a>	N/A	Seamless No RT	D	N/A / Type 7	C	Full UW-11(a) / Type 1	RT1
<a href="#">PSV (PSV)</a>	N/A	Seamless No RT	D	N/A / Type 7	C	N/A	N/A
<a href="#">Downcomer - Inlet (Downcomer - Inlet)</a>	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
<a href="#">Vent (Vent)</a>	N/A	Seamless No RT	D	N/A / Type 7	C	N/A	N/A
<a href="#">Plugged Connection 2 (Plugged Connection 2)</a>	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
<a href="#">HandHole-Inlet (HandHole-Inlet)</a>	N/A	Seamless No RT	D	N/A / Type 7	C	N/A	N/A
<a href="#">HandHole-Outlet (HandHole-Outlet)</a>	N/A	Seamless No RT	D	N/A / Type 7	C	N/A	N/A
<a href="#">Downcomer - Outlet (Downcomer - Outlet)</a>	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
<a href="#">Plugged Connection 1 (Plugged Connection 1)</a>	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
<a href="#">Drain (Drain)</a>	N/A	Seamless No RT	D	N/A / Type 7	B	UW-11(a)(4) exempt / Type 1	N/A
<a href="#">Elbow (Drain)</a>	N/A	Seamless No RT	B	UW-11(a)(4) exempt / Type 1	B	UW-11(a)(4) exempt / Type 1	N/A
<a href="#">Elbow Pipe (Drain)</a>	N/A	Seamless No RT	B	UW-11(a)(4) exempt / Type 1	C	UW-11(a)(4) exempt / Type 1	N/A
<a href="#">Outlet (Outlet)</a>	N/A	Seamless No RT	D	N/A / Type 7	C	Full UW-11(a) / Type 1	RT1
Nozzle Flange	Longitudinal Seam		Flange Face		Nozzle to Flange Circumferential Seam		
<a href="#">ASME B16.5/16.47 flange attached to Inlet (Inlet)</a>	N/A	Seamless No RT	N/A	N/A / Gasketed	C	Full UW-11(a) / Type 1	RT1
<a href="#">ASME B16.5/16.47 flange attached to PSV (PSV)</a>	N/A	Seamless No RT	N/A	N/A / Gasketed	C	N/A	N/A
<a href="#">ASME B16.5/16.47 flange attached to Vent (Vent)</a>	N/A	Seamless No RT	N/A	N/A / Gasketed	C	N/A	N/A
<a href="#">ASME B16.5/16.47 flange attached to HandHole-Inlet (HandHole-Inlet)</a>	N/A	Seamless No RT	N/A	N/A / Gasketed	C	N/A	N/A
<a href="#">ASME B16.5/16.47 flange attached to HandHole-Outlet (HandHole-Outlet)</a>	N/A	Seamless No RT	N/A	N/A / Gasketed	C	N/A	N/A
<a href="#">ASME B16.5/16.47 flange attached to right end of Elbow Pipe (Drain)</a>	N/A	Seamless No RT	N/A	N/A / Gasketed	C	UW-11(a)(4) exempt / Type 1	N/A
<a href="#">ASME B16.5/16.47 flange attached to Outlet (Outlet)</a>	N/A	Seamless No RT	N/A	N/A / Gasketed	C	Full UW-11(a) / Type 1	RT1
UG-116(e) Required Marking: <b>RT1</b>							

## Thickness Summary

Component Data								
Component Identifier	Material	Diameter (in)	Length (in)	Nominal t (in)	Design t (in)	Total Corrosion (in)	Joint E	Load
<a href="#">Inlet Head</a>	SA-516 70	72 ID	19.625	1.625*	1.5335	0.125	1.00	Internal
<a href="#">Straight Flange on Inlet Head</a>	SA-516 70	72 ID	2	1.75	1.7123	0.125	1.00	Internal
<a href="#">Shell</a>	SA-516 70	72 ID	120	1.75	1.7196	0.125	1.00	Internal
<a href="#">Straight Flange on Outlet Head</a>	SA-516 70	72 ID	2	1.75	1.7123	0.125	1.00	Internal
<a href="#">Outlet Head</a>	SA-516 70	72 ID	19.625	1.625*	1.5335	0.125	1.00	Internal
*Head minimum thickness after forming								

Definitions	
Nominal t	Vessel wall nominal thickness
Design t	Required vessel thickness due to governing loading + corrosion
Joint E	Longitudinal seam joint efficiency
Load	
Internal	Circumferential stress due to internal pressure governs
External	External pressure governs
Wind	Combined longitudinal stress of pressure + weight + wind governs
Seismic	Combined longitudinal stress of pressure + weight + seismic governs

## Weight Summary

Weight (lb) Contributed by Vessel Elements											
Component	Metal New*	Metal Corroded	Insulation	Insulation Supports	Lining	Piping + Liquid	Operating Liquid		Test Liquid		Surface Area ft²
							New	Corroded	New	Corroded	
<a href="#">Inlet Head</a>	2,555.5	2,371.8	0	0	0	0	0	0	2,352.7	2,383.7	42
<a href="#">Shell</a>	13,630.8	12,678.8	0	0	0	0	0	0	17,676.9	17,803.2	196
<a href="#">Outlet Head</a>	2,555.5	2,371.8	0	0	0	0	0	0	2,352.7	2,383.7	42
<a href="#">Saddle #1</a>	2,348	2,348	0	0	0	0	0	0	0	0	154
TOTAL:	21,089.8	19,770.4	0	0	0	0	0	0	22,382.3	22,570.6	434
*Shells with attached nozzles have weight reduced by material cut out for opening.											

\*Shells with attached nozzles have weight reduced by material cut out for opening.

Weight (lb) Contributed by Attachments										
Component	Body Flanges		Nozzles & Flanges		Packed Beds	Trays	Tray Supports	Rings & Clips	Vertical Loads	Surface Area ft²
	New	Corroded	New	Corroded						
<a href="#">Inlet Head</a>	0	0	2,880.1	2,800.7	0	0	0	0	0	31
<a href="#">Shell</a>	0	0	951.6	911.7	9,777.4	0	0	56.1	1,200	19
<a href="#">Outlet Head</a>	0	0	2,880.1	2,800.7	0	0	0	0	1,200	31
TOTAL:	0	0	6,711.8	6,513	9,777.4	0	0	56.1	2,400	80

Vessel Totals		
	New	Corroded
Operating Weight (lb)	40,035	38,517
Empty Weight (lb)	40,035	38,517
Test Weight (lb)	62,417	61,087
Surface Area (ft <sup>2</sup> )	514	-
Capacity** (US gal)	2,609	2,630
**The vessel capacity does not include volume of nozzle, piping or other attachments.		

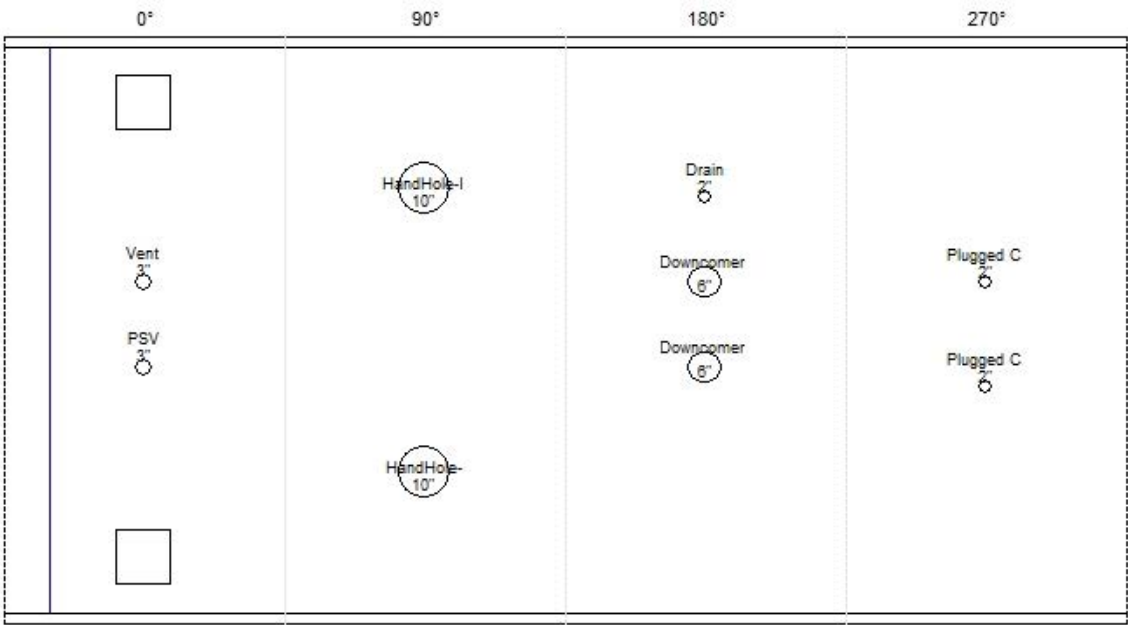
Vessel Lift Condition	
Vessel Lift Weight, New (lb)	40,035
Center of Gravity from Datum (in)	60.2047

Long Seam Summary

Shell Long Seam Angles	
Component	Seam 1
Shell	330°

Shell Plate Lengths		
Component	Starting Angle	Plate 1
Shell	330°	231.6925"

Note
1) Plate Lengths use the circumference of the vessel based on the mid diameter of the components.



## Shell Rollout

## Test Report

### Horizontal shop test based on user defined pressure

Gauge pressure at 70° F = 1,315 psi

Horizontal shop test		
Identifier	Local test pressure (psi)	Test liquid static head (psi)
Inlet Head	1,317.879	2.879
Straight Flange on Inlet Head	1,317.879	2.879
Shell	1,317.879	2.879
Straight Flange on Outlet Head	1,317.879	2.879
Outlet Head	1,317.879	2.879
Downcomer - Inlet (Downcomer - Inlet)	1,318.231	3.231
Downcomer - Outlet (Downcomer - Outlet)	1,318.231	3.231
Drain (Drain)	1,318.086	3.086
Elbow (Drain)	1,318.189	3.189
Elbow Pipe (Drain)	1,318.189	3.189
HandHole-Inlet (HandHole-Inlet)	1,316.724	1.724
HandHole-Outlet (HandHole-Outlet)	1,316.724	1.724
Inlet (Inlet)	1,317.193	2.193
Outlet (Outlet)	1,317.193	2.193
PSV (PSV)	1,315.217	0.217
Plugged Connection 1 (Plugged Connection 1)	1,316.603	1.603
Plugged Connection 2 (Plugged Connection 2)	1,316.603	1.603
Vent (Vent)	1,315.217	0.217
(1) The zero degree angular position is assumed to be up, and the test liquid height is assumed to the top-most flange.		

The field test condition has not been investigated.

The test temperature of 70 ° F is warmer than the minimum recommended temperature of 8.1 ° F so the brittle fracture provision of UG-99(h) has been met.

## Bill of Materials

Heads / Covers						
Item #	Type	Material	Thk [in]	Dia. [in]	Wt. [lb] (ea.)	Qty
H1	Ellipsoidal Head	SA-516 70 (N, Impact (-20 ° F))	1.625 (min.)	72 ID	3,133.4	2
H2	ASME B16.5/B16.47 Blind NPS 8 Class 600	A105 (N)	2.44	16.5 OD	165	2

Shells							
Item #	Type	Material	Thk [in]	Dia. [in]	Length [in]	Wt. [lb] (ea.)	Qty
S1	Cylinder	SA-516 70 (N, Impact (-20 ° F))	1.75	72 ID	120	13,769.5	1

Nozzles / Nozzle Piping							
Item #	Type	Material	NPS	Thk [in]	Dia. [in]	Length [in]	Wt. [lb]
Noz1	Nozzle	SA-350 LF2 Cl 1 (N)	-	1	34 ID	31.3	2,350.2
Noz2	Nozzle	SA-106 C Smls pipe	NPS 6 XXS	0.864	4.897 ID	19.8	87.6
Noz3	Nozzle	SA-105	NPS 1 Class 6000 - threaded	0.4675	1.315 ID	9.5	7.1
Noz4	Nozzle	SA-106 B Smls pipe	NPS 2 Sch 160	0.344	1.687 ID	5.8	3.6
P1	Nozzle Piping	SA-106 B Smls pipe	NPS 2 Sch 160	0.344	1.687 ID	4	2.5

ASME B16.9 Fittings				
Item #	Type	Material	Size [in]	Qty
EB1	B16.9 Elbow Short Radius	SA-234 WPB	NPS 2 Sch 160	1

Flanges						
Item #	Type	Material	NPS	Dia. [in]	Wt. [lb] (ea.)	Qty
AF1	ASME B16.47 Welding Neck - Class 600 - Series A	A350 LF2 Cl.1 (N)	36	51.75 x 34	1,705	2
AF2	ASME B16.5 Long Weld Neck - Class 600 - 7.8" len.	A105 (N)	2.0	Flange 6.5 x 2; Nozzle 0.655 thk. x 2 ID dia.	12	2
AF3	ASME B16.5 Long Weld Neck - Class 600 - 12.2" len.	A105 (N)	8	Flange 16.5 x 8; Nozzle 1.375 thk. x 8 ID dia.	120	2
AF4	ASME B16.5 Welding Neck - Class 600	A105 (N)	2.0	6.5 x 1.687	12	1

Fasteners				
Item #	Description	Material	Length [in]	Qty
FB1	2-1/2" series 8 bolt	SA-193 B7 Bolt <= 2 1/2	16	56
FB2	5/8" coarse bolt	SA-193 B7 Bolt <= 2 1/2	4.3	24
FB3	1-1/8" series 8 bolt	SA-193 B7 Bolt <= 2 1/2	7.8	24
SB1	1-1/2" series 8 bolt	F 1554 Gr 36	-	4

All listed flange bolts require associated nuts and washers in accordance with Division 1, UCS-11.



Packed Beds					
Item #	Dia. [in]	Depth [in]	Density [lb/cu ft]	Wt. [lb] (ea.)	Qty
PB1	71.25 OD	42.375	100	9,777.4	1

Plates				
Item #	Material	Thk [in]	Wt. [lb]	Qty [ ft²]
Plate1	SA-36	1	384.9	9.44
Plate1 - Note: Applies to saddle base plate				
Plate2	SA-36	0.75	1,963.7	64.25
Plate2 - Note: Applies to saddle web plate				
Plate3	A36	1	56.6	1.39
Plate3 - Note: Applies to lift lug plates				

## Inlet Head

ASME Section VIII Division 1, 2015 Edition (Code Case 2695)				
Component		Ellipsoidal Head		
Material		SA-516 70 (II-D p. 18, ln. 37)		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
Yes (-20° F)	Yes	No	Yes	No
		Design Pressure (psi)	Design Temperature (° F)	Design MDMT (° F)
Internal		860	200	-20
Static Liquid Head				
Condition		P <sub>s</sub> (psi)	H <sub>s</sub> (in)	SG
Test horizontal		2.88	79.75	1
Dimensions				
Inner Diameter		72"		
Head Ratio		2		
Minimum Thickness		1.625"		
Corrosion	Inner	0.125"		
	Outer	0"		
Length L <sub>sf</sub>		2"		
Nominal Thickness t <sub>sf</sub>		1.75"		
Weight and Capacity				
		Weight (lb) <sup>1</sup>		Capacity (US gal) <sup>1</sup>
New		2,555.5		246.76
Corroded		2,371.76		249.95
Radiography				
Category A joints		Seamless No RT		
Head to shell seam		Full UW-11(a) Type 1		

<sup>1</sup> includes straight flange

Results Summary	
Governing condition	Operating Hot & Corroded
Design thickness due to internal pressure (t)	<a href="#">1.5335"</a>
Minimum thickness per 4.1.2	0.1875"
Rated MDMT	-26.1° F

Material Toughness Requirements	
Material impact test temperature per UG-84 =	-20° F
Stress ratio = $1.4085 \cdot 1 / (1.625 - 0.125 - 0) =$	0.939
Reduction in MDMT from Figure UCS-66.1 =	6.1° F
MDMT = $\max[T_{\text{impact}} - T_R, -155] = \max[-20 - 6.1, -155] =$	-26.1° F
Design MDMT of -20° F is acceptable.	

Division 2 4.3.7.1 Design Thickness for Internal Pressure			
$k = D / (2 \cdot h)$			(4.3.26)
$r = D \cdot (0.5 / k - 0.08)$			(4.3.24)
$L = D \cdot (0.44 \cdot k + 0.02)$			(4.3.25)
$0.7 \leq L / D \leq 1$			(4.3.5)
$r / D \leq 0.06$			(4.3.6)
$20 \leq L / t \leq 2,000$			(4.3.7)
$\beta_{th} = \arccos[(0.5 \cdot D - r) / (L - r)]$			(4.3.8)
$\phi_{th} = (L \cdot t)^{1/2} / r$			(4.3.9)
$R_{th} = (0.5 \cdot D - r) / \cos[\beta_{th} - \phi_{th}] + r$		for $\phi_{th} < \beta_{th}$	(4.3.10)
$R_{th} = 0.5 \cdot D$		for $\phi_{th} \geq \beta_{th}$	(4.3.11)
$C_1 = 9.31 \cdot r / D - 0.086$		for $r / D \leq 0.08$	(4.3.12)
$C_1 = 0.692 \cdot r / D + 0.605$		for $r / D > 0.08$	(4.3.13)
$C_2 = 1.25$		for $r / D \leq 0.08$	(4.3.14)
$C_2 = 1.46 - 2.6 \cdot r / D$		for $r / D > 0.08$	(4.3.15)
$P_{eth} = C_1 \cdot E_T \cdot t^2 / (C_2 \cdot R_{th} \cdot (R_{th} / 2 - r))$			(4.3.16)
$C_3 = S_y$ (time-independent properties)			
$C_3 = 1.1 \cdot S$ (time-dependent properties 90% yield criterion)			
$C_3 = 1.5 \cdot S$ (time-dependent properties 67% yield criterion)			
$P_y = C_3 \cdot t / \{C_2 \cdot R_{th} \cdot (R_{th} / (2 \cdot r) - 1)\}$			(4.3.17)
$G = P_{eth} / P_y$			(4.3.20)
$P_{ck} = 0.6 \cdot P_{eth}$		for $G \leq 1$	(4.3.18)
$P_{ck} = \{(0.77508 \cdot G - 0.20354 \cdot G^2 + 0.019274 \cdot G^3) / (1 + 0.19014 \cdot G - 0.089534 \cdot G^2 + 0.0093965 \cdot G^3)\} \cdot P_y$		for $G > 1$	(4.3.19)
$P_{ak} = P_{ck} / 1.5$			(4.3.21)
$P_{ac} = 2 \cdot S \cdot E / (L / t + 0.5)$			(4.3.22)
$P_a = \min[P_{ak}, P_{ac}]$			(4.3.23)
Operating Hot & Corroded			

$k = 72.25 / (2 \cdot 18.125) =$	1.9931
$r = 72.25 \cdot (0.5 / 1.9931 - 0.08) =$	12.345"
$L = 72.25 \cdot (0.44 \cdot 1.9931 + 0.02) =$	64.8058"
$0.7 \quad L / D = 64.8058 / 72.25 = 0.897 \quad 1$	OK
$r / D = 12.345 / 72.25 = 0.1709 \quad 0.06$	OK
$20 \quad L / t = 64.8058 / 1.5 = 43.2038 \quad 2,000$	OK
$\beta_{th} = \arccos[(0.5 \cdot 72.25 - 12.345) / (64.8058 - 12.345)] =$	1.1003
$\phi_{th} = (64.8058 \cdot 1.4085)^{1/2} / 12.345 =$	0.7739
$R_{th} = (0.5 \cdot 72.25 - 12.345) / \cos[(1.1003 - 0.7739) \cdot 180 / \pi] + 12.345 =$	37.4508"
$C_1 = 0.692 \cdot 12.345 / 72.25 + 0.605 =$	0.7232
$C_2 = 1.46 - 2.6 \cdot 12.345 / 72.25 =$	1.0158
$P_{eth} = 0.7232 \cdot 28.8E+06 \cdot 1.4085^2 / (1.0158 \cdot 37.4508 \cdot (37.4508 / 2 - 12.345)) =$	170,243.28 psi
Material is not governed by time dependent properties which start at 750° F (Design T = 200° F)	
$C_3 = S_y =$	34,800 psi
$P_y = 34,800 \cdot 1.4085 / \{1.0158 \cdot 37.4508 \cdot (37.4508 / (2 \cdot 12.345) - 1)\} =$	2,492.99 psi
$G = 170,243.28 / 2,492.99 =$	68.2889
$P_{ck} = \{(0.77508 \cdot 68.2889 - 0.20354 \cdot 68.2889^2 + 0.019274 \cdot 68.2889^3) / (1 + 0.19014 \cdot 68.2889 - 0.089534 \cdot 68.2889^2 + 0.0093965 \cdot 68.2889^3)\} \cdot 2,492.99 =$	5,047.62 psi
$P_{ak} = 5,047.62 / 1.5 =$	3,365.08 psi
$P_{ac} = 2 \cdot 20,000 \cdot 1 / (64.8058 / 1.4085 + 0.5) =$	860 psi
$P_a = \min[3,365.08, 860] - 0 =$	860 psi
$t_d = 1.4085 + 0.125 = 1.5335"$	
<b>Operating Cold &amp; Corroded</b>	
$t_r = (860 + 0) \cdot 64.8058 / (2 \cdot 20,000 \cdot 1 - 0.5 \cdot (860 + 0)) =$	1.4085"

Division 2 6.1.2.3 % Extreme Fiber Elongation	
$\epsilon_f = 100 \cdot \ln[D_b / (D_f - 2 \cdot t)]$	(Table 6.1)
Forming strain not calculated.	

### Straight Flange on Inlet Head

ASME Section VIII Division 1, 2015 Edition (Code Case 2695)				
Component		Cylinder		
Material		SA-516 70 (II-D p. 18, ln. 37)		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
Yes (-20° F)	Yes	No	Yes	No
		Design Pressure (psi)	Design Temperature (° F)	Design MDMT (° F)
Internal		860	200	-20
Static Liquid Head				
Condition		P <sub>s</sub> (psi)	H <sub>s</sub> (in)	SG
Test horizontal		2.88	79.75	1
Dimensions				
Inner Diameter		72"		
Length		2"		
Nominal Thickness		1.75"		
Corrosion	Inner	0.125"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		Capacity (US gal)
New		229.49		35.25
Corroded		213.46		35.5
Radiography				
Longitudinal seam		Seamless No RT		
Right Circumferential seam		Full UW-11(a) Type 1		

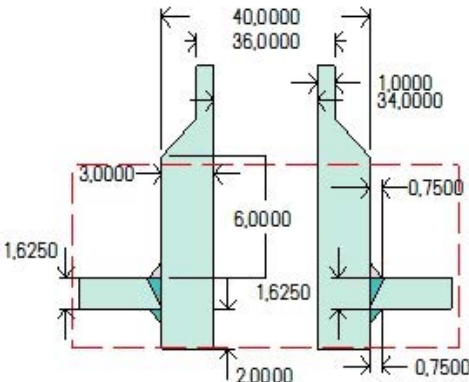
Results Summary	
Governing condition	Operating Hot & Corroded
Design thickness due to internal pressure (t)	<a href="#">1.7123"</a>
Minimum thickness per 4.1.2	0.1875"
Rated MDMT	-22.3° F

Material Toughness Requirements	
Material impact test temperature per UG-84 =	-20° F
Stress ratio = $1.5873 \cdot 1 / (1.75 - 0.125 - 0) =$	0.9768
Reduction in MDMT from Figure UCS-66.1 =	2.3° F
MDMT = $\max[T_{\text{impact}} - T_R, -155] = \max[-20 - 2.3, -155] =$	-22.3° F
Design MDMT of -20° F is acceptable.	

Division 2 4.3.3.1 Design Thickness for Internal Pressure	
$t_d = D / 2 \cdot (\exp[P / (S \cdot E)] - 1) + \text{Corrosion}$	(4.3.1)
<b>Operating Hot &amp; Corroded</b>	
$t_d = 72.25 / 2 \cdot (\exp[(860 + 0) / (20,000 \cdot 1)] - 1) + 0.125 =$	1.7123"
<b>Operating Cold &amp; Corroded</b>	
$t_r = 72.25 / 2 \cdot (\exp[(860 + 0) / (20,000 \cdot 1)] - 1) =$	1.5873"

# Inlet (Inlet)

ASME Section VIII Division 1, 2015 Edition (Code Case 2695)					
Component	Nozzle				
Nozzle Material	SA-350 LF2 CI 1 (II-D p. 18, ln. 28)				
	Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
Nozzle	No	Yes	No	Yes	No
	Design Pressure (psi)		Design Temperature (° F)		Design MDMT (° F)
Internal	860		200		-20
Static Liquid Head					
Condition	P <sub>s</sub> (psi)		H <sub>s</sub> (in)		SG
Test horizontal	2.19		60.75		1
Location and Orientation					
Attached to	Inlet Head				
Orientation	radial				
Offset, L	42"				
Angle, θ	0°				
Distance, r	0"				
Through a Category A Joint	No				

Dimensions		
Inside Diameter	34"	
Nominal Wall Thickness	3"	
Minimum Wall Thickness	1"	
Local Vessel Minimum Thickness	1.625"	
Leg <sub>41</sub>	0.75"	
Leg <sub>43</sub>	0.75"	
External Projection Available, L <sub>pr1</sub>	12.0072"	
Internal Projection, L <sub>pr2</sub>	2"	
Heavy Barrel Length, L <sub>pr3</sub>	6"	
Projection outside vessel to flange face, L <sub>f</sub>	23.3772"	
Corrosion	Inner	0.125"
	Outer	0"

ASME B16.47-2011 Flange	
Description	NPS 36 Class 600 WN A350 LF2 Cl.1 N Series A
Bolt Material	SA-193 B7 Bolt <= 2 1/2 (II-D p. 344, In. 31)
Blind included	No
Rated MDMT	-55° F
Liquid static head	0 psi
MAWP rating	1,360 psi @ 200° F
MAP rating	1,480 psi @ 70° F
Hydrotest rating	2,225 psi @ 70° F
PWHT performed	Yes
Impact Tested	No
Bore diameter, B (specified by purchaser)	34"
Notes	
Flange is impact tested per material specification to -50° F. UCS-66(i) reduction of 44.5° F applied (ratio = 0.5811). Bolts rated MDMT per Fig UCS-66 note (c) = -55° F	





## Summary Tables

Division 2 4.5.10 Maximum Local Primary Membrane Stress				
Condition	P (psi)	P <sub>L</sub> (psi)	S <sub>allow</sub> (psi)	Over stressed
Design P	860	28,013	30,000	No

Division 2 4.5.4.1 Nozzle Neck Minimum Thickness							
Condition	P (psi)	t <sub>d1</sub> (in)	t <sub>d,STD</sub> (in)	t (in)	t <sub>d</sub> (in)	t <sub>n,min</sub> (in)	Status
Design P	860	0.8774	0.4531	1.625	0.8774	1	OK

Division 2 4.5.14 Strength of Nozzle Attachment Welds Summary									
Condition	P (psi)	k <sub>y</sub>	L <sub>τ</sub> (in)	L <sub>41T</sub> (in)	L <sub>43T</sub> (in)	f <sub>welds</sub> (lb <sub>f</sub> )	τ (psi)	S (psi)	Over stressed
Design P	860	1.1679	31.4159	0.5303	0.4053	270,176.97	6,331	20,000	No

Division 2 Table 4.2.10 Minimum Fillet Weld Sizes			
Fillet Leg	Required Leg Size (in)	Actual Leg Size (in)	Status
Leg <sub>41</sub>	0.3571	0.75	weld size is adequate
Leg <sub>43</sub>	0.5357	0.75	weld size is adequate

Material Toughness Requirements Nozzle At Intersection	
Impact test temperature per material specification =	-50° F
Stress ratio = $1.4085 \cdot 1 / (1.625 - 0.125 - 0) =$	0.939
Reduction in MDMT from Figure UCS-66.1 =	6.1° F
MDMT = $\min[T_{\text{impact}} - T_{\text{UCS-66(g)}}, \max[T_{\text{impact}} - T_R, -155]] = \min[-50 - 5, \max[-50 - 6.1, -155]] =$	-56.1° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

Material Toughness Requirements Nozzle	
Impact test temperature per material specification =	-50° F
Stress ratio = $0.7524 \cdot 1 / (1 - 0.125 - 0) =$	0.8599
Reduction in MDMT from Figure UCS-66.1 =	14° F
MDMT = $\min[T_{\text{impact}} - T_{\text{UCS-66(g)}}, \max[T_{\text{impact}} - T_R, -155]] = \min[-50 - 5, \max[-50 - 14, -155]] =$	-64° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

## Shell

ASME Section VIII Division 1, 2015 Edition				
Component		Cylinder		
Material		SA-516 70 (II-D p. 18, In. 37)		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
Yes (-20° F)	Yes	No	Yes	No
		Design Pressure (psi)	Design Temperature (° F)	Design MDMT (° F)
Internal		860	200	-20
Static Liquid Head				
Condition		P <sub>s</sub> (psi)	H <sub>s</sub> (in)	SG
Test horizontal		2.88	79.75	1
Dimensions				
Inner Diameter		72"		
Length		120"		
Nominal Thickness		1.75"		
Corrosion	Inner	0.125"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		Capacity (US gal)
New		13,630.78		2,115.07
Corroded		12,678.83		2,129.78
Radiography				
Longitudinal seam		Full UW-11(a) Type 1		
Left Circumferential seam		Full UW-11(a) Type 1		
Right Circumferential seam		Full UW-11(a) Type 1		

Results Summary	
Governing condition	Internal pressure
Minimum thickness per UG-16	0.0625" + 0.125" = 0.1875"
Design thickness due to internal pressure (t)	<a href="#">1.7196"</a>
Rated MDMT	-21.9 ° F

UCS-66 Material Toughness Requirements	
Material impact test temperature per UG-84 =	-20° F
$t_r = 860 \cdot 36.125 / (20,000 \cdot 1 - 0.6 \cdot 860) =$	1.5945"
Stress ratio = $t_r \cdot E' / (t_n - c) = 1.5945 \cdot 1 / (1.75 - 0.125) =$	0.9812
UCS-66(i) reduction in MDMT, $T_R$ from Fig UCS-66.1 =	1.9° F
MDMT = $\max[T_{\text{impact}} - T_R, -155] = \max[-20 - 1.9, -155] =$	-21.9° F
Design MDMT of -20° F is acceptable.	

**Design thickness, (at 200 ° F) UG-27(c)(1)**

$$\begin{aligned}
 t &= P \cdot R / (S \cdot E - 0.60 \cdot P) + \text{Corrosion} \\
 &= 860 \cdot 36.125 / (20,000 \cdot 1.00 - 0.60 \cdot 860) + 0.125 \\
 &= \underline{1.7196"}
 \end{aligned}$$

**% Extreme fiber elongation - UCS-79(d)**

$$\begin{aligned}
 \text{EFE} &= (50 \cdot t / R_f) \cdot (1 - R_f / R_o) \\
 &= (50 \cdot 1.75 / 36.875) \cdot (1 - 36.875 / \infty) \\
 &= 2.3729\%
 \end{aligned}$$

The extreme fiber elongation does not exceed 5%.

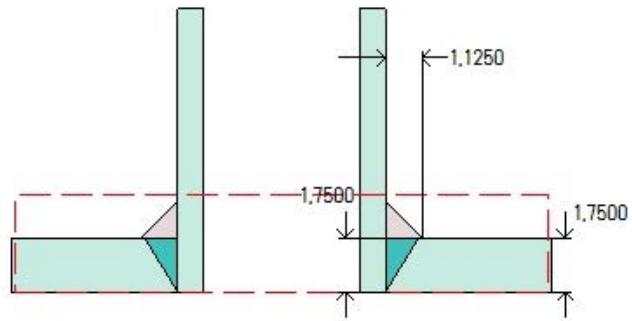
**Cyclone Pack**

ASME Section VIII Division 1, 2015 Edition	
Inputs	
Distance from Bottom of Bed to Datum	81.375"
Bed Depth	42.375"
Bed Diameter	71.25"
Bed Density	100.00 lb/ft <sup>3</sup>
Liquid Holdup	0.00% of dry weight
Weight	
Estimated Bed Weight, Empty	9,777.5 lb
Estimated Bed Weight, Operating	9,777.5 lb
Loading Conditions	
Included in Vessel Lift & Shipping Weight	Yes
Present When Vessel is Empty	Yes
Present During Test	Yes

**Downcomer - Inlet (Downcomer - Inlet)**

ASME Section VIII Division 1, 2015 Edition (Code Case 2695)					
Component	Nozzle				
Nozzle Material	SA-106 C Smls pipe (II-D p. 22, ln. 1)				
	Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
Nozzle	No	No	No	Yes	No
	Design Pressure (psi)		Design Temperature (° F)		Design MDMT (° F)
Internal	860		200		-20
Static Liquid Head					
Condition	P <sub>s</sub> (psi)		H <sub>s</sub> (in)		SG
Test horizontal	3.23		89.5		1
Location and Orientation					
Attached to	Shell				
Orientation	radial				
Offset, L	50"				
Angle, θ	180°				
Distance, r	45.75"				
Through a Category A Joint	No				

Dimensions		
Description	NPS 6 XXS	
Inside Diameter	4.897"	
Pipe Nominal Wall Thickness	0.864"	
Pipe Minimum Wall Thickness <sup>1</sup>	0.756"	
Local Vessel Minimum Thickness	1.75"	
Leg <sub>41</sub>	1.125"	
External Projection Available, L <sub>pr1</sub>	8"	
Corrosion	Inner	0.125"
	Outer	0"



<sup>1</sup> Pipe minimum thickness = nominal thickness times pipe tolerance factor of 0.875.

## Summary Tables

Division 2 4.5.5 Maximum Local Primary Membrane Stress				
Condition	P (psi)	P <sub>L</sub> (psi)	S <sub>allow</sub> (psi)	Over stressed
Design P	860	29,711	30,000	No

Division 2 4.5.4.1 Nozzle Neck Minimum Thickness							
Condition	P (psi)	t <sub>d1</sub> (in)	t <sub>d,STD</sub> (in)	t (in)	t <sub>d</sub> (in)	t <sub>n,min</sub> (in)	Status
Design P	860	0.2381	0.37	1.75	0.37	0.756	OK

Division 2 4.5.14 Strength of Nozzle Attachment Welds Summary								
Condition	P (psi)	k <sub>y</sub>	L <sub>τ</sub> (in)	L <sub>41T</sub> (in)	f <sub>welds</sub> (lb <sub>f</sub> )	τ (psi)	S (psi)	Over stressed
Design P	860	1.2872	5.2033	0.7955	7,411.4	1,044	20,000	No

Division 2 Table 4.2.10 Minimum Fillet Weld Sizes			
Fillet Leg	Required Leg Size (in)	Actual Leg Size (in)	Status
Leg <sub>41</sub>	0.3571	1.125	weld size is adequate

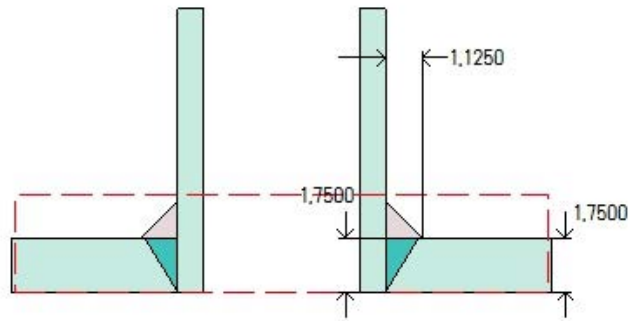
Material Toughness Requirements Nozzle	
Governing thickness, t <sub>g</sub> =	0.756"
Exemption temperature from Figure UCS-66 Curve B =	15.38° F
Stress ratio = 0.1131*1 / (0.875*0.864 - 0.125) =	0.1792
R <sub>ts</sub> 0.35, MDMT =	-155° F
Material is exempt from impact testing at the Design MDMT of -20° F.	



**Downcomer - Outlet (Downcomer - Outlet)**

ASME Section VIII Division 1, 2015 Edition (Code Case 2695)					
Component	Nozzle				
Nozzle Material	SA-106 C Smls pipe (II-D p. 22, ln. 1)				
	Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
Nozzle	No	No	No	Yes	No
	Design Pressure (psi)		Design Temperature (° F)		Design MDMT (° F)
Internal	860		200		-20
Static Liquid Head					
Condition	P <sub>s</sub> (psi)		H <sub>s</sub> (in)		SG
Test horizontal	3.23		89.5		1
Location and Orientation					
Attached to	Shell				
Orientation	radial				
Offset, L	68"				
Angle, θ	180°				
Distance, r	45.75"				
Through a Category A Joint	No				

Dimensions		
Description	NPS 6 XXS	
Inside Diameter	4.897"	
Pipe Nominal Wall Thickness	0.864"	
Pipe Minimum Wall Thickness <sup>1</sup>	0.756"	
Local Vessel Minimum Thickness	1.75"	
Leg <sub>41</sub>	1.125"	
External Projection Available, L <sub>pr1</sub>	8"	
Corrosion	Inner	0.125"
	Outer	0"



<sup>1</sup>Pipe minimum thickness = nominal thickness times pipe tolerance factor of 0.875.

## Summary Tables

Division 2 4.5.5 Maximum Local Primary Membrane Stress				
Condition	P (psi)	P <sub>L</sub> (psi)	S <sub>allow</sub> (psi)	Over stressed
Design P	860	29,711	30,000	No

Division 2 4.5.4.1 Nozzle Neck Minimum Thickness							
Condition	P (psi)	t <sub>d1</sub> (in)	t <sub>d,STD</sub> (in)	t (in)	t <sub>d</sub> (in)	t <sub>n,min</sub> (in)	Status
Design P	860	0.2381	0.37	1.75	0.37	0.756	OK

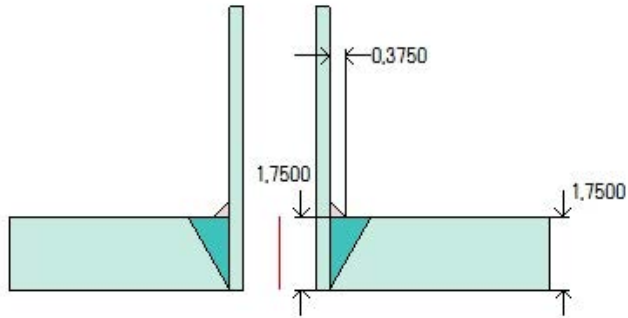
Division 2 4.5.14 Strength of Nozzle Attachment Welds Summary								
Condition	P (psi)	k <sub>y</sub>	L <sub>τ</sub> (in)	L <sub>41T</sub> (in)	f <sub>welds</sub> (lb <sub>f</sub> )	τ (psi)	S (psi)	Over stressed
Design P	860	1.2872	5.2033	0.7955	7,411.4	1,044	20,000	No

Division 2 Table 4.2.10 Minimum Fillet Weld Sizes			
Fillet Leg	Required Leg Size (in)	Actual Leg Size (in)	Status
Leg <sub>41</sub>	0.3571	1.125	weld size is adequate

Material Toughness Requirements Nozzle	
Governing thickness, t <sub>g</sub> =	0.756"
Exemption temperature from Figure UCS-66 Curve B =	15.38° F
Stress ratio = $0.1131 \cdot 1 / (0.875 \cdot 0.864 - 0.125) =$	0.1792
R <sub>ts</sub> 0.35, MDMT =	-155° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

## Drain (Drain)

### ASME Section VIII Division 1, 2015 Edition



Note: round inside edges per UG-76(c)

#### Location and Orientation

Located on	Shell
Orientation	180°
Nozzle center line offset to datum line	32"
End of nozzle to shell center	41.75"
Passes through a Category A joint	No

#### Nozzle

Description	NPS 2 Sch 160
Access opening	No
Material specification	SA-106 B Smls pipe (II-D p. 14, ln. 15)
Inside diameter, new	1.687"
Pipe nominal wall thickness	0.344"
Pipe minimum wall thickness <sup>1</sup>	0.301"
Corrosion allowance	0.125"
Projection available outside vessel, Lpr	4"
Local vessel minimum thickness	1.75"
Liquid static head included	0 psi
Longitudinal joint efficiency	1

#### Welds

Inner fillet, Leg <sub>41</sub>	0.375"
Nozzle to vessel groove weld	1.75"

<sup>1</sup>Pipe minimum thickness = nominal thickness times pipe tolerance factor of 0.875.

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 860 \cdot 0.9685 / (17,100 \cdot 1 - 0.6 \cdot 860) =$	0.0502"
Stress ratio $= t_r \cdot E^* / (t_n - c) = 0.0502 \cdot 1 / (0.301 - 0.125) =$	0.2854
Stress ratio 0.35, MDMT per UCS-66(b)(3) =	-155° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

#### Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in <sup>2</sup> )							UG-45 Summary (in)	
For P = 860 psi @ 200 ° F							The nozzle passes UG-45	
A required	A available	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	A <sub>5</sub>	A welds	t <sub>req</sub>	t <sub>min</sub>
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.2598	0.301

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg <sub>41</sub> )	0.1533	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

## Elbow (Drain)

ASME Section VIII Division 1, 2015 Edition				
Component		ASME B16.9 Elbow		
Type		Short Radius		
Material		SA-234 WPB (II-D p. 14, In. 17)		
Pipe NPS and Schedule		NPS 2 Sch 160		
Attached To		Drain (Drain)		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
No	No	No	Yes	No
		Design Pressure (psi)	Design Temperature (° F)	Design MDMT (° F)
Internal		860	200	-20
Static Liquid Head				
Condition		P <sub>s</sub> (psi)	H <sub>s</sub> (in)	SG
Test horizontal		3.19	88.3435	1
Dimensions				
Inner Diameter		1.687"		
Nominal Thickness		0.344"		
Minimum Thickness <sup>1</sup>		0.301"		
Center-to-End, A		2"		
Corrosion	Inner	0.125"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		Capacity (US gal)
New		1.95		0.03
Corroded		1.32		0.04
Radiography				
Longitudinal seam		Seamless No RT		
Left Circumferential seam		Full UW-11(a) Type 1		
Right Circumferential seam		Full UW-11(a) Type 1		

<sup>1</sup> minimum thickness = nominal thickness times pipe tolerance factor of 0.875.

Results Summary	
Governing condition	UG-16
Minimum thickness per UG-16	$0.0625" + 0.125" = 0.1875"$
Design thickness due to internal pressure (t)	<a href="#">0.1753"</a>
Rated MDMT	-155 ° F

UCS-66 Material Toughness Requirements	
$t_r = 860 * 0.9685 / (17,100 * 1 - 0.6 * 860) =$	0.0502"
Stress ratio $= t_r * E^* / (t_n - c) = 0.0502 * 1 / (0.301 - 0.125) =$	0.2854
Stress ratio 0.35, MDMT per UCS-66(b)(3) =	-155° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

#### Design thickness, (at 200 ° F) UG-27(c)(1)

$$\begin{aligned}
 t &= P * R / (S * E - 0.60 * P) + \text{Corrosion} \\
 &= 860 * 0.9685 / (17,100 * 1.00 - 0.60 * 860) + 0.125 \\
 &= \a href="#">0.1753"
 \end{aligned}$$

## Elbow Pipe (Drain)

ASME Section VIII Division 1, 2015 Edition				
Component		Nozzle Pipe		
Material		SA-106 B Smls pipe (II-D p. 14, ln. 15)		
Pipe NPS and Schedule		NPS 2 Sch 160		
Attached To		Elbow (Drain)		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
No	No	No	Yes	No
		Design Pressure (psi)	Design Temperature (° F)	Design MDMT (° F)
Internal		860	200	-20
Static Liquid Head				
Condition		P <sub>s</sub> (psi)	H <sub>s</sub> (in)	SG
Test horizontal		3.19	88.3435	1
Dimensions				
Inner Diameter		1.687"		
Length		4"		
Pipe Nominal Thickness		0.344"		
Pipe Minimum Thickness <sup>1</sup>		0.301"		
Corrosion	Inner	0.125"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		Capacity (US gal)
New		2.48		0.04
Corroded		1.68		0.05
Radiography				
Longitudinal seam		Seamless No RT		
Left Circumferential seam		Full UW-11(a) Type 1		
Right Circumferential seam		Full UW-11(a) Type 1		

<sup>1</sup>Pipe minimum thickness = nominal thickness times pipe tolerance factor of 0.875.



ASME B16.5-2013 Flange	
Description	NPS 2 Class 600 WN A105 N
Bolt Material	SA-193 B7 Bolt <= 2 1/2 (II-D p. 344, ln. 31)
Blind included	No
Rated MDMT	-55° F
Liquid static head	0 psi
MAWP rating	1,360 psi @ 200° F
MAP rating	1,480 psi @ 70° F
Hydrotest rating	2,225 psi @ 70° F
PWHT performed	Yes
Impact Tested	No
Circumferential joint radiography	Full UW-11(a) Type 1
Bore diameter, B (specified by purchaser)	1.687"
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -55° F (Coincident ratio = 0.5811) Bolts rated MDMT per Fig UCS-66 note (c) = -55° F	

Results Summary	
Governing condition	UG-16
Minimum thickness per UG-16	0.0625" + 0.125" = 0.1875"
Design thickness due to internal pressure (t)	<a href="#">0.1753"</a>
Rated MDMT	-155 ° F

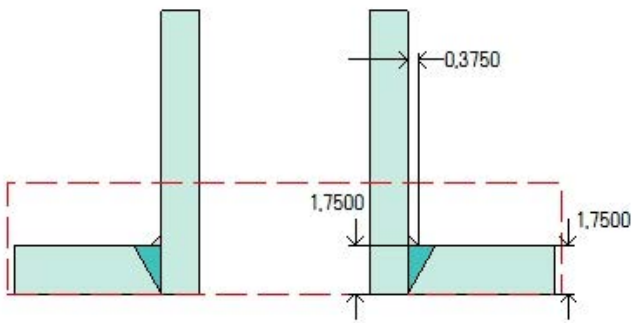
UCS-66 Material Toughness Requirements	
$t_r = 860 \cdot 0.9685 / (17,100 \cdot 1 - 0.6 \cdot 860) =$	0.0502"
Stress ratio $= t_r \cdot E^* / (t_n - c) = 0.0502 \cdot 1 / (0.301 - 0.125) =$	0.2854
Stress ratio 0.35, MDMT per UCS-66(b)(3) =	-155° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

#### Design thickness, (at 200 ° F) UG-27(c)(1)

$$\begin{aligned}
 t &= P \cdot R / (S \cdot E - 0.60 \cdot P) + \text{Corrosion} \\
 &= 860 \cdot 0.9685 / (17,100 \cdot 1.00 - 0.60 \cdot 860) + 0.125 \\
 &= \text{0.1753"}
 \end{aligned}$$

### HandHole-Inlet (HandHole-Inlet)

ASME Section VIII Division 1, 2015 Edition (Code Case 2695)					
Component	Nozzle				
Nozzle Material	SA-105 (II-D p. 18, ln. 23)				
	Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
Nozzle	No	Yes	No	Yes	No
	Design Pressure (psi)		Design Temperature (° F)		Design MDMT (° F)
Internal	860		200		-20
Static Liquid Head					
Condition	P <sub>s</sub> (psi)		H <sub>s</sub> (in)		SG
Test horizontal	1.72		47.75		1
Location and Orientation					
Attached to	Shell				
Orientation	radial				
Offset, L	30"				
Angle, θ	90°				
Distance, r	47.75"				
Through a Category A Joint	No				

Dimensions		
Inside Diameter	8"	
Nominal Wall Thickness	1.375"	
Local Vessel Minimum Thickness	1.75"	
Leg <sub>41</sub>	0.375"	
External Projection Available, L <sub>pr1</sub>	7.56"	
Projection outside vessel to flange face, L <sub>f</sub>	10"	
Corrosion	Inner	0.125"
	Outer	0"

ASME B16.5-2013 Flange	
Description	NPS 8 Class 600 LWN A105 N
Bolt Material	SA-193 B7 Bolt $\leq 2 \frac{1}{2}$ (II-D p. 344, ln. 31)
Blind included	Yes
Rated MDMT	-55° F
Liquid static head	0 psi
MAWP rating	1,360 psi @ 200° F
MAP rating	1,480 psi @ 70° F
Hydrotest rating	2,225 psi @ 70° F
PWHT performed	Yes
Impact Tested	No
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -85° F (UCS-68(c) applies, coincident ratio = 0.5811) Bolts rated MDMT per Fig UCS-66 note (c) = -55° F	

## Summary Tables

Division 2 4.5.5 Maximum Local Primary Membrane Stress				
Condition	P (psi)	P <sub>L</sub> (psi)	S <sub>allow</sub> (psi)	Over stressed
Design P	860	29,894	30,000	No

Division 2 4.5.4.1 Nozzle Neck Minimum Thickness							
Condition	P (psi)	t <sub>d1</sub> (in)	t <sub>d,STD</sub> (in)	t (in)	t <sub>d</sub> (in)	t <sub>n,min</sub> (in)	Status
Design P	860	0.3062	0.4444	1.75	0.4444	1.375	OK

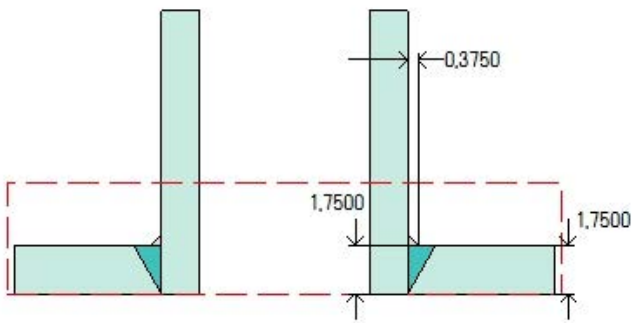
Division 2 4.5.14 Strength of Nozzle Attachment Welds Summary								
Condition	P (psi)	k <sub>y</sub>	L <sub>τ</sub> (in)	L <sub>41T</sub> (in)	f <sub>welds</sub> (lb <sub>f</sub> )	τ (psi)	S (psi)	Over stressed
Design P	860	1.303	8.443	0.2652	19,513.95	2,092	20,000	No

Division 2 Table 4.2.10 Minimum Fillet Weld Sizes			
Fillet Leg	Required Leg Size (in)	Actual Leg Size (in)	Status
Leg <sub>41</sub>	0.3571	0.375	weld size is adequate

Material Toughness Requirements LWN	
MDMT per 3.11.2.4(a)(3) =	-55° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

### HandHole-Outlet (HandHole-Outlet)

ASME Section VIII Division 1, 2015 Edition (Code Case 2695)					
Component	Nozzle				
Nozzle Material	SA-105 (II-D p. 18, ln. 23)				
	Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
Nozzle	No	Yes	No	Yes	No
	Design Pressure (psi)		Design Temperature (° F)		Design MDMT (° F)
Internal	860		200		-20
Static Liquid Head					
Condition	P <sub>s</sub> (psi)		H <sub>s</sub> (in)		SG
Test horizontal	1.72		47.75		1
Location and Orientation					
Attached to	Shell				
Orientation	radial				
Offset, L	90"				
Angle, θ	90°				
Distance, r	47.75"				
Through a Category A Joint	No				

Dimensions		
Inside Diameter	8"	
Nominal Wall Thickness	1.375"	
Local Vessel Minimum Thickness	1.75"	
Leg <sub>41</sub>	0.375"	
External Projection Available, L <sub>pr1</sub>	7.56"	
Projection outside vessel to flange face, L <sub>f</sub>	10"	
Corrosion	Inner	0.125"
	Outer	0"

ASME B16.5-2013 Flange	
Description	NPS 8 Class 600 LWN A105 N
Bolt Material	SA-193 B7 Bolt $\leq 2 \frac{1}{2}$ (II-D p. 344, ln. 31)
Blind included	Yes
Rated MDMT	-55° F
Liquid static head	0 psi
MAWP rating	1,360 psi @ 200° F
MAP rating	1,480 psi @ 70° F
Hydrotest rating	2,225 psi @ 70° F
PWHT performed	Yes
Impact Tested	No
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -85° F (UCS-68(c) applies, coincident ratio = 0.5811) Bolts rated MDMT per Fig UCS-66 note (c) = -55° F	

## Summary Tables

Division 2 4.5.5 Maximum Local Primary Membrane Stress				
Condition	P (psi)	P <sub>L</sub> (psi)	S <sub>allow</sub> (psi)	Over stressed
Design P	860	29,894	30,000	No

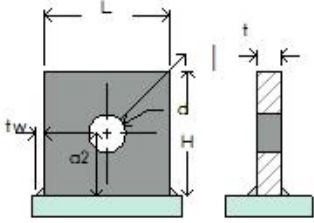
Division 2 4.5.4.1 Nozzle Neck Minimum Thickness							
Condition	P (psi)	t <sub>d1</sub> (in)	t <sub>d,STD</sub> (in)	t (in)	t <sub>d</sub> (in)	t <sub>n,min</sub> (in)	Status
Design P	860	0.3062	0.4444	1.75	0.4444	1.375	OK

Division 2 4.5.14 Strength of Nozzle Attachment Welds Summary								
Condition	P (psi)	k <sub>y</sub>	L <sub>τ</sub> (in)	L <sub>41T</sub> (in)	f <sub>welds</sub> (lb <sub>f</sub> )	τ (psi)	S (psi)	Over stressed
Design P	860	1.303	8.443	0.2652	19,513.95	2,092	20,000	No

Division 2 Table 4.2.10 Minimum Fillet Weld Sizes			
Fillet Leg	Required Leg Size (in)	Actual Leg Size (in)	Status
Leg <sub>41</sub>	0.3571	0.375	weld size is adequate

Material Toughness Requirements LWN	
MDMT per 3.11.2.4(a)(3) =	-55° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

# Lifting Lug #1

Geometry Inputs	
 <p>The diagram shows a lifting lug with a square base of length L and height H. A central hole has diameter d. The lug is attached to a shell with a weld of thickness tw. The distance from the shell to the hole center is a1, and the distance from the hole center to the top of the lug is a2. The side view shows the lug's thickness t and its attachment to the shell.</p>	
Attached To	Shell
Material	A36
Orientation	Longitudinal
Distance of Lift Point From Datum	12"
Angular Position	0°
Length, L	10"
Height, H	10"
Thickness, t	1"
Hole Diameter, d	3"
Pin Diameter, Dp	2.75"
Load Eccentricity, a <sub>1</sub>	0"
Distance from Load to Shell or Pad, a <sub>2</sub>	5"
Load Angle Normal to Vessel, β	-45°
Load Angle from Vertical, φ	-45°
Welds	
Size, t <sub>w</sub>	0.75"



Intermediate Values	
Load Factor	2.0000
Vessel Weight (new, incl. Load Factor), W	80,070.3 lb
Lug Weight (new), $W_{lug}$	28.1 lb
Distance from Center of Gravity to this lug, $x_1$	48.2047"
Distance from Center of Gravity to second lug, $x_2$	47.7953"
Allowable Stress, Tensile, $\sigma_t$	19,980 psi
Allowable Stress, Shear, $\sigma_s$	13,320 psi
Allowable Stress, Bearing, $\sigma_p$	29,970 psi
Allowable Stress, Bending, $\sigma_b$	22,201 psi
Allowable Stress, Weld Shear, $\tau_{allowable}$	13,320 psi
Allowable Stress set to 1/3 Sy per ASME B30.20	No

Summary Values	
Required Lift Pin Diameter, $d_{reqd}$	<a href="#">1.6415"</a>
Required Lug Thickness, $t_{reqd}$	<a href="#">0.684"</a>
Lug Stress Ratio, $\sigma_{ratio}$	<a href="#">0.74</a>
Weld Shear Stress Ratio, $\tau_{ratio}$	<a href="#">0.94</a>
Lug Design	Acceptable
Local Stresses WRC 107	Acceptable

### Lift Forces

$$\begin{aligned}
 F_r &= \text{force on vessel at lug} \\
 F_r &= [W / \cos(\phi_1)] * (1 - x_1 / (x_1 + x_2)) \\
 &= (80,070.3) / \cos(-45) * (1 - 48.2047 / (48.2047 + \\
 &\quad 47.7953)) \\
 &= \text{56,377 lb}_f
 \end{aligned}$$

where ' $x_1$ ' is the distance between this lug and the center of gravity

' $x_2$ ' is the distance between the second lift lug and the center of gravity

### Lug Pin Diameter - Shear stress

$$\begin{aligned}
 d_{reqd} &= (2 * F_r / (\pi * \sigma_s))^{0.5} \\
 &= (2 * 56,377 / (\pi * 13,320))^{0.5} = \text{1.6415"}
 \end{aligned}$$

$$d_{reqd} / D_p = 1.6415 / 2.75 = 0.60 \quad \text{Acceptable}$$

$$\begin{aligned}
 \sigma &= F_r / A \\
 &= F_r / (2 * (0.25 * \pi * D_p^2)) \\
 &= 56,377 / (2 * (0.25 * \pi * 2.75^2)) = 4,746 \text{ psi}
 \end{aligned}$$

$$\sigma / \sigma_s = 4,746 / 13,320 = 0.36 \quad \text{Acceptable}$$

### Lug Thickness - Tensile stress

$$\begin{aligned}t_{\text{reqd}} &= F_r / ((L - d) \cdot \sigma_t) \\&= 56,377 / ((10 - 3) \cdot 19,980) = 0.4031''\end{aligned}$$

$$t_{\text{reqd}} / t = 0.4031 / 1 = 0.40 \quad \text{Acceptable}$$

$$\begin{aligned}\sigma &= F_r / A \\&= F_r / ((L - d) \cdot t) \\&= 56,377 / ((10 - 3) \cdot 1) = 8,054 \text{ psi}\end{aligned}$$

$$\sigma / \sigma_t = 8,054 / 19,980 = 0.4 \quad \text{Acceptable}$$

### Lug Thickness - Bearing stress

$$\begin{aligned}t_{\text{reqd}} &= F_v / (D_p \cdot \sigma_p) \\&= 56,377 / (2.75 \cdot 29,970) = \underline{0.684''}\end{aligned}$$

$$t_{\text{reqd}} / t = 0.684 / 1 = 0.68 \quad \text{Acceptable}$$

$$\begin{aligned}\sigma &= F_v / A_{\text{bearing}} \\&= F_v / (D_p \cdot t) \\&= 56,377 / (2.75 \cdot (1)) = 20,501 \text{ psi}\end{aligned}$$

$$\sigma / \sigma_p = 20,501 / 29,970 = 0.68 \quad \text{Acceptable}$$

### Lug Thickness - Shear stress

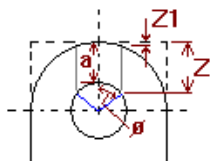
$$\begin{aligned}t_{\text{reqd}} &= [F_v / \sigma_s] / (2 \cdot L_{\text{shear}}) \\&= (56,377 / 13,320) / (2 \cdot 3.9989) = \underline{0.5292''}\end{aligned}$$

$$t_{\text{reqd}} / t = 0.5292 / 1 = 0.53 \quad \text{Acceptable}$$

$$\begin{aligned}\tau &= F_v / A_{\text{shear}} \\&= F_v / (2 \cdot t \cdot L_{\text{shear}}) \\&= 56,377 / (2 \cdot 1 \cdot 3.9989) = 7,049 \text{ psi}\end{aligned}$$

$$\tau / \sigma_s = 7,049 / 13,320 = 0.53 \quad \text{Acceptable}$$

Shear stress length (per Pressure Vessel and Stacks, A. Keith Escoe)



$$\phi = 55 \cdot D_p / d$$

$$\begin{aligned}
&= 55 \cdot 2.75 / 3 \\
&= 50.4167^\circ \\
L_{\text{shear}} &= (H - a_2 - 0.5 \cdot d) + 0.5 \cdot D_p \cdot (1 - \cos(\phi)) \\
&= (10 - 5 - 0.5 \cdot 3) + 0.5 \cdot 2.75 \cdot (1 - \cos(50.4167)) \\
&= 3.9989"
\end{aligned}$$

## Lug Plate Stress

Lug stress tensile + bending during lift:

$$\begin{aligned}
\sigma_{\text{ratio}} &= [F_{\text{ten}} / (A_{\text{ten}} \cdot \sigma_t)] + [M_{\text{bend}} / (Z_{\text{bend}} \cdot \sigma_b)] \quad 1 \\
&= [(F_r \cdot \cos(\beta)) / (t \cdot L \cdot \sigma_t)] + [(6 \cdot \text{abs}(F_r \cdot \sin(\beta) \cdot \text{Hght} - F_r \cdot \cos(\beta) \cdot a_1)) / (t \cdot L^2 \cdot \sigma_b)] \quad 1 \\
&= 56,377 \cdot \cos(-45.0) / (1 \cdot 10 \cdot 19,980) + 6 \cdot \text{abs}(56,377 \cdot \sin(-45.0) \cdot 5 - 56,377 \cdot \cos(-45.0) \cdot 0) / (1 \cdot 10^2 \cdot 22,201) \\
&= \underline{0.74} \quad \text{Acceptable}
\end{aligned}$$

## Weld Stress

Weld stress, tensile, bending and shear during lift:

Direct shear:

Shear stress at lift angle  $-45.00^\circ$ ; lift force = 56,377 lb<sub>f</sub>

$$\begin{aligned}
A_{\text{weld}} &= 2 \cdot (0.707) \cdot t_w \cdot (L + t) \\
&= 2 \cdot (0.707) \cdot 0.75 \cdot (10 + 1) = 11.6655 \text{ in}^2
\end{aligned}$$

$$\begin{aligned}
\tau_t &= F_{\text{lug}} \cdot \cos(\beta) / A_{\text{weld}} \\
&= 56,377 \cdot \cos(-45.0) / 11.6655 = 3,417 \text{ psi}
\end{aligned}$$

$$\begin{aligned}
\tau_s &= F_{\text{lug}} \cdot \sin(\beta) / A_{\text{weld}} \\
&= 56,377 \cdot \sin(-45.0) / 11.6655 = -3,417 \text{ psi}
\end{aligned}$$

$$\begin{aligned}
\tau_b &= M \cdot c / I \\
&= 3 \cdot (F_{\text{lug}} \cdot \sin(\beta) \cdot \text{Hght} - F_{\text{lug}} \cdot \cos(\beta) \cdot a_1) / (0.707 \cdot h \cdot L \cdot (3 \cdot t + L)) \\
&= 3 \cdot \text{abs}(56,377 \cdot \sin(-45.0) \cdot 5 - 56,377 \cdot \cos(-45.0) \cdot 0) / (68.9325) \\
&= 8,675 \text{ psi}
\end{aligned}$$

$$\begin{aligned}
\tau_{\text{ratio}} &= \text{sqr}((\tau_t + \tau_b)^2 + \tau_s^2) / \tau_{\text{allowable}} \quad 1 \\
&= \text{sqr}((3,417 + 8,675)^2 + (-3,417)^2) / 13,320 \\
&= \underline{0.94} \quad \text{Acceptable}
\end{aligned}$$

## WRC 107 Analysis

Geometry	
Height (radial)	10"
Width (circumferential)	1"
Length	10"
Fillet Weld Size:	0.75"
Located On	Shell (17" from right end)
Location Angle	0.00°

Applied Loads	
Radial load, $P_r$	-39,864.45 lb <sub>f</sub>
Circumferential moment, $M_c$	0 lb <sub>f</sub> -in
Circumferential shear, $V_c$	0 lb <sub>f</sub>
Longitudinal moment, $M_L$	-199,322.2 lb <sub>f</sub> -in
Longitudinal shear, $V_L$	-39,864.45 lb <sub>f</sub>
Torsion moment, $M_t$	0 lb <sub>f</sub> -in
Internal pressure, $P$	0 psi
Mean shell radius, $R_m$	36.875"
Design factor	3

### Maximum stresses due to the applied loads at the lug edge

$$\gamma = R_m / T = 36.875 / 1.75 = 21.0714$$

$$C_1 = 1.25, C_2 = 5 \text{ in}$$

Note: Actual lug  $C_1 / C_2 < 1 / 4$ ,  $C_1 / C_2 = 1 / 4$  used as this is the minimum ratio covered by WRC 107.

$$\text{Local circumferential pressure stress} = P \cdot R_i / T = 0 \text{ psi}$$

$$\text{Local longitudinal pressure stress} = P \cdot R_i / (2 \cdot T) = 0 \text{ psi}$$

$$\text{Maximum combined stress } (P_L + P_b + Q) = 25,003 \text{ psi}$$

$$\text{Allowable combined stress } (P_L + P_b + Q) = \pm 3 \cdot S = \pm 60,000 \text{ psi}$$

The maximum combined stress  $(P_L + P_b + Q)$  is within allowable limits.

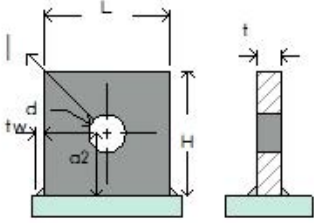
$$\text{Maximum local primary membrane stress } (P_L) = 3,439 \text{ psi}$$

$$\text{Allowable local primary membrane stress } (P_L) = \pm 1.5 \cdot S = \pm 30,000 \text{ psi}$$

The maximum local primary membrane stress  $(P_L)$  is within allowable limits.

Stresses at the lug edge per WRC Bulletin 107										
Figure	value	$\beta$	$A_u$	$A_l$	$B_u$	$B_l$	$C_u$	$C_l$	$D_u$	$D_l$
3C*	3.6111	0.1003	0	0	0	0	2,231	2,231	2,231	2,231
4C*	3.9889	0.0814	2,464	2,464	2,464	2,464	0	0	0	0
1C	0.2043	0.0597	0	0	0	0	15,956	-15,956	15,956	-15,956
2C-1	0.168	0.0597	13,121	-13,121	13,121	-13,121	0	0	0	0
3A*	0.212	0.0538	0	0	0	0	0	0	0	0
1A	0.106	0.0698	0	0	0	0	0	0	0	0
3B*	1.4893	0.0854	975	975	-975	-975	0	0	0	0
1B-1	0.0574	0.0763	7,968	-7,968	-7,968	7,968	0	0	0	0
Pressure stress*			0	0	0	0	0	0	0	0
Total circumferential stress			24,528	-17,650	6,642	-3,664	18,187	-13,725	18,187	-13,725
Primary membrane circumferential stress*			3,439	3,439	1,489	1,489	2,231	2,231	2,231	2,231
3C*	3.7948	0.0814	2,344	2,344	2,344	2,344	0	0	0	0
4C*	3.8866	0.1003	0	0	0	0	2,401	2,401	2,401	2,401
1C-1	0.1759	0.0847	13,738	-13,738	13,738	-13,738	0	0	0	0
2C	0.1329	0.0847	0	0	0	0	10,380	-10,380	10,380	-10,380
4A*	0.2774	0.0538	0	0	0	0	0	0	0	0
2A	0.0588	0.097	0	0	0	0	0	0	0	0
4B*	0.3973	0.0854	463	463	-463	-463	0	0	0	0
2B-1	0.084	0.1052	8,458	-8,458	-8,458	8,458	0	0	0	0
Pressure stress*			0	0	0	0	0	0	0	0
Total longitudinal stress			25,003	-19,389	7,161	-3,399	12,781	-7,979	12,781	-7,979
Primary membrane longitudinal stress*			2,807	2,807	1,881	1,881	2,401	2,401	2,401	2,401
Shear from $M_t$			0	0	0	0	0	0	0	0
Circ shear from $V_c$			0	0	0	0	0	0	0	0
Long shear from $V_L$			0	0	0	0	1,139	1,139	-1,139	-1,139
Total Shear stress			0	0	0	0	1,139	1,139	-1,139	-1,139
Combined stress ( $P_L+P_D+Q$ )			25,003	-19,389	7,161	-3,664	18,417	-13,943	18,417	-13,943
* denotes primary stress.										

## Lifting Lug #2

Geometry Inputs	
 <p>The diagram shows a lifting lug with a square base of length L and height H. A central hole has diameter d. The lug is attached to a shell with a weld of size tw. The distance from the load to the shell is a1, and the distance from the load to the pad is a2. The lug is shown in a side view with thickness t.</p>	
Attached To	Shell
Material	A36
Orientation	Longitudinal
Distance of Lift Point From Datum	108"
Angular Position	0°
Length, L	10"
Height, H	10"
Thickness, t	1"
Hole Diameter, d	3"
Pin Diameter, Dp	2.75"
Load Eccentricity, a <sub>1</sub>	0"
Distance from Load to Shell or Pad, a <sub>2</sub>	5"
Load Angle Normal to Vessel, β	45°
Load Angle from Vertical, φ	45°
Welds	
Size, t <sub>w</sub>	0.75"

Intermediate Values	
Load Factor	2.0000
Vessel Weight (new, incl. Load Factor), W	80,070.3 lb
Lug Weight (new), $W_{lug}$	28.1 lb
Distance from Center of Gravity to this lug, $x_1$	47.7953"
Distance from Center of Gravity to second lug, $x_2$	48.2047"
Allowable Stress, Tensile, $\sigma_t$	19,980 psi
Allowable Stress, Shear, $\sigma_s$	13,320 psi
Allowable Stress, Bearing, $\sigma_p$	29,970 psi
Allowable Stress, Bending, $\sigma_b$	22,201 psi
Allowable Stress, Weld Shear, $\tau_{allowable}$	13,320 psi
Allowable Stress set to 1/3 Sy per ASME B30.20	No

Summary Values	
Required Lift Pin Diameter, $d_{reqd}$	<a href="#">1.6485"</a>
Required Lug Thickness, $t_{reqd}$	<a href="#">0.6899"</a>
Lug Stress Ratio, $\sigma_{ratio}$	<a href="#">0.74</a>
Weld Shear Stress Ratio, $\tau_{ratio}$	<a href="#">0.95</a>
Lug Design	Acceptable
Local Stresses WRC 107	Acceptable

### Lift Forces

$$\begin{aligned}
 F_r &= \text{force on vessel at lug} \\
 F_r &= [W / \cos(\phi_1)] * (1 - x_1 / (x_1 + x_2)) \\
 &= (80,070.3) / \cos(45) * (1 - 47.7953 / (47.7953 + \\
 &\quad 48.2047)) \\
 &= \text{56.860 lb,}
 \end{aligned}$$

where ' $x_1$ ' is the distance between this lug and the center of gravity

' $x_2$ ' is the distance between the second lift lug and the center of gravity

### Lug Pin Diameter - Shear stress

$$\begin{aligned}
 d_{reqd} &= (2 * F_r / (\pi * \sigma_s))^{0.5} \\
 &= (2 * 56,860 / (\pi * 13,320))^{0.5} = \text{1.6485"}
 \end{aligned}$$

$$d_{reqd} / D_p = 1.6485 / 2.75 = 0.60 \quad \text{Acceptable}$$

$$\begin{aligned}
 \sigma &= F_r / A \\
 &= F_r / (2 * (0.25 * \pi * D_p^2)) \\
 &= 56,860 / (2 * (0.25 * \pi * 2.75^2)) = 4,787 \text{ psi}
 \end{aligned}$$

$$\sigma / \sigma_s = 4,787 / 13,320 = 0.36 \quad \text{Acceptable}$$

### Lug Thickness - Tensile stress

$$\begin{aligned}t_{\text{reqd}} &= F_r / ((L - d) \cdot \sigma_t) \\&= 56,860 / ((10 - 3) \cdot 19,980) = 0.4065''\end{aligned}$$

$$t_{\text{reqd}} / t = 0.4065 / 1 = 0.41 \quad \text{Acceptable}$$

$$\begin{aligned}\sigma &= F_r / A \\&= F_r / ((L - d) \cdot t) \\&= 56,860 / ((10 - 3) \cdot 1) = 8,123 \text{ psi}\end{aligned}$$

$$\sigma / \sigma_t = 8,123 / 19,980 = 0.41 \quad \text{Acceptable}$$

### Lug Thickness - Bearing stress

$$\begin{aligned}t_{\text{reqd}} &= F_v / (D_p \cdot \sigma_p) \\&= 56,860 / (2.75 \cdot 29,970) = \underline{0.6899''}\end{aligned}$$

$$t_{\text{reqd}} / t = 0.6899 / 1 = 0.69 \quad \text{Acceptable}$$

$$\begin{aligned}\sigma &= F_v / A_{\text{bearing}} \\&= F_v / (D_p \cdot t) \\&= 56,860 / (2.75 \cdot 1) = 20,676 \text{ psi}\end{aligned}$$

$$\sigma / \sigma_p = 20,676 / 29,970 = 0.69 \quad \text{Acceptable}$$

### Lug Thickness - Shear stress

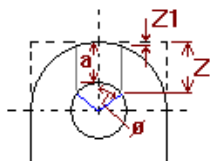
$$\begin{aligned}t_{\text{reqd}} &= [F_v / \sigma_s] / (2 \cdot L_{\text{shear}}) \\&= (56,860 / 13,320) / (2 \cdot 3.9989) = \underline{0.5337''}\end{aligned}$$

$$t_{\text{reqd}} / t = 0.5337 / 1 = 0.53 \quad \text{Acceptable}$$

$$\begin{aligned}\tau &= F_v / A_{\text{shear}} \\&= F_v / (2 \cdot t \cdot L_{\text{shear}}) \\&= 56,860 / (2 \cdot 1 \cdot 3.9989) = 7,110 \text{ psi}\end{aligned}$$

$$\tau / \sigma_s = 7,110 / 13,320 = 0.53 \quad \text{Acceptable}$$

Shear stress length (per Pressure Vessel and Stacks, A. Keith Escoe)



$$\phi = 55 \cdot D_p / d$$



$$\begin{aligned}
&= 55 \cdot 2.75 / 3 \\
&= 50.4167^\circ \\
L_{\text{shear}} &= (H - a_2 - 0.5 \cdot d) + 0.5 \cdot D_p \cdot (1 - \cos(\phi)) \\
&= (10 - 5 - 0.5 \cdot 3) + 0.5 \cdot 2.75 \cdot (1 - \cos(50.4167)) \\
&= 3.9989"
\end{aligned}$$

## Lug Plate Stress

Lug stress tensile + bending during lift:

$$\begin{aligned}
\sigma_{\text{ratio}} &= [F_{\text{ten}} / (A_{\text{ten}} \cdot \sigma_t)] + [M_{\text{bend}} / (Z_{\text{bend}} \cdot \sigma_b)] \quad 1 \\
&= [(F_r \cdot \cos(\beta)) / (t \cdot L \cdot \sigma_t)] + [(6 \cdot \text{abs}(F_r \cdot \sin(\beta) \cdot \text{Hght} - F_r \cdot \cos(\beta) \cdot a_1)) / (t \cdot L^2 \cdot \sigma_b)] \quad 1 \\
&= 56,860 \cdot \cos(45.0) / (1 \cdot 10 \cdot 19,980) + 6 \cdot \text{abs}(56,860 \cdot \sin(45.0) \cdot 5 - 56,860 \cdot \cos(45.0) \cdot 0) / (1 \cdot 10^2 \cdot 22,201) \\
&= \underline{0.74} \quad \text{Acceptable}
\end{aligned}$$

## Weld Stress

Weld stress, tensile, bending and shear during lift:

Direct shear:

Shear stress at lift angle  $45.00^\circ$  ; lift force = 56,860 lb<sub>f</sub>

$$\begin{aligned}
A_{\text{weld}} &= 2 \cdot (0.707) \cdot t_w \cdot (L + t) \\
&= 2 \cdot (0.707) \cdot 0.75 \cdot (10 + 1) = 11.6655 \text{ in}^2
\end{aligned}$$

$$\begin{aligned}
\tau_t &= F_{\text{lug}} \cdot \cos(\beta) / A_{\text{weld}} \\
&= 56,860 \cdot \cos(45.0) / 11.6655 = 3,447 \text{ psi}
\end{aligned}$$

$$\begin{aligned}
\tau_s &= F_{\text{lug}} \cdot \sin(\beta) / A_{\text{weld}} \\
&= 56,860 \cdot \sin(45.0) / 11.6655 = 3,447 \text{ psi}
\end{aligned}$$

$$\begin{aligned}
\tau_b &= M \cdot c / I \\
&= 3 \cdot (F_{\text{lug}} \cdot \sin(\beta) \cdot \text{Hght} - F_{\text{lug}} \cdot \cos(\beta) \cdot a_1) / (0.707 \cdot h \cdot L \cdot (3 \cdot t + L)) \\
&= 3 \cdot \text{abs}(56,860 \cdot \sin(45.0) \cdot 5 - 56,860 \cdot \cos(45.0) \cdot 0) / (68.9325) \\
&= 8,749 \text{ psi}
\end{aligned}$$

$$\begin{aligned}
\tau_{\text{ratio}} &= \text{sqr}((\tau_t + \tau_b)^2 + \tau_s^2) / \tau_{\text{allowable}} \quad 1 \\
&= \text{sqr}((3,447 + 8,749)^2 + (3,447)^2) / 13,320 \\
&= \underline{0.95} \quad \text{Acceptable}
\end{aligned}$$

## WRC 107 Analysis

Geometry	
Height (radial)	10"
Width (circumferential)	1"
Length	10"
Fillet Weld Size:	0.75"
Located On	Shell (113" from right end)
Location Angle	0.00°

Applied Loads	
Radial load, $P_r$	-40,205.89 lb <sub>f</sub>
Circumferential moment, $M_c$	0 lb <sub>f</sub> -in
Circumferential shear, $V_c$	0 lb <sub>f</sub>
Longitudinal moment, $M_L$	201,029.5 lb <sub>f</sub> -in
Longitudinal shear, $V_L$	40,205.89 lb <sub>f</sub>
Torsion moment, $M_t$	0 lb <sub>f</sub> -in
Internal pressure, $P$	0 psi
Mean shell radius, $R_m$	36.875"
Design factor	3

### Maximum stresses due to the applied loads at the lug edge

$$\gamma = R_m / T = 36.875 / 1.75 = 21.0714$$

$$C_1 = 1.25, C_2 = 5 \text{ in}$$

Note: Actual lug  $C_1 / C_2 < 1 / 4$ ,  $C_1 / C_2 = 1 / 4$  used as this is the minimum ratio covered by WRC 107.

$$\text{Local circumferential pressure stress} = P \cdot R_i / T = 0 \text{ psi}$$

$$\text{Local longitudinal pressure stress} = P \cdot R_i / (2 \cdot T) = 0 \text{ psi}$$

$$\text{Maximum combined stress } (P_L + P_b + Q) = 25,217 \text{ psi}$$

$$\text{Allowable combined stress } (P_L + P_b + Q) = \pm 3 \cdot S = \pm 60,000 \text{ psi}$$

The maximum combined stress  $(P_L + P_b + Q)$  is within allowable limits.

$$\text{Maximum local primary membrane stress } (P_L) = 3,469 \text{ psi}$$

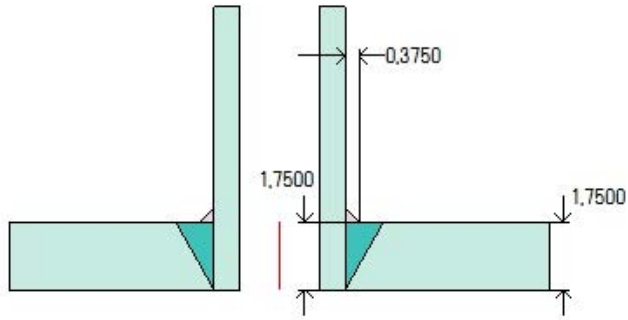
$$\text{Allowable local primary membrane stress } (P_L) = \pm 1.5 \cdot S = \pm 30,000 \text{ psi}$$

The maximum local primary membrane stress  $(P_L)$  is within allowable limits.

Stresses at the lug edge per WRC Bulletin 107										
Figure	value	$\beta$	$A_u$	$A_l$	$B_u$	$B_l$	$C_u$	$C_l$	$D_u$	$D_l$
3C*	3.6111	0.1003	0	0	0	0	2,250	2,250	2,250	2,250
4C*	3.9889	0.0814	2,485	2,485	2,485	2,485	0	0	0	0
1C	0.2043	0.0597	0	0	0	0	16,093	-16,093	16,093	-16,093
2C-1	0.168	0.0597	13,233	-13,233	13,233	-13,233	0	0	0	0
3A*	0.212	0.0538	0	0	0	0	0	0	0	0
1A	0.106	0.0698	0	0	0	0	0	0	0	0
3B*	1.4893	0.0854	-984	-984	984	984	0	0	0	0
1B-1	0.0574	0.0763	-8,037	8,037	8,037	-8,037	0	0	0	0
Pressure stress*			0	0	0	0	0	0	0	0
Total circumferential stress			6,697	-3,695	24,739	-17,801	18,343	-13,843	18,343	-13,843
Primary membrane circumferential stress*			1,501	1,501	3,469	3,469	2,250	2,250	2,250	2,250
3C*	3.7948	0.0814	2,364	2,364	2,364	2,364	0	0	0	0
4C*	3.8866	0.1003	0	0	0	0	2,422	2,422	2,422	2,422
1C-1	0.1759	0.0847	13,856	-13,856	13,856	-13,856	0	0	0	0
2C	0.1329	0.0847	0	0	0	0	10,469	-10,469	10,469	-10,469
4A*	0.2774	0.0538	0	0	0	0	0	0	0	0
2A	0.0588	0.097	0	0	0	0	0	0	0	0
4B*	0.3973	0.0854	-467	-467	467	467	0	0	0	0
2B-1	0.084	0.1052	-8,530	8,530	8,530	-8,530	0	0	0	0
Pressure stress*			0	0	0	0	0	0	0	0
Total longitudinal stress			7,223	-3,429	25,217	-19,555	12,891	-8,047	12,891	-8,047
Primary membrane longitudinal stress*			1,897	1,897	2,831	2,831	2,422	2,422	2,422	2,422
Shear from $M_t$			0	0	0	0	0	0	0	0
Circ shear from $V_c$			0	0	0	0	0	0	0	0
Long shear from $V_L$			0	0	0	0	-1,149	-1,149	1,149	1,149
Total Shear stress			0	0	0	0	-1,149	-1,149	1,149	1,149
Combined stress ( $P_L+P_D+Q$ )			7,223	-3,695	25,217	-19,555	18,575	-14,062	18,575	-14,062
* denotes primary stress.										

# PSV (PSV)

## ASME Section VIII Division 1, 2015 Edition



Note: round inside edges per UG-76(c)

### Location and Orientation

Located on	Shell
Orientation	0°
Nozzle center line offset to datum line	68"
End of nozzle to shell center	43.75"
Passes through a Category A joint	No

### Nozzle

Access opening	No
Material specification	SA-105 (II-D p. 18, In. 23) (normalized)
Inside diameter, new	2"
Nominal wall thickness	0.655"
Corrosion allowance	0.125"
Projection available outside vessel, Lpr	4.75"
Projection available outside vessel to flange face, Lf	6"
Local vessel minimum thickness	1.75"
Liquid static head included	0 psi
Longitudinal joint efficiency	1

### Welds

Inner fillet, Leg <sub>41</sub>	0.375"
Nozzle to vessel groove weld	1.75"

ASME B16.5-2013 Flange	
<b>Description</b>	NPS 2 Class 600 LWN A105 N
<b>Bolt Material</b>	SA-193 B7 Bolt $\leq 2 \frac{1}{2}$ (II-D p. 344, ln. 31)
<b>Blind included</b>	No
<b>Rated MDMT</b>	-55° F
<b>Liquid static head</b>	0 psi
<b>MAWP rating</b>	1,360 psi @ 200° F
<b>MAP rating</b>	1,480 psi @ 70° F
<b>Hydrotest rating</b>	2,225 psi @ 70° F
<b>PWHT performed</b>	Yes
<b>Impact Tested</b>	No
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -55° F (Coincident ratio = 0.5811) Bolts rated MDMT per Fig UCS-66 note (c) = -55° F	

UCS-66 Material Toughness Requirements	
LWN rated MDMT per UCS-66(c)(4) =	-55° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

#### Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in <sup>2</sup> )							UG-45 Summary (in)	
For P = 860 psi @ 200 ° F							The nozzle passes UG-45	
A required	A available	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	A <sub>5</sub>	A welds	t <sub>req</sub>	t <sub>min</sub>
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.314	0.655

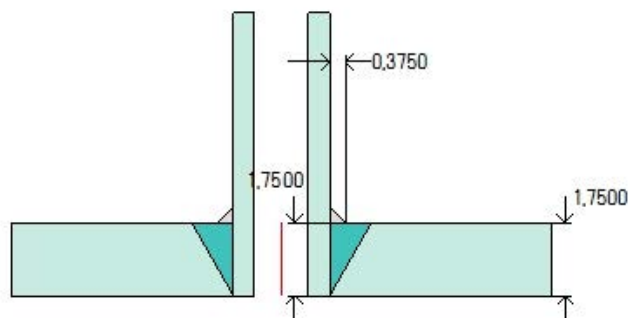
UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg <sub>41</sub> )	0.25	0.2625	weld size is adequate

**This opening does not require reinforcement per UG-36(c)(3)(a)**

## Plugged Connection 1 (Plugged Connection 1)

### ASME Section VIII Division 1, 2015 Edition



Note: round inside edges per UG-76(c)

#### Location and Orientation

Located on	Shell
Orientation	270°
Nozzle center line offset to datum line	50"
End of nozzle to shell center	40.75"
Passes through a Category A joint	No

#### Nozzle

Description	NPS 1 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	1.315"
Nominal wall thickness	0.4675"
Corrosion allowance	0.125"
Projection available outside vessel, L <sub>pr</sub>	3"
Local vessel minimum thickness	1.75"
Liquid static head included	0 psi
Longitudinal joint efficiency	1

#### Welds

Inner fillet, Leg <sub>41</sub>	0.375"
Nozzle to vessel groove weld	1.75"

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 860 \cdot 0.7825 / (20,000 \cdot 1 - 0.6 \cdot 860) =$	0.0345"
Stress ratio $= t_r \cdot E^* / (t_n - c) = 0.0345 \cdot 1 / (0.4675 - 0.125) =$	0.1008
Stress ratio 0.35, MDMT per UCS-66(b)(3) =	-155° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

#### Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in <sup>2</sup> )							UG-44 Summary (in)	
For P = 860 psi @ 200 ° F							The nozzle passes UG-44	
A required	A available	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	A <sub>5</sub>	A welds	t <sub>req</sub>	t <sub>min</sub>
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.1875	0.4675

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

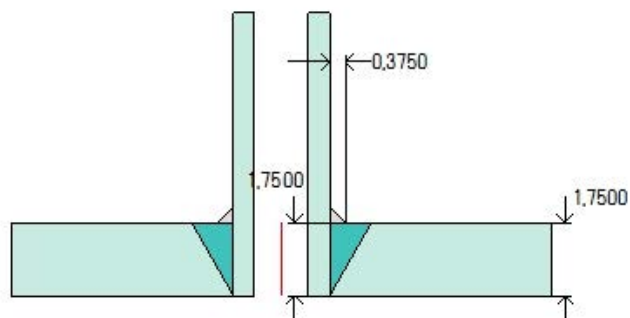
UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg <sub>41</sub> )	0.2398	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)



## Plugged Connection 2 (Plugged Connection 2)

### ASME Section VIII Division 1, 2015 Edition



Note: round inside edges per UG-76(c)

#### Location and Orientation

Located on	Shell
Orientation	270°
Nozzle center line offset to datum line	72"
End of nozzle to shell center	40.75"
Passes through a Category A joint	No

#### Nozzle

Description	NPS 1 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	1.315"
Nominal wall thickness	0.4675"
Corrosion allowance	0.125"
Projection available outside vessel, L <sub>pr</sub>	3"
Local vessel minimum thickness	1.75"
Liquid static head included	0 psi
Longitudinal joint efficiency	1

#### Welds

Inner fillet, Leg <sub>41</sub>	0.375"
Nozzle to vessel groove weld	1.75"

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 860 \cdot 0.7825 / (20,000 \cdot 1 - 0.6 \cdot 860) =$	0.0345"
Stress ratio $= t_r \cdot E^* / (t_n - c) = 0.0345 \cdot 1 / (0.4675 - 0.125) =$	0.1008
Stress ratio 0.35, MDMT per UCS-66(b)(3) =	-155° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

#### Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in <sup>2</sup> )							UG-44 Summary (in)	
For P = 860 psi @ 200 ° F							The nozzle passes UG-44	
A required	A available	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	A <sub>5</sub>	A welds	t <sub>req</sub>	t <sub>min</sub>
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.1875	0.4675

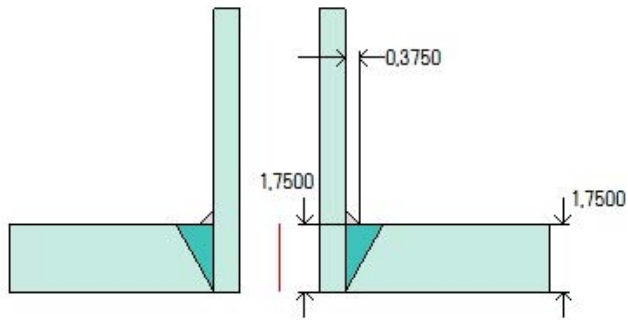
UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg <sub>41</sub> )	0.2398	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

## Vent (Vent)

### ASME Section VIII Division 1, 2015 Edition



Note: round inside edges per UG-76(c)

#### Location and Orientation

Located on	Shell
Orientation	0°
Nozzle center line offset to datum line	50"
End of nozzle to shell center	43.75"
Passes through a Category A joint	No

#### Nozzle

Access opening	No
Material specification	SA-105 (II-D p. 18, In. 23) (normalized)
Inside diameter, new	2"
Nominal wall thickness	0.655"
Corrosion allowance	0.125"
Projection available outside vessel, L <sub>pr</sub>	4.75"
Projection available outside vessel to flange face, L <sub>f</sub>	6"
Local vessel minimum thickness	1.75"
Liquid static head included	0 psi
Longitudinal joint efficiency	1

#### Welds

Inner fillet, Leg <sub>41</sub>	0.375"
Nozzle to vessel groove weld	1.75"

ASME B16.5-2013 Flange	
<b>Description</b>	NPS 2 Class 600 LWN A105 N
<b>Bolt Material</b>	SA-193 B7 Bolt $\leq 2 \frac{1}{2}$ (II-D p. 344, ln. 31)
<b>Blind included</b>	No
<b>Rated MDMT</b>	-55° F
<b>Liquid static head</b>	0 psi
<b>MAWP rating</b>	1,360 psi @ 200° F
<b>MAP rating</b>	1,480 psi @ 70° F
<b>Hydrotest rating</b>	2,225 psi @ 70° F
<b>PWHT performed</b>	Yes
<b>Impact Tested</b>	No
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -55° F (Coincident ratio = 0.5811) Bolts rated MDMT per Fig UCS-66 note (c) = -55° F	

UCS-66 Material Toughness Requirements	
LWN rated MDMT per UCS-66(c)(4) =	-55° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

#### Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in <sup>2</sup> )							UG-45 Summary (in)	
For P = 860 psi @ 200 ° F							The nozzle passes UG-45	
A required	A available	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	A <sub>5</sub>	A welds	t <sub>req</sub>	t <sub>min</sub>
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.314	0.655

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg <sub>41</sub> )	0.25	0.2625	weld size is adequate

**This opening does not require reinforcement per UG-36(c)(3)(a)**

### Straight Flange on Outlet Head

ASME Section VIII Division 1, 2015 Edition (Code Case 2695)				
Component		Cylinder		
Material		SA-516 70 (II-D p. 18, ln. 37)		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
Yes (-20° F)	Yes	No	Yes	No
		Design Pressure (psi)	Design Temperature (° F)	Design MDMT (° F)
Internal		860	200	-20
Static Liquid Head				
Condition		P <sub>s</sub> (psi)	H <sub>s</sub> (in)	SG
Test horizontal		2.88	79.75	1
Dimensions				
Inner Diameter		72"		
Length		2"		
Nominal Thickness		1.75"		
Corrosion	Inner	0.125"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		Capacity (US gal)
New		229.49		35.25
Corroded		213.46		35.5
Radiography				
Longitudinal seam		Seamless No RT		
Left Circumferential seam		Full UW-11(a) Type 1		

Results Summary	
Governing condition	Operating Hot & Corroded
Design thickness due to internal pressure (t)	<a href="#">1.7123"</a>
Minimum thickness per 4.1.2	0.1875"
Rated MDMT	-22.3° F

Material Toughness Requirements	
Material impact test temperature per UG-84 =	-20° F
Stress ratio = $1.5873 \cdot 1 / (1.75 - 0.125 - 0) =$	0.9768
Reduction in MDMT from Figure UCS-66.1 =	2.3° F
MDMT = $\max[T_{\text{impact}} - T_R, -155] = \max[-20 - 2.3, -155] =$	-22.3° F
Design MDMT of -20° F is acceptable.	

Division 2 4.3.3.1 Design Thickness for Internal Pressure	
$t_d = D / 2 \cdot (\exp[P / (S \cdot E)] - 1) + \text{Corrosion}$	(4.3.1)
<b>Operating Hot &amp; Corroded</b>	
$t_d = 72.25 / 2 \cdot (\exp[(860 + 0) / (20,000 \cdot 1)] - 1) + 0.125 =$	1.7123"
<b>Operating Cold &amp; Corroded</b>	
$t_r = 72.25 / 2 \cdot (\exp[(860 + 0) / (20,000 \cdot 1)] - 1) =$	1.5873"

## Outlet Head

ASME Section VIII Division 1, 2015 Edition (Code Case 2695)				
Component		Ellipsoidal Head		
Material		SA-516 70 (II-D p. 18, ln. 37)		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
Yes (-20° F)	Yes	No	Yes	No
		Design Pressure (psi)	Design Temperature (° F)	Design MDMT (° F)
Internal		860	200	-20
Static Liquid Head				
Condition		P <sub>s</sub> (psi)	H <sub>s</sub> (in)	SG
Test horizontal		2.88	79.75	1
Dimensions				
Inner Diameter		72"		
Head Ratio		2		
Minimum Thickness		1.625"		
Corrosion	Inner	0.125"		
	Outer	0"		
Length L <sub>sf</sub>		2"		
Nominal Thickness t <sub>sf</sub>		1.75"		
Weight and Capacity				
		Weight (lb) <sup>1</sup>		Capacity (US gal) <sup>1</sup>
New		2,555.5		246.76
Corroded		2,371.76		249.95
Radiography				
Category A joints		Seamless No RT		
Head to shell seam		Full UW-11(a) Type 1		

<sup>1</sup> includes straight flange

Results Summary	
Governing condition	Operating Hot & Corroded
Design thickness due to internal pressure (t)	<a href="#">1.5335"</a>
Minimum thickness per 4.1.2	0.1875"
Rated MDMT	-26.1° F



Material Toughness Requirements	
Material impact test temperature per UG-84 =	-20° F
Stress ratio = $1.4085 \cdot 1 / (1.625 - 0.125 - 0) =$	0.939
Reduction in MDMT from Figure UCS-66.1 =	6.1° F
MDMT = $\max[T_{\text{impact}} - T_R, -155] = \max[-20 - 6.1, -155] =$	-26.1° F
Design MDMT of -20° F is acceptable.	

Division 2 4.3.7.1 Design Thickness for Internal Pressure			
$k = D / (2 \cdot h)$			(4.3.26)
$r = D \cdot (0.5 / k - 0.08)$			(4.3.24)
$L = D \cdot (0.44 \cdot k + 0.02)$			(4.3.25)
$0.7 \leq L / D \leq 1$			(4.3.5)
$r / D \leq 0.06$			(4.3.6)
$20 \leq L / t \leq 2,000$			(4.3.7)
$\beta_{th} = \arccos[(0.5 \cdot D - r) / (L - r)]$			(4.3.8)
$\phi_{th} = (L \cdot t)^{1/2} / r$			(4.3.9)
$R_{th} = (0.5 \cdot D - r) / \cos[\beta_{th} - \phi_{th}] + r$		for $\phi_{th} < \beta_{th}$	(4.3.10)
$R_{th} = 0.5 \cdot D$		for $\phi_{th} \geq \beta_{th}$	(4.3.11)
$C_1 = 9.31 \cdot r / D - 0.086$		for $r / D \leq 0.08$	(4.3.12)
$C_1 = 0.692 \cdot r / D + 0.605$		for $r / D > 0.08$	(4.3.13)
$C_2 = 1.25$		for $r / D \leq 0.08$	(4.3.14)
$C_2 = 1.46 - 2.6 \cdot r / D$		for $r / D > 0.08$	(4.3.15)
$P_{eth} = C_1 \cdot E_T \cdot t^2 / (C_2 \cdot R_{th} \cdot (R_{th} / 2 - r))$			(4.3.16)
$C_3 = S_y$ (time-independent properties)			
$C_3 = 1.1 \cdot S$ (time-dependent properties 90% yield criterion)			
$C_3 = 1.5 \cdot S$ (time-dependent properties 67% yield criterion)			
$P_y = C_3 \cdot t / \{C_2 \cdot R_{th} \cdot (R_{th} / (2 \cdot r) - 1)\}$			(4.3.17)
$G = P_{eth} / P_y$			(4.3.20)
$P_{ck} = 0.6 \cdot P_{eth}$		for $G \leq 1$	(4.3.18)
$P_{ck} = \{(0.77508 \cdot G - 0.20354 \cdot G^2 + 0.019274 \cdot G^3) / (1 + 0.19014 \cdot G - 0.089534 \cdot G^2 + 0.0093965 \cdot G^3)\} \cdot P_y$		for $G > 1$	(4.3.19)
$P_{ak} = P_{ck} / 1.5$			(4.3.21)
$P_{ac} = 2 \cdot S \cdot E / (L / t + 0.5)$			(4.3.22)
$P_a = \min[P_{ak}, P_{ac}]$			(4.3.23)
Operating Hot & Corroded			

$k = 72.25 / (2 \cdot 18.125) =$	1.9931
$r = 72.25 \cdot (0.5 / 1.9931 - 0.08) =$	12.345"
$L = 72.25 \cdot (0.44 \cdot 1.9931 + 0.02) =$	64.8058"
$0.7 \quad L / D = 64.8058 / 72.25 = 0.897 \quad 1$	OK
$r / D = 12.345 / 72.25 = 0.1709 \quad 0.06$	OK
$20 \quad L / t = 64.8058 / 1.5 = 43.2038 \quad 2,000$	OK
$\beta_{th} = \arccos[(0.5 \cdot 72.25 - 12.345) / (64.8058 - 12.345)] =$	1.1003
$\phi_{th} = (64.8058 \cdot 1.4085)^{1/2} / 12.345 =$	0.7739
$R_{th} = (0.5 \cdot 72.25 - 12.345) / \cos[(1.1003 - 0.7739) \cdot 180 / \pi] + 12.345 =$	37.4508"
$C_1 = 0.692 \cdot 12.345 / 72.25 + 0.605 =$	0.7232
$C_2 = 1.46 - 2.6 \cdot 12.345 / 72.25 =$	1.0158
$P_{eth} = 0.7232 \cdot 28.8E+06 \cdot 1.4085^2 / (1.0158 \cdot 37.4508 \cdot (37.4508 / 2 - 12.345)) =$	170,243.28 psi
Material is not governed by time dependent properties which start at 750° F (Design T = 200° F)	
$C_3 = S_y =$	34,800 psi
$P_y = 34,800 \cdot 1.4085 / \{1.0158 \cdot 37.4508 \cdot (37.4508 / (2 \cdot 12.345) - 1)\} =$	2,492.99 psi
$G = 170,243.28 / 2,492.99 =$	68.2889
$P_{ck} = \{(0.77508 \cdot 68.2889 - 0.20354 \cdot 68.2889^2 + 0.019274 \cdot 68.2889^3) / (1 + 0.19014 \cdot 68.2889 - 0.089534 \cdot 68.2889^2 + 0.0093965 \cdot 68.2889^3)\} \cdot 2,492.99 =$	5,047.62 psi
$P_{ak} = 5,047.62 / 1.5 =$	3,365.08 psi
$P_{ac} = 2 \cdot 20,000 \cdot 1 / (64.8058 / 1.4085 + 0.5) =$	860 psi
$P_a = \min[3,365.08, 860] - 0 =$	860 psi
$t_d = 1.4085 + 0.125 = 1.5335"$	
<b>Operating Cold &amp; Corroded</b>	
$t_r = (860 + 0) \cdot 64.8058 / (2 \cdot 20,000 \cdot 1 - 0.5 \cdot (860 + 0)) =$	1.4085"

Division 2 6.1.2.3 % Extreme Fiber Elongation	
$\epsilon_f = 100 \cdot \ln[D_b / (D_f - 2 \cdot t)]$	(Table 6.1)
Forming strain not calculated.	

### Outlet (Outlet)

ASME Section VIII Division 1, 2015 Edition (Code Case 2695)					
Component	Nozzle				
Nozzle Material	SA-350 LF2 Cl 1 (II-D p. 18, ln. 28)				
	Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
Nozzle	No	Yes	No	Yes	No
	Design Pressure (psi)		Design Temperature (° F)		Design MDMT (° F)
Internal	860		200		-20
Static Liquid Head					
Condition	P <sub>s</sub> (psi)		H <sub>s</sub> (in)		SG
Test horizontal	2.19		60.75		1
Location and Orientation					
Attached to	Outlet Head				
Orientation	radial				
Offset, L	42"				
Angle, θ	0°				
Distance, r	0"				
Through a Category A Joint	No				

Dimensions		
Inside Diameter	34"	
Nominal Wall Thickness	3"	
Minimum Wall Thickness	1"	
Local Vessel Minimum Thickness	1.625"	
Leg <sub>41</sub>	0.75"	
Leg <sub>43</sub>	0.75"	
External Projection Available, L <sub>pr1</sub>	12.0072"	
Internal Projection, L <sub>pr2</sub>	2"	
Heavy Barrel Length, L <sub>pr3</sub>	6"	
Projection outside vessel to flange face, L <sub>f</sub>	23.3772"	
Corrosion	Inner	0.125"
	Outer	0"

ASME B16.47-2011 Flange	
Description	NPS 36 Class 600 WN A350 LF2 Cl.1 N Series A
Bolt Material	SA-193 B7 Bolt <= 2 1/2 (II-D p. 344, In. 31)
Blind included	No
Rated MDMT	-55° F
Liquid static head	0 psi
MAWP rating	1,360 psi @ 200° F
MAP rating	1,480 psi @ 70° F
Hydrotest rating	2,225 psi @ 70° F
PWHT performed	Yes
Impact Tested	No
Bore diameter, B (specified by purchaser)	34"
Notes	
Flange is impact tested per material specification to -50° F. UCS-66(i) reduction of 44.5° F applied (ratio = 0.5811). Bolts rated MDMT per Fig UCS-66 note (c) = -55° F	



## Summary Tables

Division 2 4.5.10 Maximum Local Primary Membrane Stress				
Condition	P (psi)	P <sub>L</sub> (psi)	S <sub>allow</sub> (psi)	Over stressed
Design P	860	28,013	30,000	No

Division 2 4.5.4.1 Nozzle Neck Minimum Thickness							
Condition	P (psi)	t <sub>d1</sub> (in)	t <sub>d,STD</sub> (in)	t (in)	t <sub>d</sub> (in)	t <sub>n,min</sub> (in)	Status
Design P	860	0.8774	0.4531	1.625	0.8774	1	OK

Division 2 4.5.14 Strength of Nozzle Attachment Welds Summary									
Condition	P (psi)	k <sub>y</sub>	L <sub>τ</sub> (in)	L <sub>41T</sub> (in)	L <sub>43T</sub> (in)	f <sub>welds</sub> (lb <sub>f</sub> )	τ (psi)	S (psi)	Over stressed
Design P	860	1.1679	31.4159	0.5303	0.4053	270,176.97	6,331	20,000	No

Division 2 Table 4.2.10 Minimum Fillet Weld Sizes			
Fillet Leg	Required Leg Size (in)	Actual Leg Size (in)	Status
Leg <sub>41</sub>	0.3571	0.75	weld size is adequate
Leg <sub>43</sub>	0.5357	0.75	weld size is adequate

Material Toughness Requirements Nozzle At Intersection	
Impact test temperature per material specification =	-50° F
Stress ratio = $1.4085 \cdot 1 / (1.625 - 0.125 - 0) =$	0.939
Reduction in MDMT from Figure UCS-66.1 =	6.1° F
MDMT = $\min[T_{\text{impact}} - T_{\text{UCS-66(g)}}, \max[T_{\text{impact}} - T_R, -155]] = \min[-50 - 5, \max[-50 - 6.1, -155]] =$	-56.1° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

Material Toughness Requirements Nozzle	
Impact test temperature per material specification =	-50° F
Stress ratio = $0.7524 \cdot 1 / (1 - 0.125 - 0) =$	0.8599
Reduction in MDMT from Figure UCS-66.1 =	14° F
MDMT = $\min[T_{\text{impact}} - T_{\text{UCS-66(g)}}, \max[T_{\text{impact}} - T_R, -155]] = \min[-50 - 5, \max[-50 - 14, -155]] =$	-64° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

**Saddle #1**

ASME Section VIII Division 1, 2015 Edition		
Saddle Material	SA-36	
Saddle Construction	Web at edge of rib	
Welded to Vessel	Yes	
Saddle Allowable Stress, S <sub>s</sub>	20,000 psi	
Saddle Yield Stress, S <sub>y</sub>	38,000 psi	
Foundation Allowable Stress	1,658 psi	
Design Pressure	Left Saddle	Right Saddle
Operating	860 psi	
Test	1,317.88 psi	
Dimensions		
Right saddle distance to datum	108"	
Tangent To Tangent Length, L	124"	
Saddle separation, L <sub>s</sub>	96"	
Vessel Radius, R	37.75"	
Tangent Distance Left, A <sub>l</sub>	14"	
Tangent Distance Right, A <sub>r</sub>	14"	
Saddle Height, H <sub>s</sub>	86"	
Saddle Contact Angle, θ	120°	
Web Plate Thickness, t <sub>s</sub>	0.75"	
Base Plate Length, E	68"	
Base Plate Width, F	10"	
Base Plate Thickness, t <sub>b</sub>	1"	
Number of Stiffening Ribs, n	2	
Largest Stiffening Rib Spacing, d <sub>i</sub>	66.25"	
Stiffening Rib Thickness, t <sub>w</sub>	0.75"	
Saddle Width, b	9"	
Bolting		
Material	F 1554 Gr 36	
Bolt Allowable Shear	10,000 psi	
Description	1.5" series 8 threaded	
Corrosion on root	0"	
Anchor Bolts per Saddle	2	

Base coefficient of friction, μ	0.45	
Weight		
	Operating, Corroded	Hydrotest
Weight on Left Saddle	18,063 lb	30,014 lb
Weight on Right Saddle	18,106 lb	30,055 lb
Weight of Saddle Pair	2,348 lb	

Notes
(1) Saddle calculations are based on the method presented in "Stresses in Large Cylindrical Pressure Vessels on Two Saddle Supports" by L.P. Zick.

Stress Summary										
Load	Condition	Saddle	Bending + pressure between saddles (psi)				Bending + pressure at the saddle (psi)			
			S <sub>1</sub> (+)	allow (+)	S <sub>1</sub> (-)	allow (-)	S <sub>2</sub> (+)	allow (+)	S <sub>2</sub> (-)	allow (-)
Seismic	Operating	Right Saddle	<a href="#">9.604</a>	24,000	<a href="#">45</a>	20,662	<a href="#">9.560</a>	24,000	<a href="#">1</a>	20,662
		Left Saddle					<a href="#">9.560</a>	24,000	<a href="#">1</a>	20,662
Wind	Operating	Right Saddle	<a href="#">9.600</a>	24,000	<a href="#">41</a>	20,662	<a href="#">9.560</a>	24,000	<a href="#">1</a>	20,662
		Left Saddle					<a href="#">9.560</a>	24,000	<a href="#">1</a>	20,662
	Test	Right Saddle	<a href="#">13.616</a>	34,200	<a href="#">61</a>	20,684	<a href="#">13.556</a>	34,200	<a href="#">1</a>	20,684
		Left Saddle					<a href="#">13.556</a>	34,200	<a href="#">1</a>	20,684
Weight	Operating	Right Saddle	<a href="#">9.598</a>	20,000	<a href="#">39</a>	17,218	<a href="#">9.560</a>	20,000	<a href="#">1</a>	17,218
		Left Saddle					<a href="#">9.560</a>	20,000	<a href="#">1</a>	17,218



Stress Summary										
Load	Condition	Saddle	Tangential shear (psi)		Circumferential stress (psi)		Stress over saddle (psi)		Splitting (psi)	
			S <sub>3</sub>	allow	S <sub>4</sub> (horns)	allow (+/-)	S <sub>5</sub>	allow	S <sub>6</sub>	allow
Seismic	Operating	Right Saddle	<a href="#">332</a>	16,000	<a href="#">-524</a>	30,000	<a href="#">753</a>	17,400	<a href="#">450</a>	13,333
		Left Saddle	<a href="#">331</a>	16,000	<a href="#">-523</a>	30,000	<a href="#">751</a>	17,400	<a href="#">449</a>	13,333
Wind	Operating	Right Saddle	<a href="#">301</a>	16,000	<a href="#">-477</a>	30,000	<a href="#">684</a>	17,400	<a href="#">409</a>	13,333
		Left Saddle	<a href="#">301</a>	16,000	<a href="#">-475</a>	30,000	<a href="#">683</a>	17,400	<a href="#">408</a>	13,333
	Test	Right Saddle	<a href="#">446</a>	27,360	<a href="#">-667</a>	34,200	<a href="#">982</a>	34,200	<a href="#">654</a>	34,200
		Left Saddle	<a href="#">445</a>	27,360	<a href="#">-666</a>	34,200	<a href="#">980</a>	34,200	<a href="#">653</a>	34,200
Weight	Operating	Right Saddle	<a href="#">288</a>	16,000	<a href="#">-455</a>	30,000	<a href="#">653</a>	17,400	<a href="#">390</a>	13,333
		Left Saddle	<a href="#">287</a>	16,000	<a href="#">-454</a>	30,000	<a href="#">652</a>	17,400	<a href="#">389</a>	13,333

Seismic base shear on vessel	
Vessel is assumed to be a rigid structure.	
Method of seismic analysis	IBC 2009 ground supported
Vertical seismic accelerations considered	Yes
Importance factor, I	1
Site Class	C
Short period spectral response acceleration as percent of g, $S_s$	27.6
1 second spectral response acceleration as percent of g, $S_1$	6.1
From ASCE Table 11.4-1, $F_a$	1.2
From ASCE Table 11.4-2, $F_v$	1.7
Occupancy Category (Table 1-1)	II
Hazardous, toxic, or explosive contents	No
Equations	
$S_{MS} = F_a * S_s$	
$S_{M1} = F_v * S_1$	
$S_{DS} = (2 / 3) * S_{MS}$	
$S_{D1} = (2 / 3) * S_{M1}$	
$F_p = 0.3 * S_{DS} * I * W * 0.7$	
Results	
$S_{MS} = 1.2 * 0.276$	0.3312
$S_{M1} = 1.7 * 0.061$	0.1037
$S_{DS} = (2 / 3) * 0.3312$	0.2208
$S_{D1} = (2 / 3) * 0.1037$	0.0691
Seismic Design Category (Section 11.6)	B
$F_p = 0.3 * 0.2208 * 1 * 36,169 * 0.7$	1,677.08 lb <sub>f</sub>

Saddle reactions due to weight + seismic			
$V_v$ = vertical seismic force acting on the saddle			
$V$ = horizontal seismic shear acting on the saddle (worst case if not slotted)			
Seismic longitudinal reaction, $Q_l$			
Seismic transverse reaction, $Q_t$			
Equations			
$Q_l = V \cdot H_s / L_s + V_v$			
$Q_t = V \cdot H_s / (R_o \cdot \sin(\theta / 2)) + V_v$			
$Q = W + \max[Q_t, Q_l]$			
Results			
Operating	Right Saddle	$Q_l = 1,677.08 \cdot 86 / 96 + 0.14 \cdot 0.2208 \cdot 18,106$	2,062.08 lb <sub>f</sub>
		$Q_t = 839.54 \cdot 86 / (37.75 \cdot \sin(120 / 2)) + 0.14 \cdot 0.2208 \cdot 18,106$	2,768.16 lb <sub>f</sub>
		$Q = 18,106 + \max[2,768.16, 2,062.08]$	20,874.16 lb <sub>f</sub>
	Left Saddle	$Q_l = 1,677.08 \cdot 86 / 96 + 0.14 \cdot 0.2208 \cdot 18,063$	2,060.75 lb <sub>f</sub>
		$Q_t = 837.55 \cdot 86 / (37.75 \cdot \sin(120 / 2)) + 0.14 \cdot 0.2208 \cdot 18,063$	2,761.59 lb <sub>f</sub>
		$Q = 18,063 + \max[2,761.59, 2,060.75]$	20,824.59 lb <sub>f</sub>

Saddle reactions due to weight + wind			
Wind longitudinal reaction, $Q_l$			
Wind transverse reaction, $Q_t$			
Wind pressure, $P_w$			11.3215 psf
Equations			
$V_{wt} = P_w * G * (C_{f(shell)} * (\text{Projected shell area}) + C_{f(saddle)} * (\text{Projected saddle area}))$			
$V_{we} = P_w * G * (C_{f(shell)} * \pi * R_o^2 / 144 + C_{f(saddle)} * (\text{Projected saddle area}))$			
$Q_t = V_{wt} * H_s / (R_o * \sin(\theta / 2))$			
$Q_l = V_{we} * H_s / L_s$			
$Q = W + \max[Q_t, Q_l]$			
Results			
Operating	Right Saddle	$V_{wt} = 11.32 * 0.85 * (0.7 * 40.2281 + 2 * 3.0156)$	329.03 lb <sub>f</sub>
		$V_{we} = 11.32 * 0.85 * (0.5 * \pi * 37.75^2 / 144 + 2 * 25.4825)$	640.05 lb <sub>f</sub>
		$Q_t = 329.03 * 86 / (37.75 * \sin(120 / 2))$	865.54 lb <sub>f</sub>
		$Q_l = 640.05 * 86 / 96$	573.37 lb <sub>f</sub>
		$Q = 18,106 + \max[865.54, 573.37]$	18,971.54 lb <sub>f</sub>
	Left Saddle	$V_{wt} = 11.32 * 0.85 * (0.7 * 40.2281 + 2 * 3.0156)$	329.03 lb <sub>f</sub>
		$V_{we} = 11.32 * 0.85 * (0.5 * \pi * 37.75^2 / 144 + 2 * 25.4825)$	640.05 lb <sub>f</sub>
		$Q_t = 329.03 * 86 / (37.75 * \sin(120 / 2))$	865.54 lb <sub>f</sub>
		$Q_l = 640.05 * 86 / 96$	573.37 lb <sub>f</sub>
		$Q = 18,063 + \max[865.54, 573.37]$	18,928.54 lb <sub>f</sub>
Test	Right Saddle	$V_{wt} = 3.74 * 0.85 * (0.7 * 40.2281 + 2 * 3.0156)$	108.58 lb <sub>f</sub>
		$V_{we} = 3.74 * 0.85 * (0.5 * \pi * 37.75^2 / 144 + 2 * 25.4825)$	211.21 lb <sub>f</sub>
		$Q_t = 108.58 * 86 / (37.75 * \sin(120 / 2))$	285.63 lb <sub>f</sub>
		$Q_l = 211.21 * 86 / 96$	189.21 lb <sub>f</sub>
		$Q = 30,055 + \max[285.63, 189.21]$	30,340.63 lb <sub>f</sub>
	Left Saddle	$V_{wt} = 3.74 * 0.85 * (0.7 * 40.2281 + 2 * 3.0156)$	108.58 lb <sub>f</sub>
		$V_{we} = 3.74 * 0.85 * (0.5 * \pi * 37.75^2 / 144 + 2 * 25.4825)$	211.21 lb <sub>f</sub>
		$Q_t = 108.58 * 86 / (37.75 * \sin(120 / 2))$	285.63 lb <sub>f</sub>
		$Q_l = 211.21 * 86 / 96$	189.21 lb <sub>f</sub>
		$Q = 30,014 + \max[285.63, 189.21]$	30,299.63 lb <sub>f</sub>

### Load Case 1: Seismic, Operating

Longitudinal stress between saddles (Seismic, Operating, right saddle loading and geometry govern)

$$S_1 = \pm 3K_1 Q (L / 12) / (\pi R^2 t)$$

$$= 3 \cdot 0.4858 \cdot 20,874.16 \cdot (124 / 12) / (\pi \cdot 36.9375^2 \cdot 1.625)$$

$$= 45 \text{ psi}$$

$$S_p = P R / (2t)$$

$$= 860 \cdot 36.125 / (2 \cdot 1.625)$$

$$= 9,559 \text{ psi}$$

Maximum tensile stress  $S_{1t} = S_1 + S_p = 9.604 \text{ psi}$   
 Maximum compressive stress (shut down)  $S_{1c} = S_1 = 45 \text{ psi}$

Tensile stress is acceptable (  $1.2 \cdot S = 24,000 \text{ psi}$ )  
 Compressive stress is acceptable (  $1.2 \cdot S_c = 20,662 \text{ psi}$ )

### Longitudinal stress at the right saddle (Seismic, Operating)

$$L_e = 2 \cdot (\text{Left head depth}) / 3 + L + 2 \cdot (\text{Right head depth}) / 3$$

$$= 2 \cdot 19.625 / 3 + 124 + 2 \cdot 19.625 / 3$$

$$= 150.1667 \text{ in}$$

$$\text{Seismic vertical acceleration coefficient } m = 0.6667 \cdot 0.0464 = 0.0309$$

$$w = W_t \cdot (1 + m) / L_e = 36,169 \cdot (1 + 0.0309) / 150.1667 = 248.3 \text{ lb/in}$$

Bending moment at the right saddle:

$$M_q = w \cdot (2H \cdot A_r / 3 + A_r^2 / 2 - (R^2 - H^2) / 4)$$

$$= 248.3 \cdot (2 \cdot 19.625 \cdot 14 / 3 + 14^2 / 2 - (37.75^2 - 19.625^2) / 4)$$

$$= 5,260.6 \text{ lb}_f\text{-in}$$

$$S_2 = \pm M_q \cdot K_1' / (\pi R^2 t)$$

$$= 5,260.6 \cdot 1 / (\pi \cdot 36.9375^2 \cdot 1.625)$$

$$= 1 \text{ psi}$$

$$S_p = P R / (2t)$$

$$= 860 \cdot 36.125 / (2 \cdot 1.625)$$

$$= 9,559 \text{ psi}$$

Maximum tensile stress  $S_{2t} = S_2 + S_p = 9.560 \text{ psi}$   
 Maximum compressive stress (shut down)  $S_{2c} = S_2 = 1 \text{ psi}$

Tensile stress is acceptable (  $1.2 \cdot S = 24,000 \text{ psi}$ )  
 Compressive stress is acceptable (  $1.2 \cdot S_c = 20,662 \text{ psi}$ )

### Tangential shear stress in the shell (right saddle, Seismic, Operating)

$$S_3 = K_{2.3} \cdot Q / (R \cdot t)$$

$$= 0.8799 \cdot 20,874.16 / (36.9375 \cdot (1.625))$$

$$= 306 \text{ psi}$$

Tangential shear stress is acceptable (  $0.8 \cdot S = 16,000 \text{ psi}$ )

### Tangential shear stress in the right head (Seismic, Operating)

$$S_3 = K_{2.3} \cdot Q / (R \cdot t_h)$$

$$= 0.8799 \cdot 20,874.16 / (36.9375 \cdot 1.5)$$

$$= 332 \text{ psi}$$

Tangential shear stress is acceptable (  $0.8 \cdot S = 16,000$  psi)

**Additional stress in the head used as a stiffener (right saddle, Seismic, Operating)**

$$\begin{aligned} S_{3h} &= K_{2.4} \cdot Q / (R \cdot t_h) \\ &= 0.4011 \cdot 20,874.16 / (36.9375 \cdot 1.5) \\ &= 151 \text{ psi} \end{aligned}$$

$$\begin{aligned} S_p &= P \cdot (K \cdot D_i + 0.2 \cdot t_h) / (2 \cdot t_h) \\ &= 860 \cdot (1 \cdot 72.25 + 0.2 \cdot 1.5) / (2 \cdot 1.5) \\ &= 20,798 \text{ psi} \end{aligned}$$

$$\text{Total stress in the head} = S_{3h} + S_p = 20,949 \text{ psi}$$

Stress in the head is acceptable (  $1.25 \cdot S_h = 25,000$  psi)

**Circumferential stress at the right saddle horns (Seismic, Operating)**

$$\begin{aligned} S_4 &= -Q / (4 \cdot t \cdot (b + 1.56 \cdot \text{Sqr}(R_o \cdot t))) - 12 \cdot K_3 \cdot Q \cdot R / (L \cdot t^2) \\ &= -20,874.16 / (4 \cdot 1.625 \cdot (9 + 1.56 \cdot \text{Sqr}(37.75 \cdot 1.625))) - 12 \cdot 0.0132 \cdot 20,874.16 \cdot 36.9375 / (124 \cdot 1.625^2) \\ &= -524 \text{ psi} \end{aligned}$$

Circumferential stress at saddle horns is acceptable (  $1.5 \cdot S_a = 30,000$  psi)

**Ring compression in shell over right saddle (Seismic, Operating)**

$$\begin{aligned} S_5 &= K_5 \cdot Q / (t \cdot (t_s + 1.56 \cdot \text{Sqr}(R_o \cdot t_c))) \\ &= 0.7603 \cdot 20,874.16 / (1.625 \cdot (0.75 + 1.56 \cdot \text{Sqr}(37.75 \cdot 1.625))) \\ &= 753 \text{ psi} \end{aligned}$$

Ring compression in shell is acceptable (  $0.5 \cdot S_y = 17,400$  psi)

**Saddle splitting load (right, Seismic, Operating)**

Area resisting splitting force = Web area + wear plate area

$$\begin{aligned} A_e &= H_{eff} \cdot t_s + t_p \cdot W_p \\ &= 12.5833 \cdot 0.75 + 0 \cdot 0 \\ &= 9.4375 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} S_6 &= K_8 \cdot Q / A_e \\ &= 0.2035 \cdot 20,874.16 / 9.4375 \\ &= 450 \text{ psi} \end{aligned}$$

Stress in saddle is acceptable (  $(2 / 3) \cdot S_s = 13,333$  psi)

**Longitudinal stress at the left saddle (Seismic, Operating)**

$$\begin{aligned} L_e &= 2 \cdot (\text{Left head depth}) / 3 + L + 2 \cdot (\text{Right head depth}) / 3 \\ &= 2 \cdot 19.625 / 3 + 124 + 2 \cdot 19.625 / 3 \\ &= 150.1667 \text{ in} \end{aligned}$$

$$\text{Seismic vertical acceleration coefficient } m = 0.6667 \cdot 0.0464 = 0.0309$$

$$w = W_t \cdot (1 + m) / L_e = 36,169 \cdot (1 + 0.0309) / 150.1667 = 248.3 \text{ lb/in}$$

Bending moment at the left saddle:

$$\begin{aligned} M_q &= w(2H^2A_1 / 3 + A_1^2 / 2 - (R^2 - H^2) / 4) \\ &= 248.3(2 \cdot 19.625^2 \cdot 14 / 3 + 14^2 / 2 - (37.75^2 - 19.625^2) / 4) \\ &= 5,260.6 \text{ lb}_f\text{-in} \end{aligned}$$

$$\begin{aligned} S_2 &= \pm M_q \cdot K_1' / (\pi R^2 t) \\ &= 5,260.6 \cdot 1 / (\pi \cdot 36.9375^2 \cdot 1.625) \\ &= 1 \text{ psi} \end{aligned}$$

$$\begin{aligned} S_p &= P \cdot R / (2t) \\ &= 860 \cdot 36.125 / (2 \cdot 1.625) \\ &= 9,559 \text{ psi} \end{aligned}$$

Maximum tensile stress  $S_{2t} = S_2 + S_p = 9,560$  psi

Maximum compressive stress (shut down)  $S_{2c} = S_2 = 1$  psi

Tensile stress is acceptable (  $1.2 \cdot S = 24,000$  psi)

Compressive stress is acceptable (  $1.2 \cdot S_c = 20,662$  psi)

#### **Tangential shear stress in the shell (left saddle, Seismic, Operating)**

$$\begin{aligned} S_3 &= K_{2.3} \cdot Q / (R \cdot t) \\ &= 0.8799 \cdot 20,824.59 / (36.9375 \cdot (1.625)) \\ &= 305 \text{ psi} \end{aligned}$$

Tangential shear stress is acceptable (  $0.8 \cdot S = 16,000$  psi)

#### **Tangential shear stress in the left head (Seismic, Operating)**

$$\begin{aligned} S_3 &= K_{2.3} \cdot Q / (R \cdot t_h) \\ &= 0.8799 \cdot 20,824.59 / (36.9375 \cdot 1.5) \\ &= 331 \text{ psi} \end{aligned}$$

Tangential shear stress is acceptable (  $0.8 \cdot S = 16,000$  psi)

#### **Additional stress in the head used as a stiffener (left saddle, Seismic, Operating)**

$$\begin{aligned} S_{3h} &= K_{2.4} \cdot Q / (R \cdot t_h) \\ &= 0.4011 \cdot 20,824.59 / (36.9375 \cdot 1.5) \\ &= 151 \text{ psi} \end{aligned}$$

$$\begin{aligned} S_p &= P \cdot (K \cdot D_i + 0.2 \cdot t_h) / (2 \cdot t_h) \\ &= 860 \cdot (1 \cdot 72.25 + 0.2 \cdot 1.5) / (2 \cdot 1.5) \\ &= 20,798 \text{ psi} \end{aligned}$$

Total stress in the head =  $S_{3h} + S_p = 20,948$  psi

Stress in the head is acceptable (  $1.25 \cdot S_h = 25,000$  psi)

#### **Circumferential stress at the left saddle horns (Seismic, Operating)**

$$\begin{aligned} S_4 &= -Q / (4 \cdot t \cdot (b + 1.56 \cdot \text{Sqr}(R_o \cdot t))) - 12 \cdot K_3 \cdot Q \cdot R / (L \cdot t^2) \\ &= -20,824.59 / (4 \cdot 1.625 \cdot (9 + 1.56 \cdot \text{Sqr}(37.75 \cdot 1.625))) - 12 \cdot 0.0132 \cdot 20,824.59 \cdot 36.9375 / (124 \cdot 1.625^2) \\ &= -523 \text{ psi} \end{aligned}$$

Circumferential stress at saddle horns is acceptable (  $1.5 \cdot S_a = 30,000$  psi)

### Ring compression in shell over left saddle (Seismic, Operating)

$$\begin{aligned} S_5 &= K_5 * Q / (t * (t_s + 1.56 * \text{Sqr}(R_o * t_c))) \\ &= 0.7603 * 20,824.59 / (1.625 * (0.75 + 1.56 * \text{Sqr}(37.75 * 1.625))) \\ &= 751 \text{ psi} \end{aligned}$$

Ring compression in shell is acceptable (  $0.5 * S_y = 17,400 \text{ psi}$  )

### Saddle splitting load (left, Seismic, Operating)

Area resisting splitting force = Web area + wear plate area

$$\begin{aligned} A_e &= H_{\text{eff}} * t_s + t_p * W_p \\ &= 12.5833 * 0.75 + 0 * 0 \\ &= 9.4375 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} S_6 &= K_8 * Q / A_e \\ &= 0.2035 * 20,824.59 / 9.4375 \\ &= 449 \text{ psi} \end{aligned}$$

Stress in saddle is acceptable (  $(2 / 3) * S_s = 13,333 \text{ psi}$  )

### Load Case 2: Wind, Operating

Longitudinal stress between saddles (Wind, Operating, right saddle loading and geometry govern)

$$\begin{aligned} S_1 &= \pm 3 * K_1 * Q * (L / 12) / (\pi * R^2 * t) \\ &= 3 * 0.4858 * 18,971.54 * (124 / 12) / (\pi * 36.9375^2 * 1.625) \\ &= 41 \text{ psi} \end{aligned}$$

$$\begin{aligned} S_p &= P * R / (2 * t) \\ &= 860 * 36.125 / (2 * 1.625) \\ &= 9,559 \text{ psi} \end{aligned}$$

Maximum tensile stress  $S_{1t} = S_1 + S_p = 9,600 \text{ psi}$

Maximum compressive stress (shut down)  $S_{1c} = S_1 = 41 \text{ psi}$

Tensile stress is acceptable (  $1.2 * S * E = 24,000 \text{ psi}$  )

Compressive stress is acceptable (  $1.2 * S_c = 20,662 \text{ psi}$  )

### Longitudinal stress at the right saddle (Wind, Operating)

$$\begin{aligned} L_e &= 2 * (\text{Left head depth}) / 3 + L + 2 * (\text{Right head depth}) / 3 \\ &= 2 * 19.625 / 3 + 124 + 2 * 19.625 / 3 \\ &= 150.1667 \text{ in} \end{aligned}$$

$$w = W_t / L_e = 36,169 / 150.1667 = 240.86 \text{ lb}_f/\text{in}$$

Bending moment at the right saddle:

$$\begin{aligned} M_q &= w * (2 * H * A_r / 3 + A_r^2 / 2 - (R^2 - H^2) / 4) \\ &= 240.86 * (2 * 19.625 * 14 / 3 + 14^2 / 2 - (37.75^2 - 19.625^2) / 4) \\ &= 5,102.9 \text{ lb}_f\text{-in} \end{aligned}$$

$$\begin{aligned} S_2 &= \pm M_q * K_1' / (\pi * R^2 * t) \\ &= 5,102.9 * 1 / (\pi * 36.9375^2 * 1.625) \end{aligned}$$



= 1 psi

$$\begin{aligned} S_p &= P \cdot R / (2 \cdot t) \\ &= 860 \cdot 36.125 / (2 \cdot 1.625) \\ &= 9,559 \text{ psi} \end{aligned}$$

Maximum tensile stress  $S_{2t} = S_2 + S_p = 9,560$  psi

Maximum compressive stress (shut down)  $S_{2c} = S_2 = 1$  psi

Tensile stress is acceptable (  $1.2 \cdot S = 24,000$  psi)

Compressive stress is acceptable (  $1.2 \cdot S_c = 20,662$  psi)

#### **Tangential shear stress in the shell (right saddle, Wind, Operating)**

$$\begin{aligned} S_3 &= K_{2.3} \cdot Q / (R \cdot (t)) \\ &= 0.8799 \cdot 18,971.54 / (36.9375 \cdot (1.625)) \\ &= 278 \text{ psi} \end{aligned}$$

Tangential shear stress is acceptable (  $0.8 \cdot S = 16,000$  psi)

#### **Tangential shear stress in the right head (Wind, Operating)**

$$\begin{aligned} S_3 &= K_{2.3} \cdot Q / (R \cdot t_h) \\ &= 0.8799 \cdot 18,971.54 / (36.9375 \cdot 1.5) \\ &= 301 \text{ psi} \end{aligned}$$

Tangential shear stress is acceptable (  $0.8 \cdot S = 16,000$  psi)

#### **Additional stress in the head used as a stiffener (right saddle, Wind, Operating)**

$$\begin{aligned} S_{3h} &= K_{2.4} \cdot Q / (R \cdot t_h) \\ &= 0.4011 \cdot 18,971.54 / (36.9375 \cdot 1.5) \\ &= 137 \text{ psi} \end{aligned}$$

$$\begin{aligned} S_p &= P \cdot (K \cdot D_i + 0.2 \cdot t_h) / (2 \cdot t_h) \\ &= 860 \cdot (1 \cdot 72.25 + 0.2 \cdot 1.5) / (2 \cdot 1.5) \\ &= 20,798 \text{ psi} \end{aligned}$$

Total stress in the head =  $S_{3h} + S_p = 20,935$  psi

Stress in the head is acceptable (  $1.25 \cdot S_h = 25,000$  psi)

#### **Circumferential stress at the right saddle horns (Wind, Operating)**

$$\begin{aligned} S_4 &= -Q / (4 \cdot t \cdot (b + 1.56 \cdot \text{Sqr}(R_o \cdot t))) - 12 \cdot K_3 \cdot Q \cdot R / (L \cdot t^2) \\ &= -18,971.54 / (4 \cdot 1.625 \cdot (9 + 1.56 \cdot \text{Sqr}(37.75 \cdot 1.625))) - 12 \cdot 0.0132 \cdot 18,971.54 \cdot 36.9375 / (124 \cdot 1.625^2) \\ &= -477 \text{ psi} \end{aligned}$$

Circumferential stress at saddle horns is acceptable (  $1.5 \cdot S_a = 30,000$  psi)

#### **Ring compression in shell over right saddle (Wind, Operating)**

$$\begin{aligned} S_5 &= K_5 \cdot Q / (t \cdot (t_s + 1.56 \cdot \text{Sqr}(R_o \cdot t_c))) \\ &= 0.7603 \cdot 18,971.54 / (1.625 \cdot (0.75 + 1.56 \cdot \text{Sqr}(37.75 \cdot 1.625))) \\ &= 684 \text{ psi} \end{aligned}$$

Ring compression in shell is acceptable (  $0.5 \cdot S_y = 17,400$  psi)

### Saddle splitting load (right, Wind, Operating)

Area resisting splitting force = Web area + wear plate area

$$\begin{aligned} A_e &= H_{eff} * t_s + t_p * W_p \\ &= 12.5833 * 0.75 + 0 * 0 \\ &= 9.4375 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} S_6 &= K_8 * Q / A_e \\ &= 0.2035 * 18,971.54 / 9.4375 \\ &= 409 \text{ psi} \end{aligned}$$

Stress in saddle is acceptable (  $(2 / 3) * S_s = 13,333 \text{ psi}$  )

### Longitudinal stress at the left saddle (Wind, Operating)

$$\begin{aligned} L_e &= 2 * (\text{Left head depth}) / 3 + L + 2 * (\text{Right head depth}) / 3 \\ &= 2 * 19.625 / 3 + 124 + 2 * 19.625 / 3 \\ &= 150.1667 \text{ in} \end{aligned}$$

$$w = W_t / L_e = 36,169 / 150.1667 = 240.86 \text{ lb}_f/\text{in}$$

Bending moment at the left saddle:

$$\begin{aligned} M_q &= w * (2 * H * A_1 / 3 + A_1^2 / 2 - (R^2 - H^2) / 4) \\ &= 240.86 * (2 * 19.625 * 14 / 3 + 14^2 / 2 - (37.75^2 - 19.625^2) / 4) \\ &= 5,102.9 \text{ lb}_f\text{-in} \end{aligned}$$

$$\begin{aligned} S_2 &= \pm M_q * K_1' / (\pi * R^2 * t) \\ &= 5,102.9 * 1 / (\pi * 36.9375^2 * 1.625) \\ &= 1 \text{ psi} \end{aligned}$$

$$\begin{aligned} S_p &= P * R / (2 * t) \\ &= 860 * 36.125 / (2 * 1.625) \\ &= 9,559 \text{ psi} \end{aligned}$$

Maximum tensile stress  $S_{2t} = S_2 + S_p = 9,560 \text{ psi}$

Maximum compressive stress (shut down)  $S_{2c} = S_2 = 1 \text{ psi}$

Tensile stress is acceptable (  $1.2 * S = 24,000 \text{ psi}$  )

Compressive stress is acceptable (  $1.2 * S_c = 20,662 \text{ psi}$  )

### Tangential shear stress in the shell (left saddle, Wind, Operating)

$$\begin{aligned} S_3 &= K_{2.3} * Q / (R * (t)) \\ &= 0.8799 * 18,928.54 / (36.9375 * (1.625)) \\ &= 277 \text{ psi} \end{aligned}$$

Tangential shear stress is acceptable (  $0.8 * S = 16,000 \text{ psi}$  )

### Tangential shear stress in the left head (Wind, Operating)

$$\begin{aligned} S_3 &= K_{2.3} * Q / (R * t_h) \\ &= 0.8799 * 18,928.54 / (36.9375 * 1.5) \\ &= 301 \text{ psi} \end{aligned}$$

Tangential shear stress is acceptable (  $0.8 \cdot S = 16,000$  psi)

#### Additional stress in the head used as a stiffener (left saddle, Wind, Operating)

$$\begin{aligned} S_{3h} &= K_{2.4} \cdot Q / (R \cdot t_h) \\ &= 0.4011 \cdot 18,928.54 / (36.9375 \cdot 1.5) \\ &= 137 \text{ psi} \end{aligned}$$

$$\begin{aligned} S_p &= P \cdot (K \cdot D_i + 0.2 \cdot t_h) / (2 \cdot t_h) \\ &= 860 \cdot (1 \cdot 72.25 + 0.2 \cdot 1.5) / (2 \cdot 1.5) \\ &= 20,798 \text{ psi} \end{aligned}$$

Total stress in the head =  $S_{3h} + S_p = 20,935$  psi

Stress in the head is acceptable (  $1.25 \cdot S_h = 25,000$  psi)

#### Circumferential stress at the left saddle horns (Wind, Operating)

$$\begin{aligned} S_4 &= -Q / (4 \cdot t \cdot (b + 1.56 \cdot \text{Sqr}(R_o \cdot t))) - 12 \cdot K_3 \cdot Q \cdot R / (L \cdot t^2) \\ &= -18,928.54 / (4 \cdot 1.625 \cdot (9 + 1.56 \cdot \text{Sqr}(37.75 \cdot 1.625))) - 12 \cdot 0.0132 \cdot 18,928.54 \cdot 36.9375 / (124 \cdot 1.625^2) \\ &= -475 \text{ psi} \end{aligned}$$

Circumferential stress at saddle horns is acceptable (  $1.5 \cdot S_a = 30,000$  psi)

#### Ring compression in shell over left saddle (Wind, Operating)

$$\begin{aligned} S_5 &= K_5 \cdot Q / (t \cdot (t_s + 1.56 \cdot \text{Sqr}(R_o \cdot t_c))) \\ &= 0.7603 \cdot 18,928.54 / (1.625 \cdot (0.75 + 1.56 \cdot \text{Sqr}(37.75 \cdot 1.625))) \\ &= 683 \text{ psi} \end{aligned}$$

Ring compression in shell is acceptable (  $0.5 \cdot S_y = 17,400$  psi)

#### Saddle splitting load (left, Wind, Operating)

Area resisting splitting force = Web area + wear plate area

$$\begin{aligned} A_e &= H_{eff} \cdot t_s + t_p \cdot W_p \\ &= 12.5833 \cdot 0.75 + 0 \cdot 0 \\ &= 9.4375 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} S_6 &= K_8 \cdot Q / A_e \\ &= 0.2035 \cdot 18,928.54 / 9.4375 \\ &= 408 \text{ psi} \end{aligned}$$

Stress in saddle is acceptable (  $(2 / 3) \cdot S_s = 13,333$  psi)

### Load Case 3: Wind, Test

#### Longitudinal stress between saddles (Wind, Test, right saddle loading and geometry govern)

$$\begin{aligned} S_1 &= \pm 3 \cdot K_1 \cdot Q \cdot (L / 12) / (\pi \cdot R^2 \cdot t) \\ &= 3 \cdot 0.4858 \cdot 30,340.63 \cdot (124 / 12) / (\pi \cdot 36.875^2 \cdot 1.75) \\ &= 61 \text{ psi} \end{aligned}$$

$$\begin{aligned} S_p &= P \cdot R / (2 \cdot t) \\ &= 1,317.88 \cdot 36 / (2 \cdot 1.75) \\ &= 13,555 \text{ psi} \end{aligned}$$

Maximum tensile stress  $S_{1t} = S_1 + S_p = 13.616$  psi  
Maximum compressive stress (shut down)  $S_{1c} = S_1 = 61$  psi

Tensile stress is acceptable (  $0.9 \cdot S_y \cdot E = 34,200$  psi)  
Compressive stress is acceptable (  $1.2 \cdot S_c = 20,684$  psi)

#### Longitudinal stress at the right saddle (Wind, Test)

$$\begin{aligned} L_e &= 2 \cdot (\text{Left head depth}) / 3 + L + 2 \cdot (\text{Right head depth}) / 3 \\ &= 2 \cdot 19.625 / 3 + 124 + 2 \cdot 19.625 / 3 \\ &= 150.1667 \text{ in} \end{aligned}$$

$$w = W_t / L_e = 60,069 / 150.1667 = 400.02 \text{ lb/in}$$

Bending moment at the right saddle:

$$\begin{aligned} M_q &= w \cdot (2 \cdot H \cdot A_r / 3 + A_r^2 / 2 - (R^2 - H^2) / 4) \\ &= 400.02 \cdot (2 \cdot 19.625 \cdot 14 / 3 + 14^2 / 2 - (37.75^2 - 19.625^2) / 4) \\ &= 8,474.8 \text{ lb}_f\text{-in} \end{aligned}$$

$$\begin{aligned} S_2 &= \pm M_q \cdot K_1' / (\pi \cdot R^2 \cdot t) \\ &= 8,474.8 \cdot 1 / (\pi \cdot 36.875^2 \cdot 1.75) \\ &= 1 \text{ psi} \end{aligned}$$

$$\begin{aligned} S_p &= P \cdot R / (2 \cdot t) \\ &= 1,317.88 \cdot 36 / (2 \cdot 1.75) \\ &= 13,555 \text{ psi} \end{aligned}$$

Maximum tensile stress  $S_{2t} = S_2 + S_p = 13.556$  psi  
Maximum compressive stress (shut down)  $S_{2c} = S_2 = 1$  psi

Tensile stress is acceptable (  $0.9 \cdot S_y = 34,200$  psi)  
Compressive stress is acceptable (  $1.2 \cdot S_c = 20,684$  psi)

#### Tangential shear stress in the shell (right saddle, Wind, Test)

$$\begin{aligned} S_3 &= K_{2.3} \cdot Q / (R \cdot (t)) \\ &= 0.8799 \cdot 30,340.63 / (36.875 \cdot (1.75)) \\ &= 414 \text{ psi} \end{aligned}$$

Tangential shear stress is acceptable (  $0.8 \cdot (0.9 \cdot S_y) = 27,360$  psi)

#### Tangential shear stress in the right head (Wind, Test)

$$\begin{aligned} S_3 &= K_{2.3} \cdot Q / (R \cdot t_h) \\ &= 0.8799 \cdot 30,340.63 / (36.875 \cdot 1.625) \\ &= 446 \text{ psi} \end{aligned}$$

Tangential shear stress is acceptable (  $0.8 \cdot (0.9 \cdot S_y) = 27,360$  psi)

#### Additional stress in the head used as a stiffener (right saddle, Wind, Test)

$$\begin{aligned} S_{3h} &= K_{2.4} \cdot Q / (R \cdot t_h) \\ &= 0.4011 \cdot 30,340.63 / (36.875 \cdot 1.625) \\ &= 203 \text{ psi} \end{aligned}$$

$$S_p = P(KD_i + 0.2t_h) / (2t_h)$$

$$= 1,317.88(1.72 + 0.2 \cdot 1.625) / (2 \cdot 1.625)$$

$$= 29,328 \text{ psi}$$

$$\text{Total stress in the head} = S_{3h} + S_p = 29,531 \text{ psi}$$

$$\text{Stress in the head is acceptable ( } 0.9S_y = 34,200 \text{ psi)}$$

#### **Circumferential stress at the right saddle horns (Wind, Test)**

$$S_4 = -Q / (4t(b + 1.56\sqrt{R_o t})) - 12K_3 Q R / (L t^2)$$

$$= -30,340.63 / (4 \cdot 1.75(9 + 1.56\sqrt{37.75 \cdot 1.75})) - 12 \cdot 0.0132 \cdot 30,340.63 \cdot 36.875 / (124 \cdot 1.75^2)$$

$$= -667 \text{ psi}$$

$$\text{Circumferential stress at saddle horns is acceptable ( } 0.9S_y = 34,200 \text{ psi)}$$

#### **Ring compression in shell over right saddle (Wind, Test)**

$$S_5 = K_5 Q / (t(t_s + 1.56\sqrt{R_o t_c}))$$

$$= 0.7603 \cdot 30,340.63 / (1.75(0.75 + 1.56\sqrt{37.75 \cdot 1.75}))$$

$$= 982 \text{ psi}$$

$$\text{Ring compression in shell is acceptable ( } 0.9S_y = 34,200 \text{ psi)}$$

#### **Saddle splitting load (right, Wind, Test)**

$$\text{Area resisting splitting force} = \text{Web area} + \text{wear plate area}$$

$$A_e = H_{eff} t_s + t_p W_p$$

$$= 12.5833 \cdot 0.75 + 0 \cdot 0$$

$$= 9.4375 \text{ in}^2$$

$$S_6 = K_8 Q / A_e$$

$$= 0.2035 \cdot 30,340.63 / 9.4375$$

$$= 654 \text{ psi}$$

$$\text{Stress in saddle is acceptable ( } 0.9S_y = 34,200 \text{ psi)}$$

#### **Longitudinal stress at the left saddle (Wind, Test)**

$$L_e = 2(\text{Left head depth}) / 3 + L + 2(\text{Right head depth}) / 3$$

$$= 2 \cdot 19.625 / 3 + 124 + 2 \cdot 19.625 / 3$$

$$= 150.1667 \text{ in}$$

$$w = W_t / L_e = 60,069 / 150.1667 = 400.02 \text{ lb/in}$$

Bending moment at the left saddle:

$$M_q = w(2H A_l / 3 + A_l^2 / 2 - (R^2 - H^2) / 4)$$

$$= 400.02(2 \cdot 19.625 \cdot 14 / 3 + 14^2 / 2 - (37.75^2 - 19.625^2) / 4)$$

$$= 8,474.8 \text{ lb-in}$$

$$S_2 = \pm M_q K_1' / (\pi R^2 t)$$

$$= 8,474.8 \cdot 1 / (\pi \cdot 36.875^2 \cdot 1.75)$$

$$= 1 \text{ psi}$$

$$S_p = P R / (2t)$$

$$= 1,317.88 \times 36 / (2 \times 1.75)$$

$$= 13,555 \text{ psi}$$

Maximum tensile stress  $S_{2t} = S_2 + S_p = 13,556 \text{ psi}$   
 Maximum compressive stress (shut down)  $S_{2c} = S_2 = 1 \text{ psi}$

Tensile stress is acceptable (  $0.9 \times S_y = 34,200 \text{ psi}$ )  
 Compressive stress is acceptable (  $1.2 \times S_c = 20,684 \text{ psi}$ )

#### **Tangential shear stress in the shell (left saddle, Wind, Test)**

$$S_3 = K_{2.3} \times Q / (R \times t)$$

$$= 0.8799 \times 30,299.63 / (36.875 \times (1.75))$$

$$= 413 \text{ psi}$$

Tangential shear stress is acceptable (  $0.8 \times (0.9 \times S_y) = 27,360 \text{ psi}$ )

#### **Tangential shear stress in the left head (Wind, Test)**

$$S_3 = K_{2.3} \times Q / (R \times t_h)$$

$$= 0.8799 \times 30,299.63 / (36.875 \times 1.625)$$

$$= 445 \text{ psi}$$

Tangential shear stress is acceptable (  $0.8 \times (0.9 \times S_y) = 27,360 \text{ psi}$ )

#### **Additional stress in the head used as a stiffener (left saddle, Wind, Test)**

$$S_{3h} = K_{2.4} \times Q / (R \times t_h)$$

$$= 0.4011 \times 30,299.63 / (36.875 \times 1.625)$$

$$= 203 \text{ psi}$$

$$S_p = P \times (K \times D_i + 0.2 \times t_h) / (2 \times t_h)$$

$$= 1,317.88 \times (1 \times 72 + 0.2 \times 1.625) / (2 \times 1.625)$$

$$= 29,328 \text{ psi}$$

Total stress in the head =  $S_{3h} + S_p = 29,531 \text{ psi}$

Stress in the head is acceptable (  $0.9 \times S_y = 34,200 \text{ psi}$ )

#### **Circumferential stress at the left saddle horns (Wind, Test)**

$$S_4 = -Q / (4 \times t \times (b + 1.56 \times \text{Sqr}(R_o \times t))) - 12 \times K_3 \times Q \times R / (L \times t^2)$$

$$= -30,299.63 / (4 \times 1.75 \times (9 + 1.56 \times \text{Sqr}(37.75 \times 1.75))) - 12 \times 0.0132 \times 30,299.63 \times 36.875 / (124 \times 1.75^2)$$

$$= -666 \text{ psi}$$

Circumferential stress at saddle horns is acceptable (  $0.9 \times S_y = 34,200 \text{ psi}$ )

#### **Ring compression in shell over left saddle (Wind, Test)**

$$S_5 = K_5 \times Q / (t \times (t_s + 1.56 \times \text{Sqr}(R_o \times t_c)))$$

$$= 0.7603 \times 30,299.63 / (1.75 \times (0.75 + 1.56 \times \text{Sqr}(37.75 \times 1.75)))$$

$$= 980 \text{ psi}$$

Ring compression in shell is acceptable (  $0.9 \times S_y = 34,200 \text{ psi}$ )

#### **Saddle splitting load (left, Wind, Test)**

Area resisting splitting force = Web area + wear plate area

$$\begin{aligned} A_e &= H_{eff} * t_s + t_p * W_p \\ &= 12.5833 * 0.75 + 0 * 0 \\ &= 9.4375 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} S_6 &= K_8 * Q / A_e \\ &= 0.2035 * 30,299.63 / 9.4375 \\ &= 653 \text{ psi} \end{aligned}$$

Stress in saddle is acceptable (  $0.9 * S_y = 34,200 \text{ psi}$ )

#### Load Case 4: Weight, Operating

**Longitudinal stress between saddles (Weight, Operating, right saddle loading and geometry govern)**

$$\begin{aligned} S_1 &= \pm 3 * K_1 * Q * (L / 12) / (\pi * R^2 * t) \\ &= 3 * 0.4858 * 18,106 * (124 / 12) / (\pi * 36.9375^2 * 1.625) \\ &= 39 \text{ psi} \end{aligned}$$

$$\begin{aligned} S_p &= P * R / (2 * t) \\ &= 860 * 36.125 / (2 * 1.625) \\ &= 9,559 \text{ psi} \end{aligned}$$

Maximum tensile stress  $S_{1t} = S_1 + S_p = 9,598 \text{ psi}$

Maximum compressive stress (shut down)  $S_{1c} = S_1 = 39 \text{ psi}$

Tensile stress is acceptable (  $S * E = 20,000 \text{ psi}$ )

Compressive stress is acceptable (  $S_c = 17,218 \text{ psi}$ )

**Longitudinal stress at the right saddle (Weight, Operating)**

$$\begin{aligned} L_e &= 2 * (\text{Left head depth}) / 3 + L + 2 * (\text{Right head depth}) / 3 \\ &= 2 * 19.625 / 3 + 124 + 2 * 19.625 / 3 \\ &= 150.1667 \text{ in} \end{aligned}$$

$$w = W_t / L_e = 36,169 / 150.1667 = 240.86 \text{ lb}_f/\text{in}$$

Bending moment at the right saddle:

$$\begin{aligned} M_q &= w * (2 * H * A_r / 3 + A_r^2 / 2 - (R^2 - H^2) / 4) \\ &= 240.86 * (2 * 19.625 * 14 / 3 + 14^2 / 2 - (37.75^2 - 19.625^2) / 4) \\ &= 5,102.9 \text{ lb}_f\text{-in} \end{aligned}$$

$$\begin{aligned} S_2 &= \pm M_q * K_1' / (\pi * R^2 * t) \\ &= 5,102.9 * 1 / (\pi * 36.9375^2 * 1.625) \\ &= 1 \text{ psi} \end{aligned}$$

$$\begin{aligned} S_p &= P * R / (2 * t) \\ &= 860 * 36.125 / (2 * 1.625) \\ &= 9,559 \text{ psi} \end{aligned}$$

Maximum tensile stress  $S_{2t} = S_2 + S_p = 9,560 \text{ psi}$

Maximum compressive stress (shut down)  $S_{2c} = S_2 = 1 \text{ psi}$

Tensile stress is acceptable (  $S = 20,000 \text{ psi}$ )

Compressive stress is acceptable (  $S_c = 17,218 \text{ psi}$ )

**Tangential shear stress in the shell (right saddle, Weight, Operating)**

$$\begin{aligned}
S_3 &= K_{2.3} * Q / (R * t) \\
&= 0.8799 * 18,106 / (36.9375 * (1.625)) \\
&= 265 \text{ psi}
\end{aligned}$$

Tangential shear stress is acceptable (  $0.8 * S = 16,000 \text{ psi}$  )

**Tangential shear stress in the right head (Weight, Operating)**

$$\begin{aligned}
S_3 &= K_{2.3} * Q / (R * t_h) \\
&= 0.8799 * 18,106 / (36.9375 * 1.5) \\
&= 288 \text{ psi}
\end{aligned}$$

Tangential shear stress is acceptable (  $0.8 * S = 16,000 \text{ psi}$  )

**Additional stress in the head used as a stiffener (right saddle, Weight, Operating)**

$$\begin{aligned}
S_{3h} &= K_{2.4} * Q / (R * t_h) \\
&= 0.4011 * 18,106 / (36.9375 * 1.5) \\
&= 131 \text{ psi}
\end{aligned}$$

$$\begin{aligned}
S_p &= P * (K * D_i + 0.2 * t_h) / (2 * t_h) \\
&= 860 * (1 * 72.25 + 0.2 * 1.5) / (2 * 1.5) \\
&= 20,798 \text{ psi}
\end{aligned}$$

Total stress in the head =  $S_{3h} + S_p = 20,929 \text{ psi}$

Stress in the head is acceptable (  $1.25 * S_h = 25,000 \text{ psi}$  )

**Circumferential stress at the right saddle horns (Weight, Operating)**

$$\begin{aligned}
S_4 &= -Q / (4 * t * (b + 1.56 * \text{Sqr}(R_o * t))) - 12 * K_3 * Q * R / (L * t^2) \\
&= -18,106 / (4 * 1.625 * (9 + 1.56 * \text{Sqr}(37.75 * 1.625))) - 12 * 0.0132 * 18,106 * 36.9375 / (124 * 1.625^2) \\
&= -455 \text{ psi}
\end{aligned}$$

Circumferential stress at saddle horns is acceptable (  $1.5 * S_a = 30,000 \text{ psi}$  )

**Ring compression in shell over right saddle (Weight, Operating)**

$$\begin{aligned}
S_5 &= K_5 * Q / (t * (t_s + 1.56 * \text{Sqr}(R_o * t_c))) \\
&= 0.7603 * 18,106 / (1.625 * (0.75 + 1.56 * \text{Sqr}(37.75 * 1.625))) \\
&= 653 \text{ psi}
\end{aligned}$$

Ring compression in shell is acceptable (  $0.5 * S_y = 17,400 \text{ psi}$  )

**Saddle splitting load (right, Weight, Operating)**

Area resisting splitting force = Web area + wear plate area

$$\begin{aligned}
A_e &= H_{eff} * t_s + t_p * W_p \\
&= 12.5833 * 0.75 + 0 * 0 \\
&= 9.4375 \text{ in}^2
\end{aligned}$$

$$\begin{aligned}
S_6 &= K_8 * Q / A_e \\
&= 0.2035 * 18,106 / 9.4375
\end{aligned}$$



$$= 390 \text{ psi}$$

Stress in saddle is acceptable (  $(2/3)S_s = 13,333 \text{ psi}$  )

#### Longitudinal stress at the left saddle (Weight, Operating)

$$\begin{aligned} L_e &= 2(\text{Left head depth}) / 3 + L + 2(\text{Right head depth}) / 3 \\ &= 2*19.625 / 3 + 124 + 2*19.625 / 3 \\ &= 150.1667 \text{ in} \end{aligned}$$

$$w = W_t / L_e = 36,169 / 150.1667 = 240.86 \text{ lb/in}$$

Bending moment at the left saddle:

$$\begin{aligned} M_q &= w(2H^2A_1 / 3 + A_1^2 / 2 - (R^2 - H^2) / 4) \\ &= 240.86(2*19.625^2*14 / 3 + 14^2 / 2 - (37.75^2 - 19.625^2) / 4) \\ &= 5,102.9 \text{ lb-in} \end{aligned}$$

$$\begin{aligned} S_2 &= \pm M_q K_1' / (\pi R^2 t) \\ &= 5,102.9*1 / (\pi*36.9375^2*1.625) \\ &= 1 \text{ psi} \end{aligned}$$

$$\begin{aligned} S_p &= P R / (2t) \\ &= 860*36.125 / (2*1.625) \\ &= 9,559 \text{ psi} \end{aligned}$$

Maximum tensile stress  $S_{2t} = S_2 + S_p = 9,560 \text{ psi}$

Maximum compressive stress (shut down)  $S_{2c} = S_2 = 1 \text{ psi}$

Tensile stress is acceptable (  $S = 20,000 \text{ psi}$  )

Compressive stress is acceptable (  $S_c = 17,218 \text{ psi}$  )

#### Tangential shear stress in the shell (left saddle, Weight, Operating)

$$\begin{aligned} S_3 &= K_{2.3} Q / (R(t)) \\ &= 0.8799*18,063 / (36.9375*(1.625)) \\ &= 265 \text{ psi} \end{aligned}$$

Tangential shear stress is acceptable (  $0.8S = 16,000 \text{ psi}$  )

#### Tangential shear stress in the left head (Weight, Operating)

$$\begin{aligned} S_3 &= K_{2.3} Q / (R t_h) \\ &= 0.8799*18,063 / (36.9375*1.5) \\ &= 287 \text{ psi} \end{aligned}$$

Tangential shear stress is acceptable (  $0.8S = 16,000 \text{ psi}$  )

#### Additional stress in the head used as a stiffener (left saddle, Weight, Operating)

$$\begin{aligned} S_{3h} &= K_{2.4} Q / (R t_h) \\ &= 0.4011*18,063 / (36.9375*1.5) \\ &= 131 \text{ psi} \end{aligned}$$

$$\begin{aligned} S_p &= P(K D_i + 0.2 t_h) / (2 t_h) \\ &= 860(1*72.25 + 0.2*1.5) / (2*1.5) \\ &= 20,798 \text{ psi} \end{aligned}$$

Total stress in the head =  $S_{3h} + S_p = 20,928$  psi

Stress in the head is acceptable (  $1.25*S_h = 25,000$  psi)

#### **Circumferential stress at the left saddle horns (Weight, Operating)**

$$\begin{aligned} S_4 &= -Q / (4*t*(b+1.56*Sqr(R_o*t))) - 12*K_3*Q*R / (L*t^2) \\ &= -18,063 / (4*1.625*(9+1.56*Sqr(37.75*1.625))) - 12*0.0132*18,063*36.9375 / (124*1.625^2) \\ &= -454 \text{ psi} \end{aligned}$$

Circumferential stress at saddle horns is acceptable (  $1.5*S_a = 30,000$  psi)

#### **Ring compression in shell over left saddle (Weight, Operating)**

$$\begin{aligned} S_5 &= K_5*Q / (t*(t_s + 1.56*Sqr(R_o*t_c))) \\ &= 0.7603*18,063 / (1.625*(0.75 + 1.56*Sqr(37.75*1.625))) \\ &= 652 \text{ psi} \end{aligned}$$

Ring compression in shell is acceptable (  $0.5*S_y = 17,400$  psi)

#### **Saddle splitting load (left, Weight, Operating)**

Area resisting splitting force = Web area + wear plate area

$$\begin{aligned} A_e &= H_{eff}*t_s + t_p*W_p \\ &= 12.5833*0.75 + 0*0 \\ &= 9.4375 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} S_6 &= K_8*Q / A_e \\ &= 0.2035*18,063 / 9.4375 \\ &= 389 \text{ psi} \end{aligned}$$

Stress in saddle is acceptable (  $(2/3)*S_s = 13,333$  psi)

#### **Shear stress in anchor bolting, one end slotted**

Maximum seismic or wind base shear = 1,677.08 lb<sub>f</sub>

Thermal expansion base shear =  $W*\mu = 19,280*0.45 = 8,676$  lb<sub>f</sub>

Corroded root area for a 1.5" series 8 threaded bolt = 1.405 in<sup>2</sup> ( 2 per saddle )

Bolt shear stress =  $8,676 / (1.405*1*2) = 3,088$  psi

Anchor bolt stress is acceptable ( 10,000 psi)

#### **Shear stress in anchor bolting, transverse**

Maximum seismic or wind base shear = 1,677.08 lb<sub>f</sub>

Corroded root area for a 1.5" series 8 threaded bolt = 1.405 in<sup>2</sup> ( 2 per saddle )

Bolt shear stress =  $1,677.08 / (1.405*2*2) = 298$  psi

Anchor bolt stress is acceptable ( 10,000 psi)

#### **Web plate buckling check (Escoe pg 251)**

Allowable compressive stress  $S_c$  is the lesser of 20,000 or 4,300 psi: (4,300)

$$\begin{aligned} S_c &= K_i \pi^2 E / (12(1 - 0.3^2)(d_i / t_s)^2) \\ &= 1.28 \pi^2 29E+06 / (12(1 - 0.3^2)(66.25 / 0.75)^2) \\ &= 4,300 \text{ psi} \end{aligned}$$

Allowable compressive load on the saddle

$$\begin{aligned} b_e &= d_i t_s / (d_i t_s + 2 t_w (b - 1)) \\ &= 66.25 \cdot 0.75 / (66.25 \cdot 0.75 + 2 \cdot 0.75 \cdot (9 - 1)) \\ &= 0.8055 \end{aligned}$$

$$\begin{aligned} F_b &= n(A_s + 2 b_e t_s) S_c \\ &= 2(6.1875 + 2 \cdot 0.8055 \cdot 0.75) \cdot 4,300 \\ &= 63,598.3 \text{ lb}_f \end{aligned}$$

Saddle loading of 31,514.63  $\text{lb}_f$  is  $F_b$ ; satisfactory.

**Primary bending + axial stress in the saddle due to end loads (assumes one saddle slotted)**

$$\begin{aligned} \sigma_b &= V(H_s - x_o)y / I + Q / A \\ &= 1,677.08(86 - 31.219) \cdot 6.375 / 196.07 + 20,874.16 / 61.4137 \\ &= 3,327 \text{ psi} \end{aligned}$$

The primary bending + axial stress in the saddle  $S_s = 20,000$  psi; satisfactory.

**Secondary bending + axial stress in the saddle due to end loads (includes thermal expansion, assumes one saddle slotted)**

$$\begin{aligned} \sigma_b &= V(H_s - x_o)y / I + Q / A \\ &= 10,353.08(86 - 31.219) \cdot 6.375 / 196.07 + 20,874.16 / 61.4137 \\ &= 18,781 \text{ psi} \end{aligned}$$

The secondary bending + axial stress in the saddle  $2S_y = 76,000$  psi; satisfactory.

**Saddle base plate thickness check (Roark sixth edition, Table 26, case 7a)**

where  $a = 66.25$ ,  $b = 9.25$  in

$$\begin{aligned} t_b &= (\beta_1 q b^2 / (1.5 S_a))^{0.5} \\ &= (3 \cdot 46 \cdot 9.25^2 / (1.5 \cdot 20,000))^{0.5} \\ &= 0.6297 \text{ in} \end{aligned}$$

The base plate thickness of 1 in is adequate.

**Foundation bearing check**

$$\begin{aligned} S_f &= Q_{\max} / (F \cdot E) \\ &= 31,514.63 / (10 \cdot 68) \\ &= 46 \text{ psi} \end{aligned}$$

Concrete bearing stress 1,658 psi ; satisfactory.

## Seismic Code

Seismic calculations are reported in the saddle report.

## Wind Code

Building Code: ASCE 7-05	
Elevation of base above grade	0.00 ft
Increase effective outer diameter by	0.00 ft
Wind Force Coefficient, Cf	0.7000
Occupancy Category (Table 1-1)	II
Basic Wind Speed, V	90.0000 mph
Importance Factor, I	1.0000
Exposure Category	B
Wind Directionality Factor, Kd	0.9500
Topographic Factor, Kzt	1.0000
Enforce minimum design load of 10 psf per ASCE 6.1.4.1.:	Yes
Hazardous, toxic, or explosive contents	No

### Wind Pressure (WP) Calculations

$$\begin{aligned}K_z &= 2.01 * (Z/z_g)^{2/\alpha} \\&= 2.01 * (15.00 / 1,200.00)^{0.2857} \\&= 0.5747\end{aligned}$$

$$\begin{aligned}q_z &= 0.00256 * K_z * K_{zt} * K_d * V^2 * I \\&= 0.00256 * 0.5747 * 1.0000 * 0.9500 * 90.0000^2 * 1.0000 \\&= 11.3215 \text{ psf}\end{aligned}$$

$$\begin{aligned}q_z &= \max[ 11.3215, 10.0000 ] \\&= 11.3215 \text{ psf}\end{aligned}$$

Table Lookup Values	
$\alpha = 7.0000$ , $z_g = 1,200.00 \text{ ft}$	[Table 6-2, page 78]

Shear calculations are reported in the saddle report.

## Sump Weight-Inlet

ASME Section VIII Division 1, 2015 Edition	
Inputs	
Load Orientation	Vertical Load
Position from datum	0"
Direction Angle	0.00°
Magnitude of Force	1,200 lb
Loading Conditions	
Present When Operating	Yes
Included in Vessel Lift Weight	Yes
Present When Vessel is Empty	Yes
Present During Test	Yes

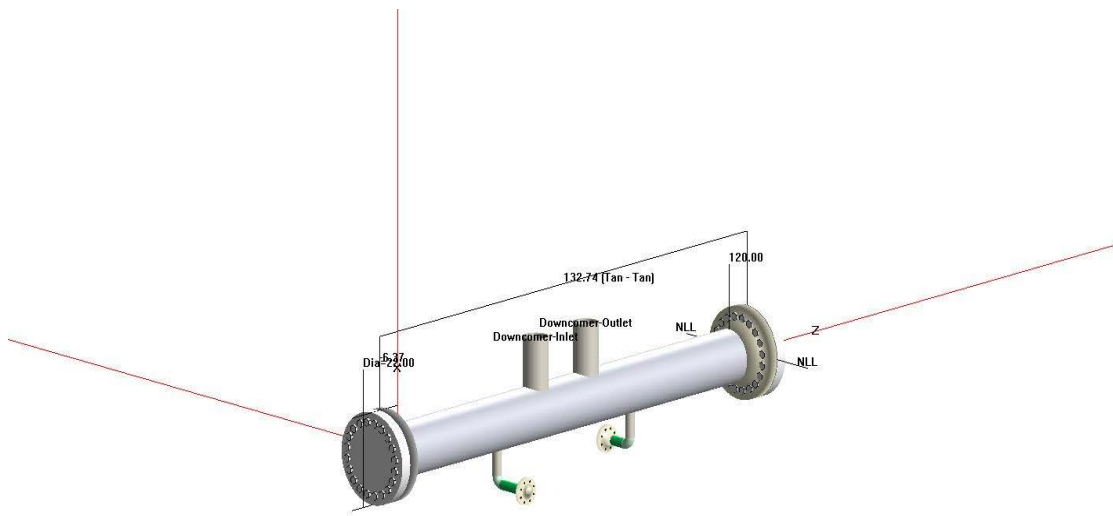
## Sump Weight-Outlet

ASME Section VIII Division 1, 2015 Edition	
Inputs	
Load Orientation	Vertical Load
Position from datum	120"
Direction Angle	0.00°
Magnitude of Force	1,200 lb
Loading Conditions	
Present When Operating	Yes
Included in Vessel Lift Weight	Yes
Present When Vessel is Empty	Yes
Present During Test	Yes

# GasTech Engineering LLC

2110 Industrial Road

Sapulpa, OK, 74066



## GTE 11048 Lower Barrel Design Calculations

**Item:** Horizontal Cyclone Separator

**Vessel No:** V-1414

**Customer:** Transcontinental Gas Pipe Line

**Contract:** 676280

**Designer:** Kamyar Najmi

**Date:** Tuesday, May 22, 2018

**Location:** Chester County, PA

**Purchaser:** Transcontinental Gas Pipe Line

**Name:** 11048-CC Lower Barrel REV 0

**P.O. Number:** 676280

**Tag Number:** V-1414

**Revision:** 1



REV 1: Hydro test pressure chnaged to 1315 psi

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<a href="#"><u>Elbow Pipe (Bridle Bottom Tap)</u></a>	24/42
<a href="#"><u>Downcomer-Inlet (Downcomer-Inlet)</u></a>	27/42
<a href="#"><u>Downcomer-Outlet (Downcomer-Outlet)</u></a>	30/42
<a href="#"><u>Liquid Outlet (Liquid Outlet)</u></a>	33/42
<a href="#"><u>Elbow (Liquid Outlet)</u></a>	36/42
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## Deficiencies Summary

***No deficiencies found.***

## Nozzle Schedule

Specifications									
Nozzle mark	Identifier	Size	Materials		Impact Tested	Normalized	Fine Grain	Flange	Blind
<a href="#">Bridle Bottom Tap</a>	Bridle Bottom Tap	NPS 2 Sch 160	Nozzle	SA-106 B Smls pipe	No	No	No	N/A	No
	<a href="#">Elbow (Bridle Bottom Tap)</a>	NPS 2 Sch 160	B16.9 Elbow	SA-234 WPB	No	No	No	N/A	No
	<a href="#">Elbow Pipe (Bridle Bottom Tap)</a>	NPS 2 Sch 160	Nozzle Piping	SA-106 B Smls pipe	No	No	No	NPS 2 Class 600 WN A105 N	No
<a href="#">Downcomer-Inlet</a>	Downcomer-Inlet	NPS 6 XXS	Nozzle	SA-106 C Smls pipe	No	No	No	N/A	No
<a href="#">Downcomer-Outlet</a>	Downcomer-Outlet	NPS 6 XXS	Nozzle	SA-106 C Smls pipe	No	No	No	N/A	No
<a href="#">Liquid Outlet</a>	Liquid Outlet	NPS 2 Sch 160	Nozzle	SA-106 B Smls pipe	No	No	No	N/A	No
	<a href="#">Elbow (Liquid Outlet)</a>	NPS 2 Sch 160	B16.9 Elbow	SA-234 WPB	No	No	No	N/A	No
	<a href="#">Elbow Pipe (Liquid Outlet)</a>	NPS 2 Sch 160	Nozzle Piping	SA-106 B Smls pipe	No	No	No	NPS 2 Class 600 WN A105 N	No

## Nozzle Summary

Dimensions												
Nozzle Identifier	OD (in)	t <sub>n</sub> (in)	Req t <sub>n</sub> (in)	A <sub>1</sub> ?	A <sub>2</sub> ?	Shell			Reinforcement Pad		Corr (in)	A <sub>a</sub> /A <sub>r</sub> (%)
						Nom t (in)	Design t (in)	User t (in)	Width (in)	t <sub>pad</sub> (in)		
<a href="#">Bridle Bottom Tap</a>	2.375	0.344	0.2969	Yes	Yes	0.562	N/A		N/A	N/A	0.125	Exempt
<a href="#">Downcomer-Inlet</a>	6.625	0.864	0.4229	Yes	Yes	0.562	0.4329		N/A	N/A	0.125	100.4
<a href="#">Downcomer-Outlet</a>	6.625	0.864	0.4229	Yes	Yes	0.562	0.4329		N/A	N/A	0.125	100.4
<a href="#">Liquid Outlet</a>	2.375	0.344	0.2969	Yes	Yes	0.562	N/A		N/A	N/A	0.125	Exempt

Definitions	
tn	Nozzle thickness
Req tn	Nozzle thickness required per UG-45/UG-16 Increased for pipe to account for 12.5% pipe thickness tolerance
Nom t	Vessel wall thickness
Design t	Required vessel wall thickness due to pressure + corrosion allowance per UG-37
User t	Local vessel wall thickness (near opening)
A <sub>a</sub>	Area available per UG-37, governing condition
A <sub>r</sub>	Area required per UG-37, governing condition
Corr	Corrosion allowance on nozzle wall

## Pressure Summary

Component Summary							
Identifier	P Design (psi)	T Design (° F)	MAWP (psi)	MAP (psi)	MDMT (° F)	MDMT Exemption	Impact Tested
<a href="#">ASME B16.5/16.47 Blind on Sump-Head (Sch 60)</a>	860	200	1,359.79	1,480	-55	Note 1	No
<a href="#">Sump</a>	860	200	1,018.2	1,376.7	-23.69	Note 2	No
<a href="#">ASME B16.5/16.47 Blind on Sump-Head (Sch 60)</a>	860	200	1,359.79	1,480	-55	Note 1	No
<a href="#">Sump-Head (Sch 60)</a>	860	200	1,359.79	1,480	-55	Note 1	No
<a href="#">Sump-Head (Sch 60)</a>	860	200	1,359.79	1,480	-55	Note 1	No
<a href="#">Bridle Bottom Tap (Bridle Bottom Tap)</a>	860	200	1,018.33	1,376.84	-155	Note 3	No
<a href="#">Elbow (Bridle Bottom Tap)</a>	860	200	2,693.57	4,823.45	-155	Note 4	No
<a href="#">Elbow Pipe (Bridle Bottom Tap)</a>	860	200	1,359.45	1,480	-155	Note 4	No
<a href="#">Downcomer-Inlet (Downcomer-Inlet)</a>	860	200	861.39	1,232.28	-23.69	Note 5	No
<a href="#">Downcomer-Outlet (Downcomer-Outlet)</a>	860	200	861.39	1,232.28	-23.69	Note 5	No
<a href="#">Liquid Outlet (Liquid Outlet)</a>	860	200	1,018.33	1,376.84	-155	Note 3	No
<a href="#">Elbow (Liquid Outlet)</a>	860	200	2,693.57	4,823.45	-155	Note 4	No
<a href="#">Elbow Pipe (Liquid Outlet)</a>	860	200	1,359.45	1,480	-155	Note 4	No

Chamber Summary	
Design MDMT	-20 ° F
Rated MDMT	-23.69 ° F @ 861.39 psi
MAWP hot & corroded	861.39 psi @ 200 ° F
MAP cold & new	1,232.28 psi @ 70 ° F
(1) This pressure chamber is not designed for external pressure.	

Notes for MDMT Rating		
Note #	Exemption	Details
1.	Flange rated MDMT per UCS-66(b)(1)(b) = -55° F (Coincident ratio = 0.5822)	Bolts rated MDMT per Fig UCS-66 note (c) = -55° F
2.	Material impact test exemption temperature from Fig UCS-66 Curve B = -7.79° F Fig UCS-66.1 MDMT reduction = 15.9° F, (coincident ratio = 0.8412)	UCS-66 governing thickness = 0.4918 in
3.	Nozzle is impact test exempt to -155° F per UCS-66(b)(3) (coincident ratio = 0.2859).	
4.	Material is impact test exempt to -155° F per UCS-66(b)(3) (coincident ratio = 0.3334)	
5.	Nozzle impact test exemption temperature from Fig UCS-66 Curve B = -7.79° F Fig UCS-66.1 MDMT reduction = 15.9° F, (coincident ratio = 0.8409)	UCS-66 governing thickness = 0.4918 in.

### Revision History

Revisions			
No.	Date	Operator	Notes
0	12/13/2017	knajmi	New vessel created ASME Section VIII Division 1 [COMPRESS 2017 Build 7710]



## Settings Summary

COMPRESS 2018 Build 7800	
ASME Section VIII Division 1, 2015 Edition	
Units	U.S. Customary
Datum Line Location	6.37" from left seam
Vessel Design Mode	Design Mode
Minimum thickness	0.0625" per UG-16(b)
Design for cold shut down only	No
Design for lethal service (full radiography required)	No
Design nozzles for	Design P only
Corrosion weight loss	100% of theoretical loss
UG-23 Stress Increase	1.20
Skirt/legs stress increase	1.0
Minimum nozzle projection	3"
Juncture calculations for $\alpha > 30$ only	Yes
Preheat P-No 1 Materials > 1.25" and <= 1.50" thick	No
UG-37(a) shell tr calculation considers longitudinal stress	No
Cylindrical shells made from pipe are entered as minimum thickness	No
Nozzles made from pipe are entered as minimum thickness	No
ASME B16.9 fittings are entered as minimum thickness	No
Butt welds	Tapered per Figure UCS-66.3(a)
Disallow Appendix 1-5, 1-8 calculations under 15 psi	No
Hydro/Pneumatic Test	
Shop Hydrotest at user defined pressure	1,315 psi
Test liquid specific gravity	1.00
Maximum stress during test	90% of yield
Required Marking - UG-116	
UG-116(e) Radiography	RT1
UG-116(f) Postweld heat treatment	None
Code Cases\Interpretations	
Use Code Case 2547	No
Use Code Case 2695	No
Apply interpretation VIII-1-83-66	Yes
Apply interpretation VIII-1-86-175	Yes

Apply interpretation VIII-1-01-37	Yes
Apply interpretation VIII-1-01-150	Yes
Apply interpretation VIII-1-07-50	Yes
Apply interpretation VIII-1-16-85	Yes
No UCS-66.1 MDMT reduction	No
No UCS-68(c) MDMT reduction	No
Disallow UG-20(f) exemptions	No
<b>UG-22 Loadings</b>	
UG-22(a) Internal or External Design Pressure	Yes
UG-22(b) Weight of the vessel and normal contents under operating or test conditions	No
UG-22(c) Superimposed static reactions from weight of attached equipment (external loads)	No
UG-22(d)(2) Vessel supports such as lugs, rings, skirts, saddles and legs	No
UG-22(f) Wind reactions	No
UG-22(f) Seismic reactions	No
UG-22(j) Test pressure and coincident static head acting during the test:	No
Note: UG-22(b),(c) and (f) loads only considered when supports are present.	

License Information	
Company Name	GasTech Engineering LLC
License	Commercial
License Key ID	23449
Support Expires	June 01, 2018

## Radiography Summary

UG-116 Radiography							
Component	Longitudinal Seam		Left Circumferential Seam		Right Circumferential Seam		Mark
	Category (Fig UW-3)	Radiography / Joint Type	Category (Fig UW-3)	Radiography / Joint Type	Category (Fig UW-3)	Radiography / Joint Type	
<a href="#">ASME B16.5/16.47 Blind on Sump-Head (Sch 60)</a>	N/A	Seamless No RT	N/A	N/A	N/A	N/A / Gasketed	N/A
<a href="#">Sump</a>	N/A	Seamless No RT	C	Full UW-11(a) / Type 1	C	Full UW-11(a) / Type 1	RT1
<a href="#">Sump-Head (Sch 60)</a>	N/A	Seamless No RT	N/A	N/A / Gasketed	C	Full UW-11(a) / Type 1	RT1
<a href="#">Sump-Head (Sch 60)</a>	N/A	Seamless No RT	C	Full UW-11(a) / Type 1	N/A	N/A / Gasketed	RT1
<a href="#">ASME B16.5/16.47 Blind on Sump-Head (Sch 60)</a>	N/A	Seamless No RT	N/A	N/A / Gasketed	N/A	N/A	N/A
Nozzle	Longitudinal Seam		Nozzle to Vessel Circumferential Seam		Nozzle free end Circumferential Seam		
<a href="#">Downcomer-Inlet (Downcomer-Inlet)</a>	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
<a href="#">Downcomer-Outlet (Downcomer-Outlet)</a>	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
<a href="#">Bridle Bottom Tap (Bridle Bottom Tap)</a>	N/A	Seamless No RT	D	N/A / Type 7	B	UW-11(a)(4) exempt / Type 1	N/A
<a href="#">Elbow (Bridle Bottom Tap)</a>	N/A	Seamless No RT	B	UW-11(a)(4) exempt / Type 1	B	UW-11(a)(4) exempt / Type 1	N/A
<a href="#">Elbow Pipe (Bridle Bottom Tap)</a>	N/A	Seamless No RT	B	UW-11(a)(4) exempt / Type 1	C	UW-11(a)(4) exempt / Type 1	N/A
<a href="#">Liquid Outlet (Liquid Outlet)</a>	N/A	Seamless No RT	D	N/A / Type 7	B	UW-11(a)(4) exempt / Type 1	N/A
<a href="#">Elbow (Liquid Outlet)</a>	N/A	Seamless No RT	B	UW-11(a)(4) exempt / Type 1	B	UW-11(a)(4) exempt / Type 1	N/A
<a href="#">Elbow Pipe (Liquid Outlet)</a>	N/A	Seamless No RT	B	UW-11(a)(4) exempt / Type 1	C	UW-11(a)(4) exempt / Type 1	N/A
Nozzle Flange	Longitudinal Seam		Flange Face		Nozzle to Flange Circumferential Seam		
<a href="#">ASME B16.5/16.47 flange attached to right end of Elbow Pipe (Bridle Bottom Tap)</a>	N/A	Seamless No RT	N/A	N/A / Gasketed	C	UW-11(a)(4) exempt / Type 1	N/A
<a href="#">ASME B16.5/16.47 flange attached to right end of Elbow Pipe (Liquid Outlet)</a>	N/A	Seamless No RT	N/A	N/A / Gasketed	C	UW-11(a)(4) exempt / Type 1	N/A
UG-116(e) Required Marking: <b>RT1</b>							

## Thickness Summary

Component Data								
Component Identifier	Material	Diameter (in)	Length (in)	Nominal t (in)	Design t (in)	Total Corrosion (in)	Joint E	Load
<a href="#">Sump</a>	SA-106 B Smls pipe	11.626 ID	120	0.562	0.4331	0.125	1.00	Internal

Definitions	
Nominal t	Vessel wall nominal thickness
Design t	Required vessel thickness due to governing loading + corrosion
Joint E	Longitudinal seam joint efficiency
Load	
Internal	Circumferential stress due to internal pressure governs
External	External pressure governs
Wind	Combined longitudinal stress of pressure + weight + wind governs
Seismic	Combined longitudinal stress of pressure + weight + seismic governs

## Weight Summary

Weight (lb) Contributed by Vessel Elements											
Component	Metal New*	Metal Corroded	Insulation	Insulation Supports	Lining	Piping + Liquid	Operating Liquid		Test Liquid		Surface Area ft <sup>2</sup>
							New	Corroded	New	Corroded	
<a href="#">ASME B16.5/16.47 Blind on Sump-Head (Sch 60)</a>	355	355	0	0	0	0	0	0	0	0	4
<a href="#">Sump</a>	718.4	564.4	0	0	0	0	255.7	266.4	524.8	547.2	33
<a href="#">ASME B16.5/16.47 Blind on Sump-Head (Sch 60)</a>	355	355	0	0	0	0	0	0	0	0	4
<b>TOTAL:</b>	<b>1,428.4</b>	<b>1,274.4</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>255.7</b>	<b>266.4</b>	<b>524.8</b>	<b>547.2</b>	<b>41</b>
*Shells with attached nozzles have weight reduced by material cut out for opening.											

Weight (lb) Contributed by Attachments										
Component	Body Flanges		Nozzles & Flanges		Packed Beds	Trays	Tray Supports	Rings & Clips	Vertical Loads	Surface Area ft <sup>2</sup>
	New	Corroded	New	Corroded						
<a href="#">ASME B16.5/16.47 Blind on Sump-Head (Sch 60)</a>	0	0	0	0	0	0	0	0	0	0
<a href="#">Sump</a>	450	450	159.5	137.7	0	0	0	0	0	20
<a href="#">ASME B16.5/16.47 Blind on Sump-Head (Sch 60)</a>	0	0	0	0	0	0	0	0	0	0
<b>TOTAL:</b>	<b>450</b>	<b>450</b>	<b>159.5</b>	<b>137.7</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>12</b>

Vessel Totals		
	New	Corroded
Operating Weight (lb)	2,294	2,128
Empty Weight (lb)	2,038	1,862
Test Weight (lb)	2,563	2,409
Surface Area (ft <sup>2</sup> )	53	-
Capacity** (US gal)	61	63
**The vessel capacity does not include volume of nozzle, piping or other attachments.		

Vessel Lift Condition	
Vessel Lift Weight, New (lb)	2,038
Center of Gravity from Datum (in)	59.9518

## Test Report

### Horizontal shop test based on user defined pressure

Gauge pressure at 70° F = 1,315 psi

Horizontal shop test		
Identifier	Local test pressure (psi)	Test liquid static head (psi)
Sump-Head (Sch 60)	1,315.86	0.86
Sump	1,315.86	0.86
Sump-Head (Sch 60)	1,315.86	0.86
Bridle Bottom Tap (Bridle Bottom Tap)	1,316.096	1.096
Downcomer-Inlet (Downcomer-Inlet)	1,315.42	0.42
Downcomer-Outlet (Downcomer-Outlet)	1,315.42	0.42
Elbow (Bridle Bottom Tap)	1,316.199	1.199
Elbow (Liquid Outlet)	1,316.199	1.199
Elbow Pipe (Bridle Bottom Tap)	1,316.199	1.199
Elbow Pipe (Liquid Outlet)	1,316.199	1.199
Liquid Outlet (Liquid Outlet)	1,316.096	1.096
(1) The zero degree angular position is assumed to be up, and the test liquid height is assumed to the top-most flange.		

The field test condition has not been investigated.

The test temperature of 70 ° F is warmer than the minimum recommended temperature of 6.31 ° F so the brittle fracture provision of UG-99(h) has been met.

## Bill of Materials

Covers						
Item #	Type	Material	Thk [in]	Dia. [in]	Wt. [lb] (ea.)	Qty
H1	ASME B16.5/B16.47 Blind NPS 12 Class 600	A105 (N)	2.87	22 OD	355	2

Shells							
Item #	Type	Material	Thk [in]	Dia. [in]	Length [in]	Wt. [lb] (ea.)	Qty
S1	Cylinder	SA-106 B Smls pipe; NPS 12 Sch 60	0.562	11.626 ID	120	730.8	1

Nozzles / Nozzle Piping							
Item #	Type	Material	NPS	Thk [in]	Dia. [in]	Length [in]	Wt. [lb]
Noz1	Nozzle	SA-106 C Smls pipe	NPS 6 XXS	0.864	6.625 OD	26.4	117
Noz2	Nozzle	SA-106 B Smls pipe	NPS 2 Sch 160	0.344	2.375 OD	13.4	8.3
P1	Nozzle Piping	SA-106 B Smls pipe	NPS 2 Sch 160	0.344	2.375 OD	10	6.2

ASME B16.9 Fittings				
Item #	Type	Material	Size [in]	Qty
EB1	B16.9 Elbow Short Radius	SA-234 WPB	NPS 2 Sch 160	2

Flanges						
Item #	Type	Material	NPS	Dia. [in]	Wt. [lb] (ea.)	Qty
AF1	ASME B16.5 Welding Neck - Class 600	A105 (N)	12	22 x 11.626	225	2
AF2	ASME B16.5 Welding Neck - Class 600	A105 (N)	2.0	6.5 x 1.687	12	2

Fasteners				
Item #	Description	Material	Length [in]	Qty
FB1	1-1/4" series 8 bolt	SA-193 B7 Bolt <= 2 1/2	8.8	40
FB2	5/8" coarse bolt	SA-193 B7 Bolt <= 2 1/2	4.3	16

All listed flange bolts require associated nuts and washers in accordance with Division 1, UCS-11.

**Liquid Level on Sump-Head (Sch 60)**

ASME Section VIII Division 1, 2015 Edition	
Location from Center Line (in)	0
Operating Liquid Specific Gravity	1



**ASME B16.5/16.47 Blind on Sump-Head (Sch 60)**

ASME B16.5-2013 Blind	
<b>Description</b>	NPS 12 Class 600 Blind A105 N
<b>Attached to</b>	Sump-Head (Sch 60)
<b>Bolt Material</b>	SA-193 B7 Bolt $\leq 2 \frac{1}{2}$ (II-D p. 344, ln. 31)
<b>Rated MDMT</b>	-55° F
<b>Liquid static head</b>	0.21 psi
<b>MAWP rating</b>	1,360 psi @ 200° F
<b>MAP rating</b>	1,480 psi @ 70° F
<b>Hydrotest rating</b>	2,225 psi @ 70° F
<b>Impact Tested</b>	No
Notes	
Blind rated MDMT per UCS-66(b)(1)(b) = -55° F (Coincident ratio = 0.5822) Bolts rated MDMT per Fig UCS-66 note (c) = -55° F	

**Sump-Head (Sch 60)**

ASME B16.5-2013 Flange	
<b>Description</b>	NPS 12 Class 600 WN A105 N
<b>Attached to</b>	Left end of Sump
<b>Bolt Material</b>	SA-193 B7 Bolt $\leq 2 \frac{1}{2}$ (II-D p. 344, ln. 31)
<b>Blind included</b>	Yes
<b>Rated MDMT</b>	-55° F
<b>Liquid static head</b>	0.21 psi
<b>MAWP rating</b>	1,360 psi @ 200° F
<b>MAP rating</b>	1,480 psi @ 70° F
<b>Hydrotest rating</b>	2,225 psi @ 70° F
<b>PWHT performed</b>	No
<b>Impact Tested</b>	No
<b>Circumferential joint radiography</b>	Full UW-11(a) Type 1
<b>Bore diameter, B (specified by purchaser)</b>	11.626"
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -55° F (Coincident ratio = 0.5822) Bolts rated MDMT per Fig UCS-66 note (c) = -55° F	

## Sump

ASME Section VIII Division 1, 2015 Edition				
Component		Cylinder		
Material		SA-106 B Smls pipe (II-D p. 14, ln. 15)		
Pipe NPS and Schedule		NPS 12 Sch 60		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
No	No	No	No	No
		Design Pressure (psi)	Design Temperature (° F)	Design MDMT (° F)
Internal		860	200	-20
Static Liquid Head				
Condition		P <sub>s</sub> (psi)	H <sub>s</sub> (in)	SG
Operating		0.21	5.938	1
Test horizontal		0.86	23.813	1
Dimensions				
Inner Diameter		11.626"		
Length		120"		
Pipe Nominal Thickness		0.562"		
Pipe Minimum Thickness <sup>1</sup>		0.4918"		
Corrosion	Inner	0.125"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		Capacity (US gal)
New		718.41		55.15
Corroded		564.45		57.54
Radiography				
Longitudinal seam		Seamless No RT		
Left Circumferential seam		Full UW-11(a) Type 1		
Right Circumferential seam		Full UW-11(a) Type 1		

<sup>1</sup>Pipe minimum thickness = nominal thickness times pipe tolerance factor of 0.875.

Results Summary	
Governing condition	Internal pressure
Minimum thickness per UG-16	$0.0625" + 0.125" = 0.1875"$
Design thickness due to internal pressure (t)	<a href="#">0.4331"</a>
Maximum allowable working pressure (MAWP)	<a href="#">1,018.2 psi</a>
Maximum allowable pressure (MAP)	<a href="#">1,376.7 psi</a>
Rated MDMT	-23.69 ° F

UCS-66 Material Toughness Requirements	
Governing thickness, $t_g =$	0.4918"
Exemption temperature from Fig UCS-66 Curve B =	-7.79° F
$t_r = 861.61 * 5.938 / (17,100 * 1 - 0.6 * 861.61) =$	0.3085"
Stress ratio $= t_r * E' / (t_n - c) = 0.3085 * 1 / (0.4918 - 0.125) =$	0.8412
Reduction in MDMT, $T_R$ from Fig UCS-66.1 =	15.9° F
$MDMT = \max[MDMT - T_R, -55] = \max[-7.79 - 15.9, -55] =$	-23.69° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

#### Design thickness, (at 200 ° F) UG-27(c)(1)

$$\begin{aligned}
 t &= P * R / (S * E - 0.60 * P) + \text{Corrosion} \\
 &= 860.21 * 5.938 / (17,100 * 1.00 - 0.60 * 860.21) + 0.125 \\
 &= \text{0.4331"}
 \end{aligned}$$

#### Maximum allowable working pressure, (at 200 ° F) UG-27(c)(1)

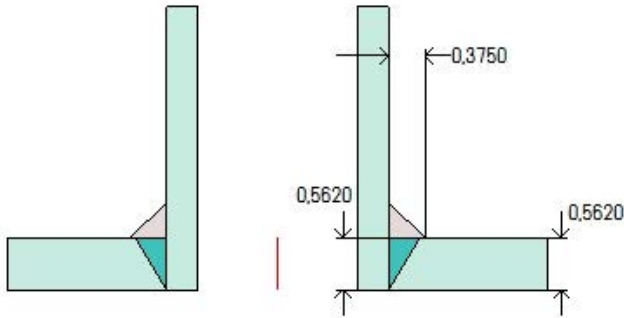
$$\begin{aligned}
 P &= S * E * t / (R + 0.60 * t) - P_s \\
 &= 17,100 * 1.00 * (0.562 * 0.875 - 0.125) / (5.938 + 0.60 * (0.562 * 0.875 - 0.125)) - 0.21 \\
 &= \text{1,018.2 psi}
 \end{aligned}$$

#### Maximum allowable pressure, (at 70 ° F) UG-27(c)(1)

$$\begin{aligned}
 P &= S * E * t / (R + 0.60 * t) \\
 &= 17,100 * 1.00 * (0.562 * 0.875) / (5.813 + 0.60 * (0.562 * 0.875)) \\
 &= \text{1,376.7 psi}
 \end{aligned}$$

## Bridle Bottom Tap (Bridle Bottom Tap)

### ASME Section VIII Division 1, 2015 Edition



Note: round inside edges per UG-76(c)

#### Location and Orientation

Located on	Sump
Orientation	180°
Nozzle center line offset to datum line	84"
End of nozzle to shell center	12.375"
Passes through a Category A joint	No

#### Nozzle

Description	NPS 2 Sch 160
Access opening	No
Material specification	SA-106 B Smls pipe (II-D p. 14, ln. 15)
Inside diameter, new	1.687"
Pipe nominal wall thickness	0.344"
Pipe minimum wall thickness <sup>1</sup>	0.301"
Corrosion allowance	0.125"
Projection available outside vessel, L <sub>pr</sub>	6"
Local vessel minimum thickness	0.4918"
Liquid static head included	0.23 psi
Longitudinal joint efficiency	1

#### Welds

Inner fillet, Leg <sub>41</sub>	0.375"
Nozzle to vessel groove weld	0.562"

<sup>1</sup>Pipe minimum thickness = nominal thickness times pipe tolerance factor of 0.875.

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 861.62 * 0.9685 / (17,100 * 1 - 0.6 * 861.62) =$	0.0503"
Stress ratio $= t_r * E^* / (t_n - c) = 0.0503 * 1 / (0.301 - 0.125) =$	0.2859
Stress ratio 0.35, MDMT per UCS-66(b)(3) =	-155° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

### Reinforcement Calculations for MAWP

The vessel wall thickness governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in <sup>2</sup> )							UG-45 Summary (in)	
For P = 1,018.56 psi @ 200 ° F							The nozzle passes UG-45	
A required	A available	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	A <sub>5</sub>	A welds	t <sub>req</sub>	t <sub>min</sub>
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.2598	0.301

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg <sub>41</sub> )	0.1533	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

## Reinforcement Calculations for MAP

The vessel wall thickness governs the MAP of this nozzle.

UG-37 Area Calculation Summary (in <sup>2</sup> )							UG-45 Summary (in)	
For P = 1,376.84 psi @ 70 ° F							The nozzle passes UG-45	
A required	A available	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	A <sub>5</sub>	A welds	t <sub>req</sub>	t <sub>min</sub>
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.1348	0.301

UG-41 Weld Failure Path Analysis Summary	
The nozzle is exempt from weld strength calculations per UW-15(b)(2)	

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg <sub>41</sub> )	0.2408	0.2625	weld size is adequate

**This opening does not require reinforcement per UG-36(c)(3)(a)**

## Elbow (Bridle Bottom Tap)

ASME Section VIII Division 1, 2015 Edition				
Component		ASME B16.9 Elbow		
Type		Short Radius		
Material		SA-234 WPB (II-D p. 14, In. 17)		
Pipe NPS and Schedule		NPS 2 Sch 160		
Attached To		Bridle Bottom Tap (Bridle Bottom Tap)		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
No	No	No	No	No
		Design Pressure (psi)	Design Temperature (° F)	Design MDMT (° F)
Internal		860	200	-20
Static Liquid Head				
Condition		P <sub>s</sub> (psi)	H <sub>s</sub> (in)	SG
Operating		0.55	15.3435	1
Test horizontal		1.2	33.2185	1
Dimensions				
Outer Diameter		2.375"		
Nominal Thickness		0.344"		
Minimum Thickness <sup>1</sup>		0.301"		
Center-to-End, A		2"		
Corrosion	Inner	0.125"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		Capacity (US gal)
New		1.95		0.03
Corroded		1.32		0.04
Radiography				
Longitudinal seam		Seamless No RT		
Left Circumferential seam		Full UW-11(a) Type 1		
Right Circumferential seam		Full UW-11(a) Type 1		

<sup>1</sup> minimum thickness = nominal thickness times pipe tolerance factor of 0.875.



Results Summary	
Governing condition	UG-16
Minimum thickness per UG-16	$0.0625" + 0.125" = 0.1875"$
Design thickness due to internal pressure (t)	<a href="#">0.1836"</a>
Maximum allowable working pressure (MAWP)	<a href="#">2.693.57 psi</a>
Maximum allowable pressure (MAP)	<a href="#">4.823.45 psi</a>
Rated MDMT	-155 ° F

UCS-66 Material Toughness Requirements	
$t_r = 861.94 * 1.1875 / (17,100 * 1 + 0.4 * 861.94) =$	0.0587"
Stress ratio $= t_r * E' / (t_n - c) = 0.0587 * 1 / (0.301 - 0.125) =$	0.3334
Stress ratio 0.35, MDMT per UCS-66(b)(3) =	-155° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

#### Design thickness, (at 200 ° F) Appendix 1-1

$$\begin{aligned}
 t &= P * R_o / (S * E + 0.40 * P) + \text{Corrosion} \\
 &= 860.55 * 1.1875 / (17,100 * 1.00 + 0.40 * 860.55) + 0.125 \\
 &= \a href="#">0.1836"
 \end{aligned}$$

#### Maximum allowable working pressure, (at 200 ° F) Appendix 1-1

$$\begin{aligned}
 P &= S * E * t / (R_o - 0.40 * t) - P_s \\
 &= 17,100 * 1.00 * (0.344 * 0.875 - 0.125) / (1.1875 - 0.40 * (0.344 * 0.875 - 0.125)) - 0.55 \\
 &= \a href="#">2.693.57 psi
 \end{aligned}$$

#### Maximum allowable pressure, (at 70 ° F) Appendix 1-1

$$\begin{aligned}
 P &= S * E * t / (R_o - 0.40 * t) \\
 &= 17,100 * 1.00 * (0.344 * 0.875) / (1.1875 - 0.40 * (0.344 * 0.875)) \\
 &= \a href="#">4.823.45 psi
 \end{aligned}$$

### Elbow Pipe (Bridle Bottom Tap)

ASME Section VIII Division 1, 2015 Edition				
Component		Nozzle Pipe		
Material		SA-106 B Smls pipe (II-D p. 14, ln. 15)		
Pipe NPS and Schedule		NPS 2 Sch 160		
Attached To		Elbow (Bridle Bottom Tap)		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
No	No	No	No	No
		Design Pressure (psi)	Design Temperature (° F)	Design MDMT (° F)
Internal		860	200	-20
Static Liquid Head				
Condition		P <sub>s</sub> (psi)	H <sub>s</sub> (in)	SG
Operating		0.55	15.3435	1
Test horizontal		1.2	33.2185	1
Dimensions				
Outer Diameter		2.375"		
Length		4"		
Pipe Nominal Thickness		0.344"		
Pipe Minimum Thickness <sup>1</sup>		0.301"		
Corrosion	Inner	0.125"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		Capacity (US gal)
New		2.48		0.04
Corroded		1.68		0.05
Radiography				
Longitudinal seam		Full UW-11(a) Type 1		
Left Circumferential seam		Full UW-11(a) Type 1		
Right Circumferential seam		Full UW-11(a) Type 1		

<sup>1</sup>Pipe minimum thickness = nominal thickness times pipe tolerance factor of 0.875.

ASME B16.5-2013 Flange	
Description	NPS 2 Class 600 WN A105 N
Bolt Material	SA-193 B7 Bolt <= 2 1/2 (II-D p. 344, ln. 31)
Blind included	No
Rated MDMT	-55° F
Liquid static head	0.55 psi
MAWP rating	1,360 psi @ 200° F
MAP rating	1,480 psi @ 70° F
Hydrotest rating	2,225 psi @ 70° F
PWHT performed	No
Impact Tested	No
Circumferential joint radiography	Full UW-11(a) Type 1
Bore diameter, B (specified by purchaser)	1.687"
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -55° F (Coincident ratio = 0.5824) Bolts rated MDMT per Fig UCS-66 note (c) = -55° F	

Results Summary	
Governing condition	UG-16
Minimum thickness per UG-16	0.0625" + 0.125" = 0.1875"
Design thickness due to internal pressure (t)	<a href="#">0.1836"</a>
Maximum allowable working pressure (MAWP)	<a href="#">2,693.57 psi</a>
Maximum allowable pressure (MAP)	<a href="#">4,823.45 psi</a>
Rated MDMT	-155 ° F

UCS-66 Material Toughness Requirements	
$t_r = 861.94 \times 1.1875 / (17,100 \times 1 + 0.4 \times 861.94) =$	0.0587"
Stress ratio $= t_r \times E^* / (t_n - c) = 0.0587 \times 1 / (0.301 - 0.125) =$	0.3334
Stress ratio 0.35, MDMT per UCS-66(b)(3) =	-155° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

#### Design thickness, (at 200 ° F) Appendix 1-1

$$\begin{aligned}
 t &= P \cdot R_o / (S \cdot E + 0.40 \cdot P) + \text{Corrosion} \\
 &= 860.55 \times 1.1875 / (17,100 \times 1.00 + 0.40 \times 860.55) + 0.125 \\
 &= \text{0.1836"}
 \end{aligned}$$

**Maximum allowable working pressure, (at 200 ° F) Appendix 1-1**

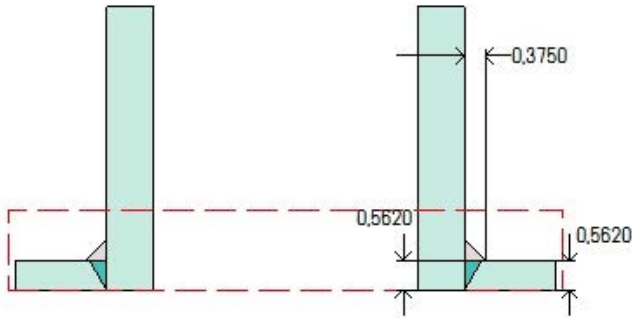
$$\begin{aligned} P &= S \cdot E \cdot t / (R_o - 0.40 \cdot t) - P_s \\ &= 17,100 \cdot 1.00 \cdot (0.344 \cdot 0.875 - 0.125) / (1.1875 - 0.40 \cdot (0.344 \cdot 0.875 - 0.125)) - 0.55 \\ &= \underline{2.693.57} \text{ psi} \end{aligned}$$

**Maximum allowable pressure, (at 70 ° F) Appendix 1-1**

$$\begin{aligned} P &= S \cdot E \cdot t / (R_o - 0.40 \cdot t) \\ &= 17,100 \cdot 1.00 \cdot (0.344 \cdot 0.875) / (1.1875 - 0.40 \cdot (0.344 \cdot 0.875)) \\ &= \underline{4.823.45} \text{ psi} \end{aligned}$$

## Downcomer-Inlet (Downcomer-Inlet)

### ASME Section VIII Division 1, 2015 Edition



Note: round inside edges per UG-76(c)

#### Location and Orientation

Located on	Sump
Orientation	0°
Nozzle center line offset to datum line	50"
End of nozzle to shell center	18"
Passes through a Category A joint	No

#### Nozzle

Description	NPS 6 XXS
Access opening	No
Material specification	SA-106 C Smls pipe (II-D p. 22, ln. 1)
Inside diameter, new	4.897"
Pipe nominal wall thickness	0.864"
Pipe minimum wall thickness <sup>1</sup>	0.756"
Corrosion allowance	0.125"
Projection available outside vessel, L <sub>pr</sub>	11.625"
Local vessel minimum thickness	0.4918"
Liquid static head included	0 psi
Longitudinal joint efficiency	1

#### Welds

Inner fillet, Leg <sub>41</sub>	0.375"
Nozzle to vessel groove weld	0.562"

<sup>1</sup>Pipe minimum thickness = nominal thickness times pipe tolerance factor of 0.875.

UCS-66 Material Toughness Requirements Nozzle At Intersection	
Governing thickness, $t_g =$	0.4918"
Exemption temperature from Fig UCS-66 Curve B =	-7.79° F
$t_r = 861.39 * 5.938 / (17,100 * 1 - 0.6 * 861.39) =$	0.3084"
Stress ratio $= t_r * E^* / (t_n - c) = 0.3084 * 1 / (0.4918 - 0.125) =$	0.8409
Reduction in MDMT, $T_R$ from Fig UCS-66.1 =	15.9° F
MDMT = max[ MDMT - $T_R$ , -55] = max[ -7.79 - 15.9 , -55] =	-23.69° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 861.39 * 2.5735 / (20,000 * 1 - 0.6 * 861.39) =$	0.1138"
Stress ratio $= t_r * E^* / (t_n - c) = 0.1138 * 1 / (0.756 - 0.125) =$	0.1803
Stress ratio 0.35, MDMT per UCS-66(b)(3) =	-155° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

### Reinforcement Calculations for MAWP

Available reinforcement per UG-37 governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in <sup>2</sup> )							UG-45 Summary (in)	
For P = 861.39 psi @ 200 ° F The opening is adequately reinforced							The nozzle passes UG-45	
A required	A available	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	A <sub>5</sub>	A welds	t <sub>req</sub>	t <sub>min</sub>
1.5875	1.5876	0.3004	1.1466	--	--	0.1406	0.37	0.756

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(1)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg <sub>41</sub> )	0.25	0.2625	weld size is adequate

#### Reinforcement Calculations for MAP

Available reinforcement per UG-37 governs the MAP of this nozzle.

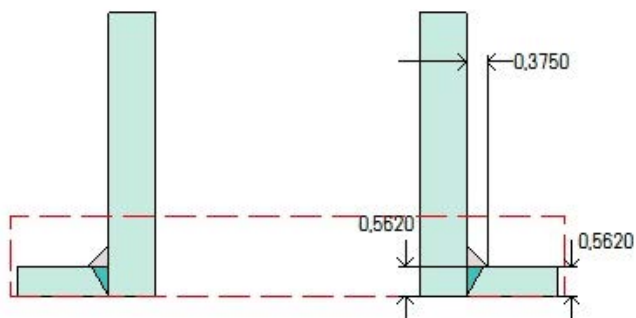
UG-37 Area Calculation Summary (in <sup>2</sup> )							UG-45 Summary (in)	
For P = 1,232.28 psi @ 70 ° F The opening is adequately reinforced							The nozzle passes UG-45	
A required	A available	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	A <sub>5</sub>	A welds	t <sub>req</sub>	t <sub>min</sub>
2.1441	2.1442	0.2643	1.7393	--	--	0.1406	0.245	0.756

UG-41 Weld Failure Path Analysis Summary	
The nozzle is exempt from weld strength calculations per UW-15(b)(1)	

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg <sub>41</sub> )	0.25	0.2625	weld size is adequate

## Downcomer-Outlet (Downcomer-Outlet)

### ASME Section VIII Division 1, 2015 Edition



Note: round inside edges per UG-76(c)

#### Location and Orientation

Located on	Sump
Orientation	0°
Nozzle center line offset to datum line	68"
End of nozzle to shell center	18"
Passes through a Category A joint	No

#### Nozzle

Description	NPS 6 XXS
Access opening	No
Material specification	SA-106 C Smls pipe (II-D p. 22, ln. 1)
Inside diameter, new	4.897"
Pipe nominal wall thickness	0.864"
Pipe minimum wall thickness <sup>1</sup>	0.756"
Corrosion allowance	0.125"
Projection available outside vessel, L <sub>pr</sub>	11.625"
Local vessel minimum thickness	0.4918"
Liquid static head included	0 psi
Longitudinal joint efficiency	1

#### Welds

Inner fillet, Leg <sub>41</sub>	0.375"
Nozzle to vessel groove weld	0.562"

<sup>1</sup>Pipe minimum thickness = nominal thickness times pipe tolerance factor of 0.875.



UCS-66 Material Toughness Requirements Nozzle At Intersection	
Governing thickness, $t_g =$	0.4918"
Exemption temperature from Fig UCS-66 Curve B =	-7.79° F
$t_r = 861.39 * 5.938 / (17,100 * 1 - 0.6 * 861.39) =$	0.3084"
Stress ratio $= t_r * E^* / (t_n - c) = 0.3084 * 1 / (0.4918 - 0.125) =$	0.8409
Reduction in MDMT, $T_R$ from Fig UCS-66.1 =	15.9° F
MDMT = max[ MDMT - $T_R$ , -55] = max[ -7.79 - 15.9 , -55] =	-23.69° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 861.39 * 2.5735 / (20,000 * 1 - 0.6 * 861.39) =$	0.1138"
Stress ratio $= t_r * E^* / (t_n - c) = 0.1138 * 1 / (0.756 - 0.125) =$	0.1803
Stress ratio 0.35, MDMT per UCS-66(b)(3) =	-155° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

### Reinforcement Calculations for MAWP

Available reinforcement per UG-37 governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in <sup>2</sup> )							UG-45 Summary (in)	
For P = 861.39 psi @ 200 ° F The opening is adequately reinforced							The nozzle passes UG-45	
A required	A available	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	A <sub>5</sub>	A welds	t <sub>req</sub>	t <sub>min</sub>
1.5875	1.5876	0.3004	1.1466	--	--	0.1406	0.37	0.756

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(1)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg <sub>41</sub> )	0.25	0.2625	weld size is adequate

#### Reinforcement Calculations for MAP

Available reinforcement per UG-37 governs the MAP of this nozzle.

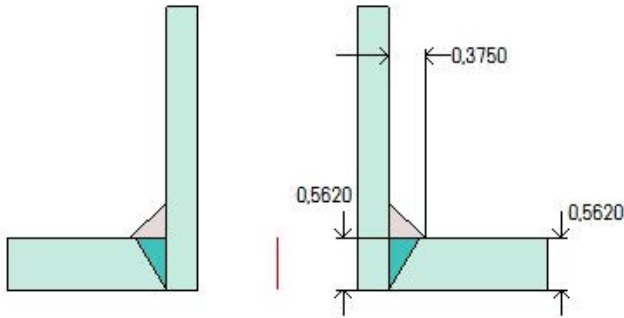
UG-37 Area Calculation Summary (in <sup>2</sup> )							UG-45 Summary (in)	
For P = 1,232.28 psi @ 70 ° F The opening is adequately reinforced							The nozzle passes UG-45	
A required	A available	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	A <sub>5</sub>	A welds	t <sub>req</sub>	t <sub>min</sub>
2.1441	2.1442	0.2643	1.7393	--	--	0.1406	0.245	0.756

UG-41 Weld Failure Path Analysis Summary	
The nozzle is exempt from weld strength calculations per UW-15(b)(1)	

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg <sub>41</sub> )	0.25	0.2625	weld size is adequate

## Liquid Outlet (Liquid Outlet)

### ASME Section VIII Division 1, 2015 Edition



Note: round inside edges per UG-76(c)

#### Location and Orientation

Located on	Sump
Orientation	180°
Nozzle center line offset to datum line	36"
End of nozzle to shell center	12.375"
Passes through a Category A joint	No

#### Nozzle

Description	NPS 2 Sch 160
Access opening	No
Material specification	SA-106 B Smls pipe (II-D p. 14, ln. 15)
Inside diameter, new	1.687"
Pipe nominal wall thickness	0.344"
Pipe minimum wall thickness <sup>1</sup>	0.301"
Corrosion allowance	0.125"
Projection available outside vessel, L <sub>pr</sub>	6"
Local vessel minimum thickness	0.4918"
Liquid static head included	0.23 psi
Longitudinal joint efficiency	1

#### Welds

Inner fillet, Leg <sub>41</sub>	0.375"
Nozzle to vessel groove weld	0.562"

<sup>1</sup>Pipe minimum thickness = nominal thickness times pipe tolerance factor of 0.875.

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 861.62 * 0.9685 / (17,100 * 1 - 0.6 * 861.62) =$	0.0503"
Stress ratio $= t_r * E^* / (t_n - c) = 0.0503 * 1 / (0.301 - 0.125) =$	0.2859
Stress ratio 0.35, MDMT per UCS-66(b)(3) =	-155° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

### Reinforcement Calculations for MAWP

The vessel wall thickness governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in <sup>2</sup> )							UG-45 Summary (in)	
For P = 1,018.56 psi @ 200 ° F							The nozzle passes UG-45	
A required	A available	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	A <sub>5</sub>	A welds	t <sub>req</sub>	t <sub>min</sub>
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.2598	0.301

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg <sub>41</sub> )	0.1533	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

## Reinforcement Calculations for MAP

The vessel wall thickness governs the MAP of this nozzle.

UG-37 Area Calculation Summary (in <sup>2</sup> )							UG-45 Summary (in)	
For P = 1,376.84 psi @ 70 ° F							The nozzle passes UG-45	
A required	A available	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	A <sub>5</sub>	A welds	t <sub>req</sub>	t <sub>min</sub>
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.1348	0.301

UG-41 Weld Failure Path Analysis Summary	
The nozzle is exempt from weld strength calculations per UW-15(b)(2)	

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg <sub>41</sub> )	0.2408	0.2625	weld size is adequate

**This opening does not require reinforcement per UG-36(c)(3)(a)**

## Elbow (Liquid Outlet)

ASME Section VIII Division 1, 2015 Edition				
Component		ASME B16.9 Elbow		
Type		Short Radius		
Material		SA-234 WPB (II-D p. 14, In. 17)		
Pipe NPS and Schedule		NPS 2 Sch 160		
Attached To		Liquid Outlet (Liquid Outlet)		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
No	No	No	No	No
		Design Pressure (psi)	Design Temperature (° F)	Design MDMT (° F)
Internal		860	200	-20
Static Liquid Head				
Condition		P <sub>s</sub> (psi)	H <sub>s</sub> (in)	SG
Operating		0.55	15.3435	1
Test horizontal		1.2	33.2185	1
Dimensions				
Outer Diameter		2.375"		
Nominal Thickness		0.344"		
Minimum Thickness <sup>1</sup>		0.301"		
Center-to-End, A		2"		
Corrosion	Inner	0.125"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		Capacity (US gal)
New		1.95		0.03
Corroded		1.32		0.04
Radiography				
Longitudinal seam		Seamless No RT		
Left Circumferential seam		Full UW-11(a) Type 1		
Right Circumferential seam		Full UW-11(a) Type 1		

<sup>1</sup> minimum thickness = nominal thickness times pipe tolerance factor of 0.875.

Results Summary	
Governing condition	UG-16
Minimum thickness per UG-16	$0.0625" + 0.125" = 0.1875"$
Design thickness due to internal pressure (t)	<a href="#">0.1836"</a>
Maximum allowable working pressure (MAWP)	<a href="#">2.693.57 psi</a>
Maximum allowable pressure (MAP)	<a href="#">4.823.45 psi</a>
Rated MDMT	-155 ° F

UCS-66 Material Toughness Requirements	
$t_r = 861.94 * 1.1875 / (17,100 * 1 + 0.4 * 861.94) =$	0.0587"
Stress ratio $= t_r * E' / (t_n - c) = 0.0587 * 1 / (0.301 - 0.125) =$	0.3334
Stress ratio 0.35, MDMT per UCS-66(b)(3) =	-155° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

#### Design thickness, (at 200 ° F) Appendix 1-1

$$\begin{aligned}
 t &= P * R_o / (S * E + 0.40 * P) + \text{Corrosion} \\
 &= 860.55 * 1.1875 / (17,100 * 1.00 + 0.40 * 860.55) + 0.125 \\
 &= \text{0.1836"}
 \end{aligned}$$

#### Maximum allowable working pressure, (at 200 ° F) Appendix 1-1

$$\begin{aligned}
 P &= S * E * t / (R_o - 0.40 * t) - P_s \\
 &= 17,100 * 1.00 * (0.344 * 0.875 - 0.125) / (1.1875 - 0.40 * (0.344 * 0.875 - 0.125)) - 0.55 \\
 &= \text{2.693.57 psi}
 \end{aligned}$$

#### Maximum allowable pressure, (at 70 ° F) Appendix 1-1

$$\begin{aligned}
 P &= S * E * t / (R_o - 0.40 * t) \\
 &= 17,100 * 1.00 * (0.344 * 0.875) / (1.1875 - 0.40 * (0.344 * 0.875)) \\
 &= \text{4.823.45 psi}
 \end{aligned}$$

### Elbow Pipe (Liquid Outlet)

ASME Section VIII Division 1, 2015 Edition				
Component		Nozzle Pipe		
Material		SA-106 B Smls pipe (II-D p. 14, ln. 15)		
Pipe NPS and Schedule		NPS 2 Sch 160		
Attached To		Elbow (Liquid Outlet)		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
No	No	No	No	No
		Design Pressure (psi)	Design Temperature (° F)	Design MDMT (° F)
Internal		860	200	-20
Static Liquid Head				
Condition		P <sub>s</sub> (psi)	H <sub>s</sub> (in)	SG
Operating		0.55	15.3435	1
Test horizontal		1.2	33.2185	1
Dimensions				
Outer Diameter		2.375"		
Length		6"		
Pipe Nominal Thickness		0.344"		
Pipe Minimum Thickness <sup>1</sup>		0.301"		
Corrosion	Inner	0.125"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		Capacity (US gal)
New		3.73		0.06
Corroded		2.52		0.08
Radiography				
Longitudinal seam		Full UW-11(a) Type 1		
Left Circumferential seam		Full UW-11(a) Type 1		
Right Circumferential seam		Full UW-11(a) Type 1		

<sup>1</sup>Pipe minimum thickness = nominal thickness times pipe tolerance factor of 0.875.



ASME B16.5-2013 Flange	
Description	NPS 2 Class 600 WN A105 N
Bolt Material	SA-193 B7 Bolt <= 2 1/2 (II-D p. 344, ln. 31)
Blind included	No
Rated MDMT	-55° F
Liquid static head	0.55 psi
MAWP rating	1,360 psi @ 200° F
MAP rating	1,480 psi @ 70° F
Hydrotest rating	2,225 psi @ 70° F
PWHT performed	No
Impact Tested	No
Circumferential joint radiography	Full UW-11(a) Type 1
Bore diameter, B (specified by purchaser)	1.687"
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -55° F (Coincident ratio = 0.5824) Bolts rated MDMT per Fig UCS-66 note (c) = -55° F	

Results Summary	
Governing condition	UG-16
Minimum thickness per UG-16	0.0625" + 0.125" = 0.1875"
Design thickness due to internal pressure (t)	<a href="#">0.1836"</a>
Maximum allowable working pressure (MAWP)	<a href="#">2,693.57 psi</a>
Maximum allowable pressure (MAP)	<a href="#">4,823.45 psi</a>
Rated MDMT	-155 ° F

UCS-66 Material Toughness Requirements	
$t_r = 861.94 \times 1.1875 / (17,100 \times 1 + 0.4 \times 861.94) =$	0.0587"
Stress ratio $= t_r \times E^* / (t_n - c) = 0.0587 \times 1 / (0.301 - 0.125) =$	0.3334
Stress ratio 0.35, MDMT per UCS-66(b)(3) =	-155° F
Material is exempt from impact testing at the Design MDMT of -20° F.	

#### Design thickness, (at 200 ° F) Appendix 1-1

$$\begin{aligned}
 t &= P \times R_o / (S \times E + 0.40 \times P) + \text{Corrosion} \\
 &= 860.55 \times 1.1875 / (17,100 \times 1.00 + 0.40 \times 860.55) + 0.125 \\
 &= \text{0.1836"}
 \end{aligned}$$

**Maximum allowable working pressure, (at 200 ° F) Appendix 1-1**

$$\begin{aligned} P &= S \cdot E \cdot t / (R_o - 0.40 \cdot t) - P_s \\ &= 17,100 \cdot 1.00 \cdot (0.344 \cdot 0.875 - 0.125) / (1.1875 - 0.40 \cdot (0.344 \cdot 0.875 - 0.125)) - 0.55 \\ &= \underline{2.693.57} \text{ psi} \end{aligned}$$

**Maximum allowable pressure, (at 70 ° F) Appendix 1-1**

$$\begin{aligned} P &= S \cdot E \cdot t / (R_o - 0.40 \cdot t) \\ &= 17,100 \cdot 1.00 \cdot (0.344 \cdot 0.875) / (1.1875 - 0.40 \cdot (0.344 \cdot 0.875)) \\ &= \underline{4.823.45} \text{ psi} \end{aligned}$$

**Sump-Head (Sch 60)**

ASME B16.5-2013 Flange	
<b>Description</b>	NPS 12 Class 600 WN A105 N
<b>Attached to</b>	Right end of Sump
<b>Bolt Material</b>	SA-193 B7 Bolt $\leq 2 \frac{1}{2}$ (II-D p. 344, ln. 31)
<b>Blind included</b>	Yes
<b>Rated MDMT</b>	-55° F
<b>Liquid static head</b>	0.21 psi
<b>MAWP rating</b>	1,360 psi @ 200° F
<b>MAP rating</b>	1,480 psi @ 70° F
<b>Hydrotest rating</b>	2,225 psi @ 70° F
<b>PWHT performed</b>	No
<b>Impact Tested</b>	No
<b>Circumferential joint radiography</b>	Full UW-11(a) Type 1
<b>Bore diameter, B (specified by purchaser)</b>	11.626"
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -55° F (Coincident ratio = 0.5822) Bolts rated MDMT per Fig UCS-66 note (c) = -55° F	

**ASME B16.5/16.47 Blind on Sump-Head (Sch 60)**

ASME B16.5-2013 Blind	
<b>Description</b>	NPS 12 Class 600 Blind A105 N
<b>Attached to</b>	Sump-Head (Sch 60)
<b>Bolt Material</b>	SA-193 B7 Bolt $\leq 2 \frac{1}{2}$ (II-D p. 344, ln. 31)
<b>Rated MDMT</b>	-55° F
<b>Liquid static head</b>	0.21 psi
<b>MAWP rating</b>	1,360 psi @ 200° F
<b>MAP rating</b>	1,480 psi @ 70° F
<b>Hydrotest rating</b>	2,225 psi @ 70° F
<b>Impact Tested</b>	No
Notes	
Blind rated MDMT per UCS-66(b)(1)(b) = -55° F (Coincident ratio = 0.5822) Bolts rated MDMT per Fig UCS-66 note (c) = -55° F	

## **15.0 QC DATA PACKAGE**



# 11048-01

WILLIAMS  
TRANSCONTINENTAL

HORIZONTAL CENTRIFUGAL SEPARATOR

PO #: 3100038034

Quote #: Q17-8579 R3

PROJECT MANAGER

Kamyar Najmi

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 Page 1 of 2

1. Manufactured and certified by **GasTech Engineering LLC, 2110 Industrial Rd., Sapulpa, Oklahoma, 74066**

(Name and address of Manufacturer)

Manufactured for **Williams Transco Station 200, 60 Bacton Hill Road, Frazer, Pennsylvania, 19355-1026**

(Name and address of Purchaser)

3. Location of Installation **NOT KNOWN**

(Name and address)

4. Type **Horizontal** **11048-01** **N/A** **11048-300 Rev. 1** **3379** **2018**  
(Horizontal or vertical, tank) (Manufacturer's serial number) (CRN) (Drawing number) (National Board number) (Year built)

5. ASME Code, Section VIII, Division 1 **2017/ N/A** **2695** **N/A**  
(Edition and Addenda, if applicable (date)) (Code Case numbers) (Special service per UG-120(d))

6. Shell: **SA-516 70 N** **1.750"** **0.125"** **6' 0.0" (ID)** **10' 0.0"**  
(Material spec. number, grade) (Nominal thickness) (Corr. allow.) (Inner diameter) (Length (overall))

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	
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

7. Seams: **Type 1** **Full** **100%** **1150°F** **1 (hr) 45 (min)** **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 <b>SA-516 70 N</b> (Spec. no., grade)												(b) Material <b>SA-516 70 N</b> (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)		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) End		1.625"	0.125"	N/A	N/A	2:1	N/A	N/A	N/A	Concave		(b) End		1.625"	0.125"	N/A	N/A	2:1	N/A	N/A	N/A	Concave	

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
	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A

MAWP **860 psi** **N/A** at max. temp. **200 °F** **N/A**  
(Internal) (External) (Internal) (External)  
Min. design metal temp. **-20 °F** at **860 psi** Hydro, pneu., or comb. test pressure **HYDRO at 1315 psi**

Proof test **N/A**

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	36"	Cl. 600 RFWN	SA-350 LF2 C11 N	SA-350 LF2 C11 N	3"	0.125"	Integral	UW-16.1 (c)	Type 1	Head
Outlet (N2)	1	36"	Cl. 600 RFWN	SA-350 LF2 C11 N	SA-350 LF2 C11 N	3"	0.125"	Integral	UW-16.1 (c)	Type 1	N/A
PSV (N3)	1	2"	Cl. 600 RFLWN	SA-105N	SA-105N	0.655"	0.125"	Integral	UW-16.1 (c)	N/A	N/A
Vent (N4)	1	2"	Cl. 600 RFLWN	SA-105N	SA-105N	0.655"	0.125"	Integral	UW-16.1 (c)	N/A	N/A
Handhole (N5A/B)	2	8"	Cl. 600 RFLWN	SA-105N	SA-105N	1.375"	0.125"	Integral	UW-16.1 (c)	N/A	N/A
Downcomer (N6A/B)	2	6"	Pipe	SA-106C	N/A	0.864"	0.125"	Integral	UW-16.1 (c)	N/A	N/A
Downcomer (N7A/B)	2	6"	Pipe	SA-106C	N/A	0.864"	0.125"	Integral	UW-16.1 (c)	N/A	N/A
Bridle (N8)	1	2"	Cl. 600 RFWN	SA-106B	SA-105N	0.344"	0.125"	Integral	UW-16.1 (a)	Type 1	N/A
Bridle (N9)	1	2"	Cl. 600 RFWN	SA-106B	SA-105N	0.344"	0.125"	Integral	UW-16.1 (c)	Type 1	N/A
Drain (N10)	1	2"	Cl. 600 RFWN	SA-106B	SA-105N	0.344"	0.125"	Integral	UW-16.1 (c)	Type 1	N/A

Additional Nozzles - See Attached U-4...

11. Supports: Skirt **No** Lugs **2** Legs **0** Other **Saddles** Attached **Saddles- Shell/Welded, Lifting Lugs- Shell/Welded**  
(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:

**Shell, 6, Greens Bayou Pipe Mill, 7438-1.**

(Name of part, item number, Manufacturer's name and identifying stamp)

**Safety relief device to be installed by others.**  
**Charpy Impact Test: UG-84 to -20°F.**

Manufactured by **GasTech Engineering LLC, 2110 Industrial Rd., Sapulpa, Oklahoma, 74066**Manufacturer's Serial No. **11048-01**CRN **N/A**National Board No. **3379****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 **258** expires **December 31, 2018**

Date **10/08/2018**

Co. name

**GasTech Engineering LLC**  
(Manufacturer)

Signed

  
(Representative)**CERTIFICATE OF SHOP/FIELD INSPECTION**Vessel constructed by **GasTech Engineering LLC** at **2110 Industrial Rd., Sapulpa, Oklahoma, 74066**

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 Hartford, CT

have inspected the component described in this Manufacturer's Data Report on September 21, 2018, 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 **10/08/2018**

Signed

  
(Authorized Inspector)

Commissions

**11448, OK713**

(National Board Authorized Inspector Commission number)



676280

## FORM U-4 MANUFACTURER'S DATA REPORT SUPPLEMENTARY SHEET

Purchase Order No.

As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

V-1414

Item No.

1. Manufactured and certified by GasTech Engineering LLC, 2110 Industrial Rd., Sapulpa, Oklahoma, 74066  
(Name and address of Manufacturer)

2. Manufactured for Williams Transco Station 200, 60 Bacton Hill Road, Frazer, Pennsylvania, 19355-1026  
(Name and address of Purchaser)

3. Location of installation NOT KNOWN

(Name and address)

4. Type Horizontal N/A 11048-01  
(Horizontal, vertical, or sphere) (Tank, separator, heat exch., etc.) (Manufacturer's serial number)

N/A  
(CRN)

11048-300 Rev. 1  
(Drawing number)

3379  
(National Board number)

2018  
(Year built)

Data Report

Item Number

Remarks

## Additional 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	
Drain (N11A/B)	2	2"	Cl. 600 RFWN	SA-106B	SA-105N	0.344"	0.125"	Integral	UW-16.1 (c)	Type 1	N/A
Cleanout (N12A/B)	2	12"	Cl. 600 RFWN	SA-106B	SA-105N	0.562"	0.125"	Integral	UW-16.1 (c)	Type 1	N/A
Spare (C1A/B)	2	1"	Cl. 6000 CPLG	SA-105	N/A	0.4675"	0.125"	Integral	N/A	N/A	N/A

Certificate of Authorization: Type "U"No. 258Expires December 31, 2018Date 10/08/2018

Name

GasTech Engineering LLC  
(Manufacturer)

Signed

*Carl Danner*  
(Representative)

Date 10/08/2018

Name

*Ronald J. Hunter*  
(Authorized Inspector)

Commissions

11448, OK713

(National Board Authorized Inspector Commission number)



U  
W  
HT  
RT-1

3379

CERTIFIED BY

**GT Gastech<sup>®</sup>**  
Engineering LLC  
PROCESS PLANTS AND EQUIPMENT

860

MAWP

PSIG @

200

°F

DESIGN

V-1414

TAG NO.

-20

MDMT

°F @

860

MAWP

PSIG

11048-01

SERIAL NO.

2018

YEAR BUILT

HORIZONTAL CENTRIFUGAL

SEPARATOR

P.O. 676280

09.13.2018

SAPULPA, OK USA

RT-1

NB 3520

CERTIFIED BY

**GT Gastech**  
Engineering LLC  
PROCESS PLANTS AND EQUIPMENT

800 MAWP PSIG @ 200 °F DESIGN

V-1414 TAG NO. -20 °F @ 800 PSIG MDMT MAWP

11048-01 SERIAL NO. 2013 YEAR BUILT

HORIZONTAL CENTRIFUGAL  
SEPARATOR  
PO. 676280

SAPULPA, OK USA

# GasTech Engineering LLC

## Inspection & Testing Plan (ITP)

2110 Industrial Road Sapulpa, OK 74066

(918) 663-8383

**Customer:** WILLIAMS / TRANSCONTINENTAL **PO #** 676280 **Tag #** \_\_\_\_\_ **GasTech Serial #** 11048-01  
**GasTech Job #** 11048-01 **Drawing #** 11048-300 **National Board #** \_\_\_\_\_  
**Description:** HORIZONTAL CENTRIFUGAL SEPARATOR **Shell Thk:** 1.75 In **Site:** \_\_\_\_\_  
**RT-** 1 **PWHT:** 1.75 hr(s) **Design:** 1315 **Hydro Test:** 4 **hr(s)** **Impacts:** Yes **Design MDMT:** -20  
**P.O. Delivery:** 5/15/2018 **PM:** Kamyar N. **Code Case(s):** 2695 **QM:** Jake Floyd **Office:** (918) 663-8383

(R)-Review, (N)-Notification, (H)-Hold, (W)-Witness, (I)- Inspection	Reference Document	Verifying Document	GasTech Eng.	Third Party	Authorized
AI Review <u>[Signature]</u> Date: <u>5-29-18</u>	Document Acceptance Standard	* (OEM Manual)	Q.C. Initial/Date	Inspector Initial/Date	Inspector Initial/Date
Design code calculations (ASME VIII, Div. 1)	ASME VIII, Div. 1	*Code Calculations	R/H <u>W 5-22-18</u>	H	H <u>[Signature]</u> <u>5-29-18</u>
Vessel construction and auxiliary piping drawings	ASME VIII, Div. 1	Drawings	R/H <u>W 5-22-18</u>	H	H <u>[Signature]</u>
Welding procedures (ASME IX- WPS's and PQR's)	ASME IX	WPS & PQR(s)	R/H <u>W 5-22-18</u>	R	H <u>[Signature]</u>
Welder qualifications (WPQ's / Welder Continuity Log)	ASME IX	WPQ's	R/H <u>W 5-22-18</u>	R	H <u>[Signature]</u> <u>9/21/18</u>
Pre-Inspection Meeting: Schedule, NDE procedures, etc.	Cust. Specification	NDE Procedures	R/H	R	
Roundness verification of vessels, heads, and headers	ASME VIII, Div. 1	*As-Built Drawing	I/H <u>LD 9-19-18</u>		R/N <u>[Signature]</u> <u>9/19/18</u>
Material Test Reports, Certificates of Conformance	ASME II	*Material MTR's	R <u>CD 9-14-18</u>	R	R/N <u>[Signature]</u> <u>9/21/18</u>
Fit up of shell course round seams (except closing seams)	ASME VIII, Div. 1	*Heat No. Map	I/H <u>RL 8-3-18</u>		
Shell round seam welding and radiography.	ASME V	*RT Report	I/R <u>8-9-18</u>	R	R/N <u>[Signature]</u> <u>9/21/18</u>
Lay out shell and header connection locations	ASME VIII, Div. 1	*ITP	I/H <u>RL 8-10-18</u>		



(R)-Review, (N)-Notification, (H)-Hold, (W)-Witness, (I)- Inspection	Reference Document Acceptance Standard	Verifying Document * (OEM Manual)	GasTech Eng. Q.C. Initial/Date	Third Party Inspector Initial/Date	Authorized Inspector Initial/Date
Nozzle Fit Up for welding	ASME VIII, Div. 1	*NDE Reports	I/R <i>RL</i> <i>9-10-18</i>		
Verification of Seal Welding	In Accordance w/Williams ITP	*NDE Reports	I/R <i>CD</i> <i>9-19-18</i>	H	
Welding of connections and ultrasonic testing of welds	ASME V	*UT Report	I/R <i>CD</i> <i>9-19-18</i>	H	H <i>CD</i> <i>9/21/18</i>
Fit supports, lugs & attachments. MT blend areas & lugs	ASME V	*MT Report	I/H <i>CD</i> <i>9-19-18</i>		
Internals - Vessel welding and other NDE of internals	ASME V	*NDE Reports	I/R/H <i>CD</i> <i>9-19-18</i>	H <i>CD</i>	H <i>CD</i> <i>9/19/18</i>
Final internal inspection prior to closing vessel - Photo	ASME V	*RT Report	I/H <i>CD</i> <i>9-19-18</i>	H <i>CD</i>	
Fit up end plates, closures, flanges, heads to vessel ends	ASME VIII, Div. 1	*Heat No. Map	I/H <i>CD</i> <i>9-19-18</i>	H <i>CD</i>	H <i>CD</i> <i>9/19/18</i>
Trial fitting – Ladders, platforms, intake manifold, etc.	ASME VIII, Div. 1	*As-Built Drawing	I/H		
Final exterior inspection of vessel welding - other NDE	ASME V	*NDE Reports	I/R <i>CD</i> <i>9-21-18</i>		H <i>CD</i> <i>9/21/18</i>
As-built inspection of dimensions.	G.A. Drawing	*As-Built Drawing	I/H/R	H	
Post Weld Heat Treat. Verify chart.	ASME VIII, Div. 1	* PWHT Chart	R <i>CD</i> <i>9-21-18</i>	R	R <i>CD</i> <i>9/21/18</i>
Pressure vessels hydrostatic test. Verify chart - Photo	Hydro Procedure, GTE-QUA-205-P	* Hydro Report & Chart	I/H/R <i>CD</i> <i>9-21-18</i>	H <i>CD</i>	H <i>CD</i> <i>9/21/18</i>
Manufacturer's Data Report for Pressure Vessels (U-1A)	ASME VIII, Div. 1	*Data Report	R/H <i>CD</i> <i>10-8-18</i>		H <i>CD</i> <i>10/8/18</i>
Code stamping – Nameplate attached to vessel	ASME VIII, Div. 1	*Photo	I/H <i>CD</i> <i>9-21-18</i>	I	H <i>CD</i> <i>9/21/18</i>
Surface preparation and blasting	Paint Matrix Dwg	*Paint Report	R <i>RL</i> <i>10-3-18</i>	R <i>CD</i>	
Fit & weld auxiliary piping and radiographic testing	RT Procedure, GXS I-B-RT-ASME	*RT Report	I/R/H <i>CD</i> <i>9-19-18</i>	H <i>CD</i>	

(R)-Review, (N)-Notification, (H)-Hold, (W)-Witness, (I)- Inspection	Reference Document Acceptance Standard	Verifying Document * (OEM Manual)	GasTech Eng. Q.C. Initial/Date	Third Party Inspector Initial/Date	Authorized Inspector Initial/Date
Hydro/Pneumatic test auxiliary piping (each pressure)- Chart/Photo	ASME B31.3	*Hydro Report	I/H/R CB 10-3-18	H CB	
Surface preparation of piping and supports - Blast profile	Paint Matrix Dwg	*Paint Report	R RL 10-3-18	H CB	
Air Soap Bubble Test of Reinforcing Pads	ASME VIII, Div. 1	*NDE Reports	H N/A		
Fastener Torque Verification	Construction Drawing	*Torque Record	W/H 10-9-18		
Assembly of piping and instrumentation, verify to P&ID	ASME B31.3	*Final Check-list	I/H RL 10-9-18	CB	
Factory Acceptance Test - Valves	Cust. Specification	*Final Check-list	W/H		
Inspection of galvanizing and coating system(s)	Paint Matrix Dwg	*Paint Report	I/H RL 10-3-18	H CB	
Final inspection of unit(s) before loading. Release to load	BOM Dwg, ASME	Packing List	I/H 10/10-18	I CB	
Witness loading & protection. Documents. OEM Manual. (Must ship w/vessel)	Cust. Specification	*QC Data Package	W/H 10-10-18	H	

10/10/18 3" Ball 1/2" Jamesbury Ball valves - Reorder + SHIP (short) to JOB site. TJS PER JAKE + KAMYAR

10/10/18 PSV - To SHIP ship to JOB site. TJS PER JAKE + KAMYAR



# GLOBE X-RAY SERVICES, INC.

8441 SOUTH UNION • TULSA, OKLAHOMA 74132 • (918) 446-1696

N.R.C. #35-15194-01  
TEXAS #5-1892  
FAA # CS2R753K

## RADIOGRAPHIC TECHNIQUE SHEET

PAGE \_\_\_\_\_ OF \_\_\_\_\_

MFG/CUST. <b>Gastech</b>		JOB#/ID <b>11048-01 Vessel</b>		RT DATE <b>9-11-18</b>	
MAT'L TYPE <b>C-S.</b>	MAT'L THK. <b>1.75"</b>	WELD REINF. <b>.125"</b>	TOTAL THK. <b>1.875"</b>	RT TECHNIQUE <b>GXS-1B-01</b>	
ISOTOPE/ X-RAY VOLTAGE <b>Co60</b>	CI./MA. <b>44</b>	FOCAL SIZE <b>.129"</b>	SOD <b>36"</b>	OFD <b>1.875"</b>	EXPOSURE TIME <b>9:15</b>
EXPOSURE		VIEWING		FILM PROCESS	
SINGLE WALL <input checked="" type="checkbox"/> DBL. WALL <input type="checkbox"/>		SINGLE WALL <input checked="" type="checkbox"/> DBL. WALL <input type="checkbox"/>		MAN <input checked="" type="checkbox"/> AUTO <input type="checkbox"/>	
FILM MFG/TYPE <b>AGFAD 7</b>	NO. EXPOSURES <b>1</b>	RT QUALITY <b>2T</b>	APPLICABLE CODE SPEC. <b>ASME II</b>	ACCEPTANCE STD. <b>ASME VIII</b>	
RT TRCH. LEVEL II <b>M.Williams J. Baysinger</b>			RT PROCEDURE <b>GXS-1B</b>		

PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	W E L D E R	# F O I L D M E /R	S S H I Z M E	I Q I & S I D E	D E N S I T Y	A C C E P T	R E J E C T	S L A G	P O R	C R A C K	I P	L F	U C	A R T I F A C T	COMMENTS
<b>AS-1</b>	<b>1-2</b>	<b>S</b>	<b>1</b>	<b>1/4</b>	<b>IBF</b>	<b>2-4</b>	<b>/</b>			<b>.142</b>						
	<b>2-3</b>						<b>/</b>									
	<b>3-4</b>						<b>/</b>									
	<b>4-5</b>															<b>Retake clean</b>
	<b>5-6</b>															<b>Retake clean</b>
	<b>6-7</b>						<b>/</b>									
	<b>7-8</b>						<b>/</b>									
	<b>8-9</b>						<b>/</b>									
	<b>9-10</b>						<b>/</b>									
	<b>10-11</b>							<b>/</b>	<b>3"</b>				<b>.25</b>			
	<b>11-12</b>															<b>retake clean</b>
	<b>12-13</b>						<b>/</b>									
	<b>13-14</b>						<b>/</b>									
	<b>14-15</b>						<b>/</b>									
	<b>15-16</b>						<b>/</b>									
	<b>16-17</b>															<b>re shoot</b>
	<b>17-18</b>						<b>/</b>									
	<b>18-1</b>						<b>/</b>									

FILM INTERPRETATION BY:

*[Signature]* RT Level II

DATE:

**9-12-18**

A.I./CUST.

*[Signature]* Bryan Level II

DATE:

**9-13-18**

GSX ASSUMES NO RESPONSIBILITY FOR LOSSES OF ANY KIND DUE TO INTERPRETATION



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8441 SOUTH UNION • TULSA, OKLAHOMA 74132 • (918) 446-1696

N.R.C. #35-15194-01  
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## RADIOGRAPHIC TECHNIQUE SHEET

PAGE \_\_\_\_\_ OF \_\_\_\_\_

MFG/CUST. <i>Gastech</i>		JOB#ID <i>11048-01 Vessel</i>		RT DATE <i>9-11-18</i>												
MAT'L TYPE <i>C.S.</i>	MAT'L THK. <i>1.75"</i>	WELD REINF. <i>.125"</i>	TOTAL THK. <i>1.875"</i>	RT TECHNIQUE <i>GXS-1B-0</i>												
ISOTOPE/ X-RAY VOLTAGE <i>Co60</i>	CI./MA. <i>44</i>	FOCAL SIZE <i>.129"</i>	SOD <i>36"</i>	OFD <i>1.875"</i>	EXPOSURE TIME <i>9:15</i>											
EXPOSURE SINGLE WALL <input checked="" type="checkbox"/> DBL. WALL <input type="checkbox"/>		VIEWING SINGLE WALL <input checked="" type="checkbox"/> DBL. WALL <input type="checkbox"/>		FILM PROCESS MAN <input checked="" type="checkbox"/> AUTO <input type="checkbox"/>												
FILM MFG/TYPE <i>AGFAD 7</i>	NO. EXPOSURES <i>1</i>	RT QUALITY <i>2T</i>	APPLICABLE CODE SPEC. <i>ASME II</i>	ACCEPTANCE STD. <i>ASME II</i>												
RT TRCH. LEVEL II <i>M.W. Williams</i>		RT PROCEDURE <i>J. Bausinger</i>		<i>GXS-1B</i>												
PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	W E L D E R	# H I L D M E /R	S S I Z E	I Q I & S I D E	D E N S I T Y	A C C E P T	R E J E C T	S L A G	P O R	C R A C K	I P	L F	U C	A R T I F I C I A L	COMMENTS
<i>RS-2</i>	<i>1-2</i>	<i>L</i>	<i>1</i>	<i>1/4</i>	<i>BF 2-4</i>	<i>1</i>	<i>/</i>									
	<i>2-3</i>					<i>/</i>										
	<i>3-4</i>					<i>/</i>										
	<i>4-5</i>					<i>/</i>										
	<i>5-6</i>					<i>/</i>										
	<i>6-7</i>					<i>/</i>										
	<i>7-8</i>					<i>/</i>										
	<i>8-9</i>															<i>reshoot clear</i>
	<i>9-10</i>															<i>reshoot clear</i>
	<i>10-11</i>					<i>/</i>										
	<i>11-12</i>					<i>/</i>										
	<i>12-13</i>					<i>/</i>										
	<i>13-14</i>					<i>/</i>										
	<i>14-15</i>															<i>reshoot</i>
	<i>15-16</i>					<i>/</i>										
	<i>16-17</i>					<i>/</i>									<i>/</i>	
	<i>17-18</i>					<i>/</i>										
	<i>18-1</i>					<i>/</i>										
FILM INTERPRETATION BY: <i>RT level II</i>															DATE: <i>9-12-18</i>	
A.I./CUST. <i>Greg Bateman</i>															DATE: <i>9-13-18</i>	

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## RADIOGRAPHIC TECHNIQUE SHEET

PAGE \_\_\_\_\_ OF \_\_\_\_\_

MFG/CUST. <i>Gastech</i>		JOB#ID <i>11048-01 Vessel</i>		RT DATE <i>9-12-18</i>													
MAT'L TYPE <i>C.S.</i>	MAT'L THK. <i>1.75"</i>	WELD REINF. <i>.125"</i>	TOTAL THK. <i>1.875"</i>	RT TECHNIQUE <i>GXS-1B-01</i>													
ISOTOPE/ X-RAY VOLTAGE <i>Ir192</i>	CI./MA. <i>75</i>	FOCAL SIZE <i>.132"</i>	SOD <i>36"</i>	OFD <i>1.875"</i>	EXPOSURE TIME <i>40:00</i>												
EXPOSURE SINGLE WALL <input checked="" type="checkbox"/> DBL. WALL <input type="checkbox"/>		VIEWING SINGLE WALL <input checked="" type="checkbox"/> DBL. WALL <input type="checkbox"/>		FILM PROCESS MAN <input checked="" type="checkbox"/> AUTO <input type="checkbox"/>													
FILM MFG/TYPE <i>AGFAD 7</i>	NO. EXPOSURES <i>2</i>	RT QUALITY <i>2T</i>	APPLICABLE CODE SPEC. <i>ASME II</i>	ACCEPTANCE STD. <i>ASME III</i>													
RT TRCH. LEVEL II <i>M. Williams J. Baysinger</i>			RT PROCEDURE <i>GXS-1B</i>														
PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	W E L D E R	#H F O I L D M E /R	SS H I Z M E	IQI & S I D E	D E N S I T Y	A C C E P T	R E J E C T	S L A G	P O R	C R A C K	I P	L F	U C	A R T I F I C I A L	COMMENTS	
<i>RS-1</i>	<i>4-5</i>	<i>S</i>	<i>1</i>	<i>1/4</i>	<i>18F</i>	<i>2-4</i>	<i>/</i>										
	<i>5-6</i>						<i>/</i>										
	<i>10-11</i>						<i>/</i>										
	<i>11-12</i>																
	<i>16-17</i>						<i>/</i>										
<i>RS-2</i>	<i>8-9</i>	<i>L</i>					<i>/</i>										
	<i>9-10</i>		<i>/</i>														
	<i>14-15</i>		<i>/</i>														
FILM INTERPRETATION BY: <i>[Signature]</i> RT Level II																	DATE: <i>9-13-18</i>
A.I./CUST. <i>[Signature]</i> <i>Booth II</i> <i>9/21/18</i>																	DATE: <i>9-13-18</i>

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N.R.C. #35-15194-01  
TEXAS #5-1892  
FAA # CS2R753K

## RADIOGRAPHIC TECHNIQUE SHEET

PAGE \_\_\_\_\_ OF \_\_\_\_\_

MFG/CUST. <b>Gastech</b>		JOB#/ID <b>11048-01 Vessel</b>		RT DATE <b>9-13-18</b>													
MAT'L TYPE <b>C.S.</b>	MAT'L THK. <b>1.75"</b>	WELD REINF. <b>.125"</b>	TOTAL THK. <b>1.875"</b>	RT TECHNIQUE <b>GXS-1B-01</b>													
ISOTOPE/ X-RAY VOLTAGE <b>Ir-192</b>	CI./MA. <b>75</b>	FOCAL SIZE <b>.122"</b>	SOD <b>36"</b>	OFD <b>1.875"</b>	EXPOSURE TIME <b>41:00</b>												
EXPOSURE SINGLE WALL <input checked="" type="checkbox"/> DBL. WALL <input type="checkbox"/>		VIEWING SINGLE WALL <input checked="" type="checkbox"/> DBL. WALL <input type="checkbox"/>		FILM PROCESS MAN <input checked="" type="checkbox"/> AUTO <input type="checkbox"/>													
FILM MFG/TYPE <b>AGFAD 7</b>	NO. EXPOSURES <b>1</b>	RT QUALITY <b>2T</b>	APPLICABLE CODE SPEC. <b>ASME</b>	ACCEPTANCE STD. <b>ASME VIII</b>													
RT TRCH. LEVEL II <b>M. Williams J. Baysinger</b>		RT PROCEDURE <b>GXS-1B</b>															
PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	W E L D E R	#H F I L D M E /R	SS H I Z E M E	I Q I & S I D E	D E N S I T Y	A C C E P T	R E J E C T	S L A G	P O R	C R A C K	I P	L F	U C	A R T I F I C I A L	COMMENTS	
<b>RS-1</b>	<b>11-12</b>	<b>5</b>	<b>1</b>	<b>NA</b>	<b>BF 2-4</b>	<b>1</b>											
FILM INTERPRETATION BY: <b>[Signature]</b> <b>RT Level II</b>																	DATE: <b>9-14-18</b>
A.I./CUST. <b>[Signature]</b> <b>9/21/18</b>																	DATE: <b>9-19-18</b>

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N.R.C. #35-15194-01  
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FAA # CS2R753K

## RADIOGRAPHIC TECHNIQUE SHEET

PAGE \_\_\_\_\_ OF \_\_\_\_\_

MFG/CUST. <b>CASTech</b>		JOB#/ID <b>11048-01 Sump Pipe</b>		RT DATE <b>6-12-18</b>													
MAT'L TYPE <b>C/S</b>	MAT'L THK. <b>1688</b>	WELD REINF. <b>.125</b>	TOTAL THK. <b>.1813</b>	RT TECHNIQUE <b>GXS 1-B-03</b>													
ISOTOPE/ X-RAY VOLTAGE <b>IR192</b>	CI./MA. <b>62</b>	FOCAL SIZE <b>.141</b>	SOD <b>1234</b>	OFD <b>198</b>	EXPOSURE TIME <b>2:30</b>												
EXPOSURE SINGLE WALL <input type="checkbox"/> DBL. WALL <input checked="" type="checkbox"/>		VIEWING SINGLE WALL <input checked="" type="checkbox"/> DBL. WALL <input type="checkbox"/>		FILM PROCESS MAN. <input checked="" type="checkbox"/> AUTO <input type="checkbox"/>													
FILM MFG/TYPE <b>AGFA D5</b>	NO. EXPOSURES	RT QUALITY <b>2T</b>	APPLICABLE CODE SPEC. <b>ASME Sec II</b>		ACCEPTANCE STD. <b>ASME Sec VIII</b>												
RT TRCH. LEVEL II <b>R. Arnold LVII</b>		RT PROCEDURE <b>GXS 1-B</b>															
PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	W E L D E R	#H F O I L D M E /R	SS H I Z M E	I Q I & S I D E	D E N S I T Y	A C C E P T	R E J E C T	S L A G	P O R	C R A C K	I P	L F	U C	A R T I F I C I A L	COMMENTS	
<b>W-RS-3</b>	<b>T. 2</b>	<b>U</b>	<b>1</b>	<b>NA/BF</b>	<b>2.4</b>	<b>/</b>											
	<b>2.3</b>					<b>/</b>											
	<b>3.4</b>								<b>2"</b>								
<b>W-RS-4</b>	<b>T. 2</b>					<b>/</b>											
	<b>2.3</b>					<b>/</b>											
	<b>3.T</b>					<b>/</b>											
FILM INTERPRETATION BY:																	DATE: <b>6-13-18</b>
A.I./CUST.																	DATE: <b>9/21/18</b>

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NRC #35-15194-01  
TEXAS #5-1892  
FAA # CS2R703K

## RADIOGRAPHIC TECHNIQUE SHEET

PAGE \_\_\_\_\_ OF \_\_\_\_\_

MFG/CUST. <i>Gastech</i>		JOB#ID <i>11048-01 Nozzle</i>		RT DATE <i>6-7-18</i>												
MAT'L TYPE <i>C.S.</i>	MAT'L THK. <i>1.3"</i>	WELD REINF. <i>.125"</i>	TOTAL THK. <i>1.5"</i>	RT TECHNIQUE <i>GXS-1B-01</i>												
ISOTOPE/ X-RAY VOLTAGE <i>Ir192</i>	CI/MA. <i>45</i>	FOCAL SIZE <i>.134"</i>	SOD <i>16.5"</i>	OFD <i>1.5"</i>	EXPOSURE TIME <i>9:45</i>											
EXPOSURE		VIEWING		FILM PROCESS												
SINGLE WALL <input checked="" type="checkbox"/> DBL. WALL <input type="checkbox"/>		SINGLE WALL <input checked="" type="checkbox"/> DBL. WALL <input type="checkbox"/>		MAN <input checked="" type="checkbox"/> AUTO <input type="checkbox"/>												
FILM MFG/TYPE <i>AGFAD 7</i>	NO. EXPOSURES <i>2</i>	RT QUALITY <i>2T</i>	APPLICABLE CODE SPEC. <i>ASME II</i>		ACCEPTANCE STD. <i>ASME VIII</i>											
RT TRCH. LEVEL II <i>M. Williams</i>			RT PROCEDURE <i>GXS-1B</i>													
PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	W E L D E R	#H F O I L D M E /R	SS H I Z M E	IQI & S I D E	D E N S I T Y	A C C E P T	R E J E C T	S L A G	P O R	C R A C K	I P	L F	U C	A R T I F I C I A L F I L M F A C T	COMMENTS
<i>RS-5</i>	<i>1-2</i>	<i>11</i>	<i>1</i>	<i>N/A</i>	<i>1BF</i>	<i>2-4</i>	<i>/</i>									
	<i>2-3</i>						<i>/</i>									
	<i>3-4</i>						<i>/</i>									
	<i>4-5</i>						<i>/</i>									
	<i>5-6</i>						<i>/</i>									
	<i>6-7</i>						<i>/</i>									
	<i>7-8</i>						<i>/</i>									
	<i>8-9</i>						<i>/</i>									
<i>RS-6</i>	<i>9-10</i>						<i>/</i>									
	<i>1-2</i>						<i>/</i>									
	<i>2-3</i>						<i>/</i>									
	<i>3-4</i>						<i>/</i>									
	<i>4-5</i>						<i>/</i>		<i>/</i>							
	<i>5-6</i>						<i>/</i>									
	<i>6-7</i>						<i>/</i>									
	<i>7-8</i>						<i>/</i>									
FILM INTERPRETATION BY: <i>Carl Durr RT Level II</i>																DATE: <i>6-8-18</i>
A.I./CUST. <i>Curry Bottoms RA Hunter 9/31/18</i>																DATE: <i>6-18-18</i>

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## RADIOGRAPHIC TECHNIQUE SHEET

PAGE \_\_\_\_\_ OF \_\_\_\_\_

MFG/CUST. <u>Gastech</u>		JOB#/ID <u>1104801 Sump Piping</u>		RT DATE <u>5-25-18</u>												
MAT'L TYPE <u>C.S.</u>	MAT'L THK. <u>.344"</u>	WELD REINF. <u>.125"</u>	TOTAL THK. <u>.469"</u>	RT TECHNIQUE <u>GXS-IB-03</u>												
ISOTOPE/ X-RAY VOLTAGE <u>Ir-192</u>	CI./MA. <u>72</u>	FOCAL SIZE <u>.134"</u>	SOD <u>2.5"</u>	OFD <u>.469"</u>	EXPOSURE TIME <u>8sec</u>											
EXPOSURE		VIEWING		FILM PROCESS												
SINGLE WALL <input type="checkbox"/> DBL. WALL <input checked="" type="checkbox"/>		SINGLE WALL <input checked="" type="checkbox"/> DBL. WALL <input type="checkbox"/>		MAN. <input checked="" type="checkbox"/> AUTO <input type="checkbox"/>												
FILM MFG/TYPE <u>AGFA D 3</u>	NO. EXPOSURES <u>16</u>	RT QUALITY <u>2T</u>	APPLICABLE CODE SPEC. <u>ASME II</u>	ACCEPTANCE STD. <u>ASME VIII</u>												
RT TRCH. LEVEL II <u>M. Williams</u>			RT PROCEDURE <u>GXS-IB</u>													
PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	W E L D E R	#H F O L D M E /R	SS H I Z E	IQI & S I D E	D E N S I T Y	A C C E P T	R E J E C T	S L A G	P O R	C R A C K	I P	L F	U C	A R T I F I C I A L	COMMENTS
W-1	1-2	XX	1/8"	15F	2-4	/	/									
	2-3					/	/									
	3-4					/	/									
	4-1					/	/									
W-2	1-2					/	/									
	2-3					/	/									
	3-4					/	/									
	4-1					/	/									
W-3	1-2					/	/									
	2-3					/	/									
	3-4					/	/									
	4-1					/	/									
W-4	1-2					/	/									
	2-3					/	/									
	3-4					/	/									
	4-1					/	/									
FILM INTERPRETATION BY: <u>[Signature]</u> RT Incl. <u>7</u>																DATE: <u>5-29-18</u>
A.I./CUST. <u>Camy Bottoms II</u> <u>9/21/18</u>																DATE: <u>5-29-18</u>

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N.R.C. #35-15194-01  
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FAA # CS2R753K

## RADIOGRAPHIC TECHNIQUE SHEET

PAGE \_\_\_\_\_ OF \_\_\_\_\_

MFG/CUST. <i>Gastech</i>		JOB#ID <i>11048-01 Sump Piping</i>		RT DATE <i>5-25-18</i>													
MAT'L TYPE <i>C.S.</i>	MAT'L THK. <i>.344"</i>	WELD REINF. <i>.125"</i>	TOTAL THK. <i>.469"</i>	RT TECHNIQUE <i>GXS-1B-D3</i>													
ISOTOPE/ X-RAY VOLTAGE <i>Ir-192</i>	CI./MA. <i>72</i>	FOCAL SIZE <i>.134"</i>	SOD <i>2.5"</i>	OFD <i>.469"</i>	EXPOSURE TIME <i>8sec</i>												
EXPOSURE		VIEWING		FILM PROCESS													
SINGLE WALL <input type="checkbox"/> DBL. WALL <input checked="" type="checkbox"/>		SINGLE WALL <input checked="" type="checkbox"/> DBL. WALL <input type="checkbox"/>		MAN <input checked="" type="checkbox"/> AUTO <input type="checkbox"/>													
FILM MFG/TYPE <i>AGFAD 3</i>	NO. EXPOSURES <i>16</i>	RT QUALITY <i>2T</i>	APPLICABLE CODE SPEC. <i>ASME II</i>	ACCEPTANCE STD. <i>ASME III</i>													
RT TRCH. LEVEL II <i>M. Williams</i>			RT PROCEDURE <i>GXS-1B</i>														
PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	W E L D E R	# H F I L D M E /R	S S H I Z M E	I Q I & S I D E	D E N S I T Y	A C C E P T	R E J E C T	S L A G	P O R	C R A C K	I P	L F	U C	A R T I F I C I A L	COMMENTS	
<i>W-5</i>	<i>1-2</i>	<i>XX</i>	<i>1/8"</i>	<i>15F2-4</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	
	<i>2-3</i>				<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	
	<i>3-4</i>				<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	
	<i>4-1</i>				<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	
<i>W-6</i>	<i>1-2</i>				<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	
	<i>2-3</i>				<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	
	<i>3-4</i>				<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	
	<i>4-1</i>				<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	
<i>W-7</i>	<i>1-2</i>				<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	
	<i>2-3</i>				<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	
	<i>3-4</i>				<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	
	<i>4-1</i>				<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	
<i>W-8</i>	<i>1-2</i>				<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	
	<i>2-3</i>				<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	
	<i>3-4</i>				<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	
	<i>4-1</i>				<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	<i>/</i>	
FILM INTERPRETATION BY: <i>[Signature]</i> <i>RT level II</i>																	DATE: <i>5-29-18</i>
A.I./CUST. <i>Guy Bottoms II</i> <i>SAH</i> <i>9/21/18</i>																	DATE: <i>5-29-18</i>

GSX ASSUMES NO RESPONSIBILITY FOR LOSSES OF ANY KIND DUE TO INTERPRETATION



# GLOBE X-RAY SERVICES, INC.

8441 SOUTH UNION • TULSA, OKLAHOMA 74132 • (918) 446-1696

N.R.C. #35-15194-01  
TEXAS #5-1892  
FAA # CS2R753K

## RADIOGRAPHIC TECHNIQUE SHEET

PAGE \_\_\_\_\_ OF \_\_\_\_\_

MFG/CUST. <i>Gastech</i>		JOB#/ID <i>11048-01 Supp Piping</i>		RT DATE <i>5-25-18</i>													
MAT'L TYPE <i>C.S.</i>	MAT'L THK. <i>.344"</i>	WELD REINF. <i>.125"</i>	TOTAL THK. <i>.469"</i>	RT TECHNIQUE <i>GXS-1B.03</i>													
ISOTOPE/ X-RAY VOLTAGE <i>I-192</i>	CI./MA. <i>72</i>	FOCAL SIZE <i>.134"</i>	SOD <i>2.5'</i>	OFD <i>.469"</i>	EXPOSURE TIME <i>8 sec</i>												
EXPOSURE		VIEWING		FILM PROCESS													
SINGLE WALL <input type="checkbox"/> DBL. WALL <input checked="" type="checkbox"/>		SINGLE WALL <input type="checkbox"/> DBL. WALL <input type="checkbox"/>		MAN. <input checked="" type="checkbox"/> AUTO <input type="checkbox"/>													
FILM MFG/TYPE <i>AGFAD 3</i>	NO. EXPOSURES <i>16</i>	RT QUALITY <i>2T</i>	APPLICABLE CODE SPEC. <i>ASME II</i>		ACCEPTANCE STD. <i>ASME III</i>												
RT TRCH. LEVEL II <i>M. Williams</i>			RT PROCEDURE <i>GXS-1B</i>														
PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	W E L D E R	#H F O L D M E /R	SS H I Z M E	IQI & S I D E	D E N S I T Y	A C C E P T	R E J E C T	S L A G	P O R	C R A C K	I P	L F	U C	A R T I F I C I A L	COMMENTS	
<i>W-9</i>	<i>1-2</i>	<i>XX</i>	<i>1</i>	<i>1/8"</i>	<i>15F</i>	<i>2-4</i>	<i>/</i>										
	<i>2-3</i>						<i>/</i>										
	<i>3-4</i>						<i>/</i>										
	<i>4-1</i>						<i>/</i>										
<i>W-10</i>	<i>1-2</i>						<i>/</i>										
	<i>2-3</i>						<i>/</i>										
	<i>3-4</i>						<i>/</i>										
	<i>4-1</i>						<i>/</i>										
<i>W-11</i>	<i>1-2</i>						<i>/</i>										
	<i>2-3</i>						<i>/</i>										
	<i>3-4</i>						<i>/</i>										
	<i>4-1</i>						<i>/</i>										
<i>W-12</i>	<i>1-2</i>						<i>/</i>										
	<i>2-3</i>						<i>/</i>										
	<i>3-4</i>						<i>/</i>										
	<i>4-1</i>						<i>/</i>										
FILM INTERPRETATION BY: <i>[Signature]</i> <i>Richard H</i>																	DATE: <i>5-29-18</i>
A.I./CUST. <i>Greg Bottoms II</i> <i>9/21/18</i>																	DATE: <i>5-29-18</i>

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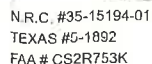
N.R.C. #35-15194-01  
TEXAS #5-1892  
FAA # CS2R753K

## RADIOGRAPHIC TECHNIQUE SHEET

PAGE \_\_\_\_\_ OF \_\_\_\_\_

MFG/CUST. <b>Gastech</b>		JOB#ID <b>11048-01 Brake Piping</b>		RT DATE <b>9-14-18</b>													
MAT'L TYPE <b>C.S.</b>	MAT'L THK. <b>.344"</b>	WELD REINF. <b>.125"</b>	TOTAL THK. <b>.469"</b>	RT TECHNIQUE <b>GXS-1B-03</b>													
ISOTOPE/ X-RAY VOLTAGE <b>Ir-192</b>	CI./MA. <b>108</b>	FOCAL SIZE <b>.124"</b>	SOD <b>2.5"</b>	OFD <b>.469"</b>	EXPOSURE TIME <b>:07</b>												
EXPOSURE SINGLE WALL <input type="checkbox"/> DBL. WALL <input checked="" type="checkbox"/>		VIEWING SINGLE WALL <input checked="" type="checkbox"/> DBL. WALL <input type="checkbox"/>		FILM PROCESS MAN <input checked="" type="checkbox"/> AUTO <input type="checkbox"/>													
FILM MFG/TYPE <b>AGFAD 3</b>	NO. EXPOSURES <b>8</b>	RT QUALITY <b>2T</b>	APPLICABLE CODE SPEC. <b>ASME II</b>	ACCEPTANCE STD. <b>ASME III</b>													
RT TRCH. LEVEL II <b>M. Williams</b>		J. Baysinger		RT PROCEDURE <b>GXS-1B</b>													
PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	W E L D E R	# H F O I L D M E / R	SS H I Z M E	IQI & S I D E	D E N S I T Y	A C C E P T	R E J E C T	S L A G	P O R	C R A C K	I P	L F	U C	A R T I F I C I A L	COMMENTS	
<b>W-13</b>	<b>1-2</b>	<b>XX</b>	<b>1 1/8</b>	<b>15</b>	<b>F2-4</b>	<b>/</b>											
	<b>2-3</b>					<b>/</b>											
	<b>3-4</b>																<b>Resnet</b>
	<b>4-1</b>																<b>Resnet</b>
<b>W-14</b>	<b>1-2</b>					<b>/</b>											
	<b>2-3</b>					<b>/</b>											
	<b>3-4</b>					<b>/</b>											
	<b>4-1</b>					<b>/</b>											
FILM INTERPRETATION BY: <b>RT level H</b>																	DATE: <b>9-15-18</b>
A.I./CUST. <b>Gary Bateman Jr</b>																	DATE: <b>9-19-18</b>

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# RADIOGRAPHIC TECHNIQUE SHEET

PAGE \_\_\_\_\_ OF \_\_\_\_\_

MFG/CUST. <b>hastan</b>		JOB# / ID <b>11048-01 Bridle pipe</b>		RT DATE <b>9-20-18</b>													
MAT'L TYPE <b>CS</b>		MAT'L THK. <b>.344</b>		WELD REINF. <b>.125</b>													
ISOTOPE/ X-RAY VOLTAGE <b>Ir-192</b>		CI./MA. <b>101</b>		FOCAL SIZE <b>.138</b>													
EXPOSURE SINGLE WALL <input type="checkbox"/> DBL. WALL <input checked="" type="checkbox"/>		VIEWING SINGLE WALL <input checked="" type="checkbox"/> DBL. WALL <input type="checkbox"/>		FILM PROCESS MAN. <input checked="" type="checkbox"/> AUTO <input type="checkbox"/>													
FILM MFG/TYPE <b>AGFA D3</b>		NO. EXPOSURES <b>11 Film</b>		RT QUALITY <b>2Y</b>													
APPLICABLE CODE SPEC. <b>ASME sec II</b>		ACCEPTANCE STD. <b>ASME sec VIII</b>		EXPOSURE TIME <b>6.5x-1-03</b>													
RT TRCH. LEVEL II <b>M. Williams J. Baysinger</b>		RT PROCEDURE <b>6.5x-1-13</b>		Pb FRT <b>.010</b> BK. <b>.010</b>													
PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	W E L D E R	#H F O L D M E /R	SS H I Z M E	IQI & S I D E	D E N S I T Y	A C C E P T	R E J E C T	S L A G	P O R	C R A C K	I P	L F	U C	A R T I F I C I A L	COMMENTS	
<b>W13</b>	<b>3-4</b>	<b>XX</b>	<b>1</b>	<b>1276F</b>	<b>2-4</b>	<b>/</b>											
	<b>4-1</b>					<b>/</b>											
FILM INTERPRETATION BY: <b>Carl D... RT level II</b>																	DATE: <b>9-21-18</b>
A.I./CUST. <b>BAH... Gary Batterson</b>																	DATE: <b>9/21/18</b>

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N.R.C. #35-15194-01  
TEXAS #5-1892  
FAA # CS2R753K

## RADIOGRAPHIC TECHNIQUE SHEET

PAGE \_\_\_\_\_ OF \_\_\_\_\_

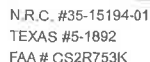
MFG/CUST. <b>Gastech</b>		JOB#ID <b>1104801 Assy Piping</b>		RT DATE <b>9-18-18</b>													
MAT'L TYPE <b>C.S.</b>	MAT'L THK. <b>.344"</b>	WELD REINF. <b>.125"</b>	TOTAL THK. <b>.469"</b>	RT TECHNIQUE <b>GXS-1B-D3</b>													
ISOTOPE/ X-RAY VOLTAGE <b>Ir-192</b>	CI./MA. <b>72</b>	FOCAL SIZE <b>.121"</b>	SOD <b>2.5"</b>	OFD <b>.469"</b>	EXPOSURE TIME <b>78ec</b>												
EXPOSURE SINGLE WALL <input type="checkbox"/> DBL. WALL <input checked="" type="checkbox"/>		VIEWING SINGLE WALL <input checked="" type="checkbox"/> DBL. WALL <input type="checkbox"/>		FILM PROCESS MAN. <input checked="" type="checkbox"/> AUTO <input type="checkbox"/>													
FILM MFG/TYPE <b>AGFAD 3</b>	NO. EXPOSURES <b>4</b>	RT QUALITY <b>RT</b>	APPLICABLE CODE SPEC. <b>ASME II</b>	ACCEPTANCE STD. <b>ASME III</b>													
RT TRCH. LEVEL II <b>M. Williams J. Baysinger</b>			RT PROCEDURE <b>GXS-1B</b>														
PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	W E L D E R	#H F I L D M E /R	SS H I Z M E	IQI & S I D E	D E N S I T Y	A C C E P T	R E J E C T	S L A G	P O R	C R A C K	I P	L F	U C	A R T I F A C T	COMMENTS	
<b>w-15</b>	<b>1-2</b>	<b>JT</b>	<b>1/8"</b>	<b>15P</b>	<b>2-4</b>	<b>/</b>	<b>/</b>	<b>/</b>	<b>/</b>								
	<b>2-3</b>					<b>/</b>	<b>/</b>	<b>/</b>	<b>/</b>								
	<b>3-4</b>					<b>/</b>	<b>/</b>	<b>/</b>	<b>/</b>								
	<b>4-1</b>					<b>/</b>	<b>/</b>	<b>/</b>	<b>/</b>								

FILM INTERPRETATION BY:

DATE:

UST.

DATE:



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RADIOGRAPHIC  
TECHNIQUE SHEET

PAGE \_\_\_\_\_ OF \_\_\_\_\_

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N.R.C. #35-15194-01  
TEXAS #5-1892  
FAA # CS2R753K

## RADIOGRAPHIC TECHNIQUE SHEET

PAGE \_\_\_\_\_ OF \_\_\_\_\_

MFG/CUST. <b>Gastech</b>		JOB#ID <b>11048-01 Assy Piping</b>		RT DATE <b>9-18-18</b>													
MAT'L TYPE <b>C.S.</b>	MAT'L THK. <b>.300"</b>	WELD REINF. <b>.125"</b>	TOTAL THK. <b>.425"</b>	RT TECHNIQUE <b>GXS-1B-03</b>													
ISOTOPE/ X-RAY VOLTAGE <b>Ir-192</b>	CI./MA. <b>72</b>	FOCAL SIZE <b>.121"</b>	SOD <b>3.5"</b>	OFD <b>.425"</b>	EXPOSURE TIME <b>12.60L</b>												
EXPOSURE		VIEWING		FILM PROCESS													
SINGLE WALL <input type="checkbox"/> DBL. WALL <input checked="" type="checkbox"/>		SINGLE WALL <input checked="" type="checkbox"/> DBL. WALL <input type="checkbox"/>		MAN. <input checked="" type="checkbox"/> AUTO <input type="checkbox"/>													
FILM MFG/TYPE <b>AGFAD 3</b>	NO. EXPOSURES <b>6</b>	RT QUALITY <b>RT</b>	APPLICABLE CODE SPEC. <b>ASME II</b>	ACCEPTANCE STD. <b>ASME III</b>													
RT TRCH. LEVEL II <b>M. Williams J. Bausinger</b>			RT PROCEDURE <b>GXS-1B</b>														
PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	W E L D E R	#H F O I L D M E /R	SS H I Z M E	IQI & S I D E	D E N S I T Y	A C C E P T	R E J E C T	S L A G	P O R	C R A C K	I P	L F	U C	A R T I F I C I A L	COMMENTS	
<b>W-17</b>	<b>1-2</b>	<b>X</b>	<b>1 1/8"</b>	<b>12F</b>	<b>2-4</b>	<b>/</b>											
	<b>2-3</b>					<b>/</b>											
	<b>3-1</b>																<b>re shoot</b>
<b>W-18</b>	<b>1-2</b>					<b>/</b>											
	<b>2-3</b>					<b>/</b>											
	<b>3-1</b>					<b>/</b>											
FILM INTERPRETATION BY: <b>RT Level II</b>																	DATE: <b>9-19-18</b>
A.I./CUST. <b>Guy Bottoms II</b>																	DATE: <b>9-19-18</b>

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N.R.C. #35-15194-01  
TEXAS #5-1892  
FAA # CS2R753K

## RADIOGRAPHIC TECHNIQUE SHEET

PAGE \_\_\_\_\_ OF \_\_\_\_\_

MFG/CUST. <i>Gastech</i>		JOB#ID <i>11048-01 Assv Piping</i>		RT DATE <i>9-19-18</i>													
MAT'L TYPE <i>C.S.</i>	MAT'L THK. <i>.300"</i>	WELD REINF. <i>.125"</i>	TOTAL THK. <i>.425"</i>	RT TECHNIQUE <i>GX5-1B.03</i>													
ISOTOPE/ X-RAY VOLTAGE <i>Ir-192</i>	CI./MA. <i>103</i>	FOCAL SIZE <i>.115"</i>	SOD <i>3.5"</i>	OFD <i>.425"</i>	EXPOSURE TIME <i>:11</i>												
EXPOSURE SINGLE WALL <input type="checkbox"/> DBL. WALL <input checked="" type="checkbox"/>		VIEWING SINGLE WALL <input checked="" type="checkbox"/> DBL. WALL <input type="checkbox"/>		FILM PROCESS MAN. <input checked="" type="checkbox"/> AUTO <input type="checkbox"/>													
FILM MFG/TYPE <i>AGFAD3</i>	NO. EXPOSURES <i>1</i>	RT QUALITY <i>2T</i>	APPLICABLE CODE SPEC. <i>ASME II</i>	ACCEPTANCE STD. <i>ASME VIII</i>													
RT TRCH. LEVEL II <i>M. Williams</i>			RT PROCEDURE <i>GX5-1B</i>														
PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	W E L D E R	#H F O I L D M E /R	SS H I Z M E	IQI & S I D E	D E N S I T Y	A C C E P T	R E J E C T	S L A G	P O R	C R A C K	I P	L F	U C	A R T I F I C I A L	COMMENTS	
<i>w-17</i>	<i>3-1</i>	<i>X</i>	<i>1 1/8"</i>	<i>2F</i>	<i>2-4</i>	<i>/</i>											
FILM INTERPRETATION BY: <i>[Signature]</i> <i>RT Level II</i>																	DATE: <i>9-20-18</i>
A.I./CUST. <i>[Signature]</i> <i>Greg Bellows</i>																	DATE: <i>9/21/18</i>

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## UT EXAMINATION RECORD

Job Number 11048-01 Customer Williams / M&H Energy Services

Procedure Identification and Rev. GTE-P-QUA-211, Rev. 0

Acceptance Standard ASME BPVC Section VIII, Div. 1, 2017

Scanned Areas: The following locations were scanned in accordance with ASME Section V, Article 4, and interpreted in accordance with the above Acceptance Standard.

Joint Description	Weld ID Numbers	Material	Accept	Reject
Nozzle - Insertion	N1, N2, N3, N4, N5A, N5B, N6A, N6B, N7A, N7B, N9.	C.S.	X	
Nozzle - Insertion	N10, N11A, N11B, C1A, C1B.	C.S.	X	

### Calibration Record ID #'s

	t, 0" to 1"	t, >1" to 2"	t, >2" to 4"	D, 20" to 13"	D, 13" to 7"	D, 7" to 4"	D, 4" to 2"	D, 2" to 1"
0°	433624829	433624829						
45°	433624822	433624824						
60°	433624825	433624826						
70°	433624827							

### Examination Scans Performed Per Weld ID:

### Restricted Access Areas

<input checked="" type="checkbox"/>	Straight Beam Scan for Lamination, Prior to Weld Exam
<input checked="" type="checkbox"/>	Dual Angle Sheer Wave Scan Perpendicular to the Weld - From Below on Exterior
<input checked="" type="checkbox"/>	Dual Angle Sheer Wave Scan Perpendicular to the Weld - From Above on Exterior
<input type="checkbox"/>	Dual Angle Sheer Wave Scan Perpendicular to the Weld - From Below on Interior
<input type="checkbox"/>	Dual Angle Sheer Wave Scan Perpendicular to the Weld - From Above on Interior
<input checked="" type="checkbox"/>	Dual Angle Sheer Wave Scan Parallel to the Weld - From Left on Exterior
<input checked="" type="checkbox"/>	Dual Angle Sheer Wave Scan Parallel to the Weld - From Right on Exterior
<input type="checkbox"/>	Dual Angle Sheer Wave Scan Parallel to the Weld - From Left on Interior
<input type="checkbox"/>	Dual Angle Sheer Wave Scan Parallel to the Weld - From Right on Interior
<input type="checkbox"/>	Straight beam Scan of Weld from Exterior - Ground Flush on OD
<input type="checkbox"/>	Straight beam Scan of Weld from Interior - Ground Flush on ID

Surface Condition: As Welded, With Areas Adjacent to the Weld Buffed Smooth

Examination Personnel Carl Duncan UT Level II

Signature  Examination Date 09/19/18

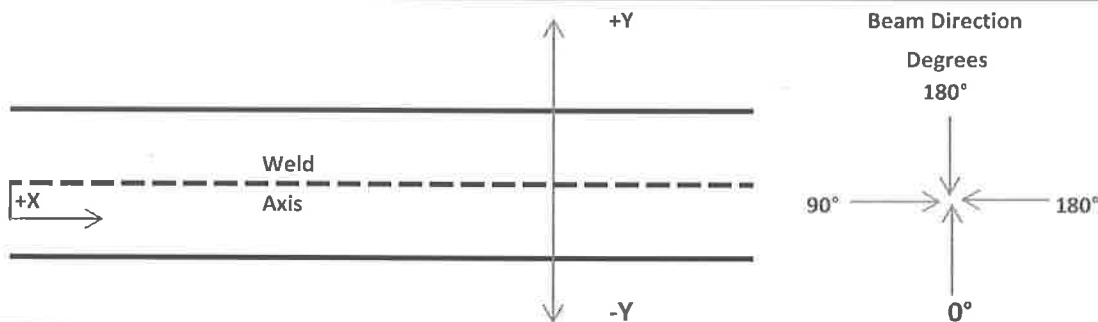


## UT EXAMINATION RECORD

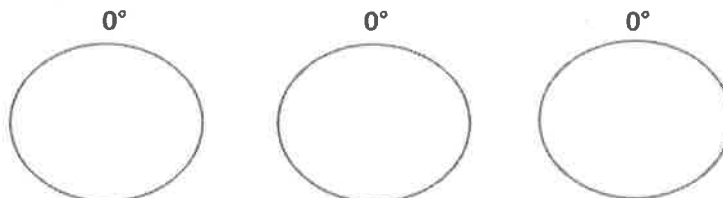
Job Number 11048-01 Customer Williams / M&H Energy Sevices

### Recordable Indications

Weld ID	Ind. #	Max DAC %	S.P. in.	Loc. (X) in.	Loc. (Y) in.	Calibration Record ID	Beam Ang. & (Beam Dir. Deg.)	Comments & Status
								Limited Scan



### Sketch



Interpretation Personnel Carl Duncan UT Level II

Signature *Carl Duncan* Examination Date 09/19/18





## UT CALIBRATION RECORD

### UT INSTRUMENT

Calibration Identification Number 433624822 Calibration Standard ASME BPVC Section V  
 Instrument Make Olympus Model Epoch 650 Instrument Serial Number 150069007

### SEARCH UNIT

Probe Serial Number 1003975 Probe Diameter 0.5" Probe Wedge Brand Olympus  
 Wedge Part Number ABSA-5T-45 Probe Wedge Angle 45° Probe Shoes N/A  
 Probe Frequency 2.25 MHZ Wedge Part Identification U8700412

### RECORDING

Recording Equipment N/A Automatic Scanning Equipment N/A Program # 1

### COUPLANT

Couplant Brand Name Magnaflux Couplant Type Sonotech, Sonotrace 40

#### CABLE

Search Unit Cable Length 6'  
 Search Unit Cable Type RG 174/U

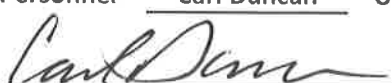
#### PROGRAM

Computer Program Identification 45#0-1  
 Computer Program revision 001

### CALIBRATION

Distance Calibration Block : IIW Type 2 Block Electronic Simulator Identification N/A  
 Calibration Block 2 Identification ASME Calibration Block Instrument Dampening 50 Ω  
 Calibration Block Serial Number 0.75-0 Simulation Block Identification N/A  
 Electronic Simulator Calibration Data N/A Simulation Block Calibration Data N/A  
 Instrument Reference Level Gain 41.7 dB Instrument Reject Setting Off  
 Calibration Distance Readings 2.000 ", 4.000 " Calibration Reference Reflector 1/32 in. SDH  
 Calibration Indication Amplitude 50 % FSH

### ACCEPTANCE

Calibration Personnel Carl Duncan UT Level II  
 Signature  Calibrated Before and After Examination Dated 09/19/18



## UT CALIBRATION RECORD

### UT INSTRUMENT

Calibration Identification Number 433624824 Calibration Standard ASME BPVC Section V  
 Instrument Make Olympus Model Epoch 650 Instrument Serial Number 150069007

### SEARCH UNIT

Probe Serial Number 1003975 Probe Diameter 0.5" Probe Wedge Brand Olympus  
 Wedge Part Number ABSA-5T-45 Probe Wedge Angle 45° Probe Shoes N/A  
 Probe Frequency 2.25 MHZ Wedge Part Identification U8700412

### RECORDING

Recording Equipment N/A Automatic Scanning Equipment N/A Program # 2

### COUPLANT

Couplant Brand Name Magnaflux Couplant Type Sonotech, Sonotrace 40

#### CABLE

Search Unit Cable Length 6'  
 Search Unit Cable Type RG 174/U

#### PROGRAM

Computer Program Identification 45#1-2  
 Computer Program revision 001

### CALIBRATION

Distance Calibration Block : IIW Type 2 Block Electronic Simulator Identification N/A  
 Calibration Block 2 Identification ASME Calibration Block Instrument Dampening 50 Ω  
 Calibration Block Serial Number 1.5-0 Simulation Block Identification N/A  
 Electronic Simulator Calibration Data N/A Simulation Block Calibration Data N/A  
 Instrument Reference Level Gain 40.7 dB Instrument Reject Setting Off  
 Calibration Distance Readings 2.000 ", 4.000 " Calibration Reference Reflector 1/8 in. SDH  
 Calibration Indication Amplitude 50 % FSH

### ACCEPTANCE

Calibration Personnel Carl Duncan UT Level II  
 Signature  Calibrated Before and After Examination Dated 09/19/18



## UT CALIBRATION RECORD

### UT INSTRUMENT

Calibration Identification Number 433624825 Calibration Standard ASME BPVC Section V  
 Instrument Make Olympus Model Epoch 650 Instrument Serial Number 150069007

### SEARCH UNIT

Probe Serial Number 1003975 Probe Diameter 0.5" Probe Wedge Brand Olympus  
 Wedge Part Number ABSA-5T-60 Probe Wedge Angle 60° Probe Shoes N/A  
 Probe Frequency 2.25 MHZ Wedge Part Identification U8700414

### RECORDING

Recording Equipment N/A Automatic Scanning Equipment N/A Program # 4

### COUPLANT

Couplant Brand Name Magnaflux Couplant Type Sonotech, Sonotrace 40

#### CABLE

Search Unit Cable Length 6'  
 Search Unit Cable Type RG 174/U

#### PROGRAM

Computer Program Identification 60#0-1  
 Computer Program revision 001

### CALIBRATION

Distance Calibration Block : IIW Type 2 Block Electronic Simulator Identification N/A  
 Calibration Block 2 Identification ASME Calibration Block Instrument Dampening 50 Ω  
 Calibration Block Serial Number 0.75-0 Simulation Block Identification N/A  
 Electronic Simulator Calibration Data N/A Simulation Block Calibration Data N/A  
 Instrument Reference Level Gain 40.8 dB Instrument Reject Setting Off  
 Calibration Distance Readings 2.000 ", 4.000 " Calibration Reference Reflector 1/32 in. SDH  
 Calibration Indication Amplitude 50 % FSH

### ACCEPTANCE

Calibration Personnel Carl Duncan UT Level II  
 Signature  Calibrated Before and After Examination Dated 09/19/18



## UT CALIBRATION RECORD

### UT INSTRUMENT

Calibration Identification Number 433624826 Calibration Standard ASME BPVC Section V  
 Instrument Make Olympus Model Epoch 650 Instrument Serial Number 150069007

### SEARCH UNIT

Probe Serial Number 1003975 Probe Diameter 0.5" Probe Wedge Brand Olympus  
 Wedge Part Number ABSA-ST-60 Probe Wedge Angle 60° Probe Shoes N/A  
 Probe Frequency 2.25 MHZ Wedge Part Identification U8700414

### RECORDING

Recording Equipment N/A Automatic Scanning Equipment N/A Program # 5

### COUPLANT

Couplant Brand Name Magnaflux Couplant Type Sonotech, Sonotrace 40

#### CABLE

Search Unit Cable Length 6'  
 Search Unit Cable Type RG 174/U

#### PROGRAM

Computer Program Identification 60#1-2  
 Computer Program revision 001

### CALIBRATION

Distance Calibration Block IW Type 2 Block Electronic Simulator Identification N/A  
 Calibration Block 2 Identification ASME Calibration Block Instrument Dampening 50 Ω  
 Calibration Block Serial Number 1.5-0 Simulation Block Identification N/A  
 Electronic Simulator Calibration Data N/A Simulation Block Calibration Data N/A  
 Instrument Reference Level Gain 43.3 dB Instrument Reject Setting Off  
 Calibration Distance Readings 2.000 ", 4.000 " Calibration Reference Reflector 1/8 in. SDH  
 Calibration Indication Amplitude 50 % FSH

### ACCEPTANCE

Calibration Personnel Carl Duncan UT Level II  
 Signature  Calibrated Before and After Examination Dated 09/19/18



## UT CALIBRATION RECORD

### UT INSTRUMENT

Calibration Identification Number 433624827 Calibration Standard ASME BPVC Section V  
 Instrument Make Olympus Model Epoch 650 Instrument Serial Number 150069007

### SEARCH UNIT

Probe Serial Number 1003975 Probe Diameter 0.5" Probe Wedge Brand Olympus  
 Wedge Part Number ABSA-5T-70 Probe Wedge Angle 70° Probe Shoes N/A  
 Probe Frequency 2.25 MHZ Wedge Part Identification U8700416

### RECORDING

Recording Equipment N/A Automatic Scanning Equipment N/A Program # 8

### COUPLANT

Couplant Brand Name Magnaflux Couplant Type Sonotech, Sonotrace 40

#### CABLE

Search Unit Cable Length 6'  
 Search Unit Cable Type RG 174/U

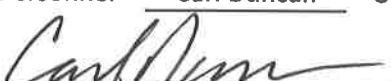
#### PROGRAM

Computer Program Identification 70#0-1  
 Computer Program revision 001

### CALIBRATION

Distance Calibration Block : IIW Type 2 Block Electronic Simulator Identification N/A  
 Calibration Block 2 Identification ASME Calibration Block Instrument Dampening 50 Ω  
 Calibration Block Serial Number 0.75-0 Simulation Block Identification N/A  
 Electronic Simulator Calibration Data N/A Simulation Block Calibration Data N/A  
 Instrument Reference Level Gain 45.3 dB Instrument Reject Setting Off  
 Calibration Distance Readings 2.000 ", 4.000 " Calibration Reference Reflector 1/32 in. SDH  
 Calibration Indication Amplitude 50 % FSH

### ACCEPTANCE

Calibration Personnel Carl Duncan UT Level II  
 Signature  Calibrated Before and After Examination Dated 09/19/18



## UT CALIBRATION RECORD

### UT INSTRUMENT

Calibration Identification Number 433624829 Calibration Standard ASME BPVC Section V  
 Instrument Make Olympus Model Epoch 650 Instrument Serial Number 150069007

### SEARCH UNIT

Probe Serial Number 989238 Probe Diameter 0.5" Probe Wedge Brand Olympus  
 Wedge Part Number A182S-RM Probe Wedge Angle 0° Probe Shoes N/A  
 Probe Frequency 3.5 MHZ Wedge Part Identification N/A

### RECORDING

Recording Equipment N/A Automatic Scanning Equipment N/A Program # 11

### COUPLANT

Couplant Brand Name Magnaflux Couplant Type Sonotech, Sonotrace 40

#### CABLE

Search Unit Cable Length 6'  
 Search Unit Cable Type RG 174/U


#### PROGRAM

Computer Program Identification STRAIT-3-5MHZ  
 Computer Program revision 001

### CALIBRATION

Distance Calibration Block : IIW Type 2 Block Electronic Simulator Identification N/A  
 Calibration Block 2 Identification ASME Calibration Block Instrument Dampening 50 Ω  
 Calibration Block Serial Number IIW Simulation Block Identification N/A  
 Electronic Simulator Calibration Data N/A Simulation Block Calibration Data N/A  
 Instrument Reference Level Gain 30 dB Instrument Reject Setting Off  
 Calibration Distance Readings 1.000 ", 4.000 " Calibration Reference Reflector N/A  
 Calibration Indication Amplitude 50 % FSH

### ACCEPTANCE

Calibration Personnel Carl Duncan UT Level II  
 Signature  Calibrated Before and After Examination Dated 09/19/18

**GASTECH ENGINEERING LLC**

2110 Industrial Road Sapulpa, OK 74066

918-663-8383

Page: 1 of 1**Magnetic Particle Examination Record**Customer: WILLIAMS TRANSCONTINENTAL Date: 9/19/2018Job No.: 11048-01 Reference Code/Specifications: ASME Sec. VIII Div. 1 Appendix 6 and Sec. V Article 7MT Procedure No.: GTE-QUA-203-P Revision No.: 3Magnetizing Equipment: Contour Probe Serial No: 8070 Technique: ☒ Yoke ☐ ProdsCurrent Type: ☒ A/C ☐ D/C Magnetical Particle Type: ☐ Wet ☒ Dry ☐ Fluorescent ☒ VisibleAmperage (Prod Technique Only) N/A Amps/inch of Prod Spacing) N/A Prod Spacing N/APart/Item Material Type: C.S Material Thickness Range: 0.444"~1.75"Lighting Equipment: ☐ Fluorescent Light Model # Coast HP550 Serial # 1001☐ White Light using Parker Research Y300 or Y400 Probe light☒ Flashlight # of Batteries 9 Type: AA Max. Distance from object: 12 in☐ Other: \_\_\_\_\_Light Intensity on surface to be examined: Minimum 100 foot candles \_\_\_\_\_  $\mu\text{W}/\text{cm}^2$ Comments: MT any attachment / removal areas.**Examination Results**

Item#	Part Identification	Accept	Reject	Indication Description
7,8,9	N1 Inlet, N2 Outlet Nozzles	X		No indication at the time of inspection
3,2	N3 PSV, N4 Vent Nozzles	X		No indication at the time of inspection
6,2	N5A/B Handhole	X		No indication at the time of inspection
15,2,10	N6A/B, N7A/B Downcomer	X		No indication at the time of inspection
15,19,13, 4	N8, N9 Bridle	X		No indication at the time of inspection
2,4,10,11, 2,12,	N10, N11A/B Drain	X		No indication at the time of inspection
16,2	Lifting Lug	X		No indication at the time of inspection
	All fillet Welds	X		No indication at the time of inspection

See attachment for additional examination results: \_\_\_\_\_

Examiner: Tonya JansonQualification Level: MT Level II

# GasTech Engineering LLC.

## Fastener Torque Verification

This is to certify that Fastener Torque verification has been performed on the bolted joints below. This examination included the witnessing of torque wrench applied to each bolt. All bolted joints accepted herein are certified by GasTech Engineering LLC.

Unit Serial Number: 11048-01

Nominal Size	Class (#)	Quantity	Min. Torque	Act. Torque	Max Torque
8	600	2	400	560	700
12	600	2	500	640	800
2	600	6	60	70	80

Signed:  VT Level: \_\_\_\_\_ Date: 10-9-18  
GasTech Inspector

Signed: \_\_\_\_\_ Date: \_\_\_\_\_  
Customer Inspector, if present





1030 N. Iriquois Ave.

Tulsa, OK 74106

918-585-8200

# Furnace Heat Treatment Report Bill Of Lading

(PWHT Chart On Reverse Page)

Sold To:		Ship To:	
Customer Name	Gastech Engineering Corp.	Customer Name	Gastech Engineering Corp.
Bill to Address	1007 E. Admiral Blvd	Ship to Address	1007 E. Admiral Blvd
City, ST, Zip	Tulsa, OK 74120	City, ST, Zip	Tulsa, OK 74120
Telephone	918-663-8383	Telephone	918-663-8383
Contact:	Dan Bethrum	Contact:	Dan Bethrum
E-Mail	dbethurum@gastecheng.com	E-Mail	dbethurum@gastecheng.com

Customer PO No.	634678	Ship Date	09/20/18
Customer Job No.	11048	Ship Time	
Bill of Lading No.		Ship Method	Customer

Part Quantity	Part Number	Part Name	Weight
1	11048	Vessel	22,000

Part Description
PWHT of (1) 10' S/S x 1.75" Thk x 72" ID x 22,000#Vessel

Zentech Job Number	1-30-18-1036	Zentech Operator	Berk Imirhan
Experian Seq. Num.	721	Furnace Number	F-4 N

<b>Terms &amp; Conditions</b>	CUSTOMER OR RECEIVING PARTY HEREBY ACKNOWLEDGES (BY SIGNATURE) THE ABOVE ITEM(S) ARE RECEIVED IN GOOD CONDITION FURTHERMORE ACCEPTS WORK TIME AND TEMPERATURE CHARTS AND AGREES TO ALL THE ZENTECH STANDARD TERMS AND CONDITIONS PUBLISHED OR ATTACHED.
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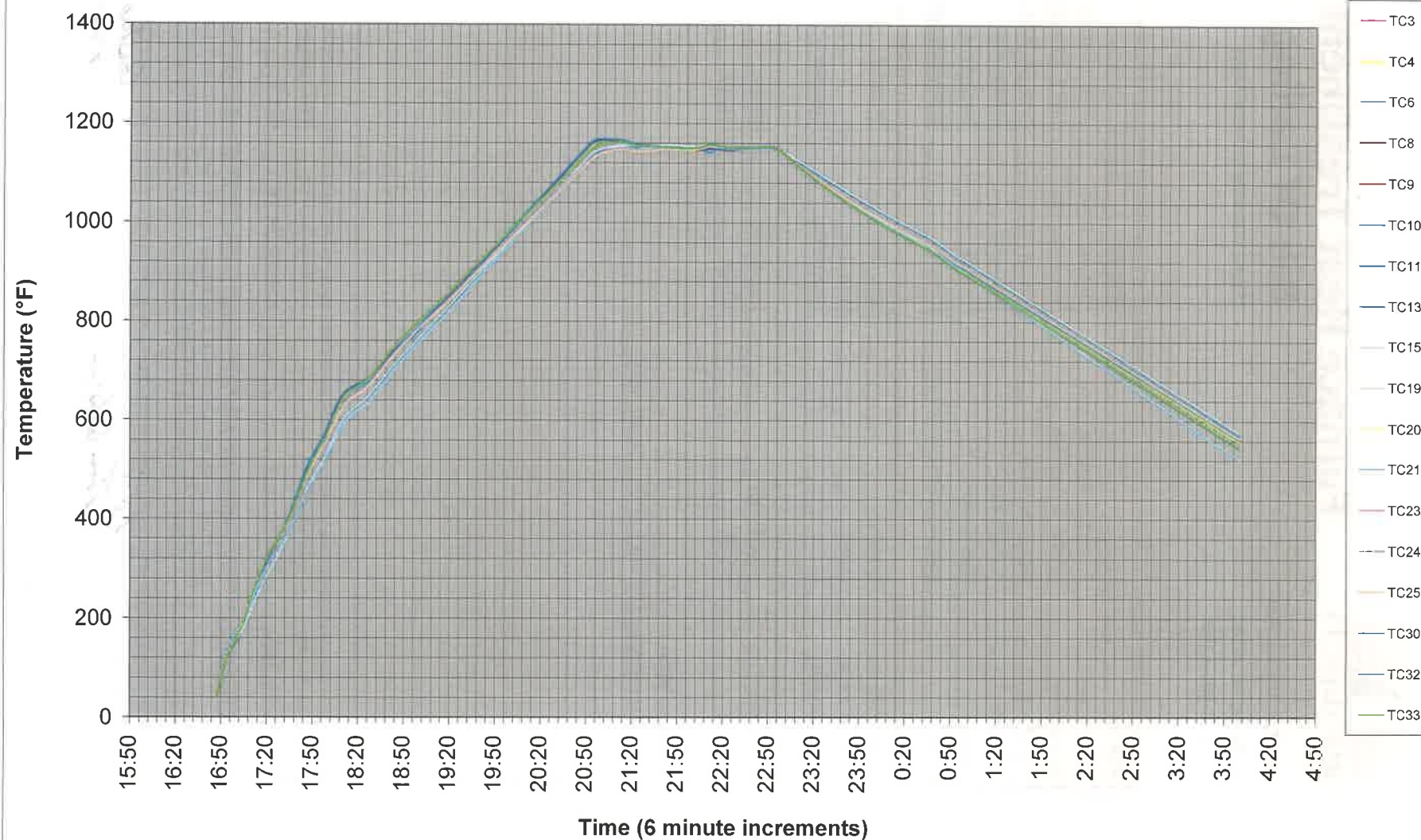
Received By Signature		Received By Company	
Received By Name	Tim Gibson	Received Date	9-20-18

Customer: Gastech Engineering Corp.  
Job: 11048  
PO: 634678  
Part No.: 11048

Zentech Job 1-30-18-1036

9/20/18

Zentech Thermal Processing  
Furnace No. F-4 N



Calibration Date: 7/1/18  
Calibration Due: 11/1/18

Thermocouple Type : K

Zentech Operator  
Signature : 



1007 E. Admiral Blvd.  
Tulsa, OK 74120

## PRESSURE VESSEL HYDRO CERTIFICATE

*This vessel was hydrostatically tested and is hereby accepted, in accordance with ASME BPVC Section VIII, Division 1.  
This hydro test was performed in accordance with the Pressure Vessel Hydro Test Procedure of GasTech Engineering.*

GASTECH JOB #: 11048-01 DRAWING #: 11048-300

CUSTOMER PURCHASE ORDER #: 676280

VESSEL DESCRIPTION: HCS

PRESSURE GUAGE CALIBRATION DUE: 6/22/19

PRESSURE GUAGE: 683254

GUAGE TYPE: Crystal-Vision GUAGE RANGE: 0-10,000

TEMPERATURE GUAGE: Same

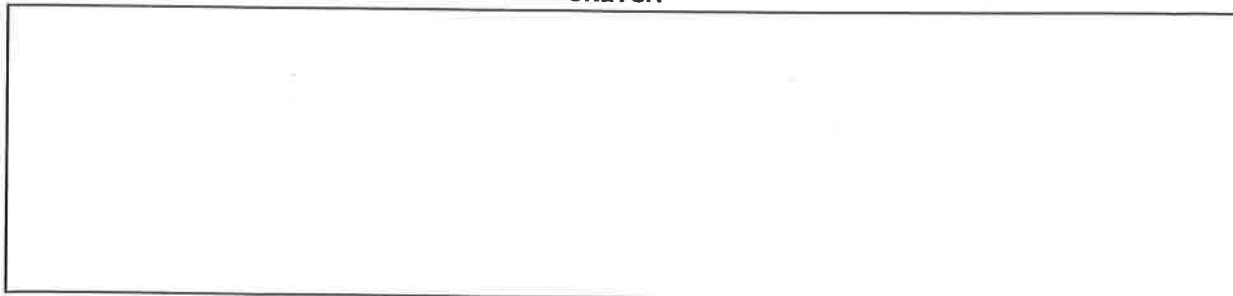
WATER PROPERTIES: potable

DESIGN PRESSURE (PSI): 870 TEST PRESSURE (PSI): 1315

HOLD TIME AT TEST PRESSURE: 4 Hrs

TESTED BY: [Signature] HYDRO TEST DATE: 9-21-18

### SKETCH



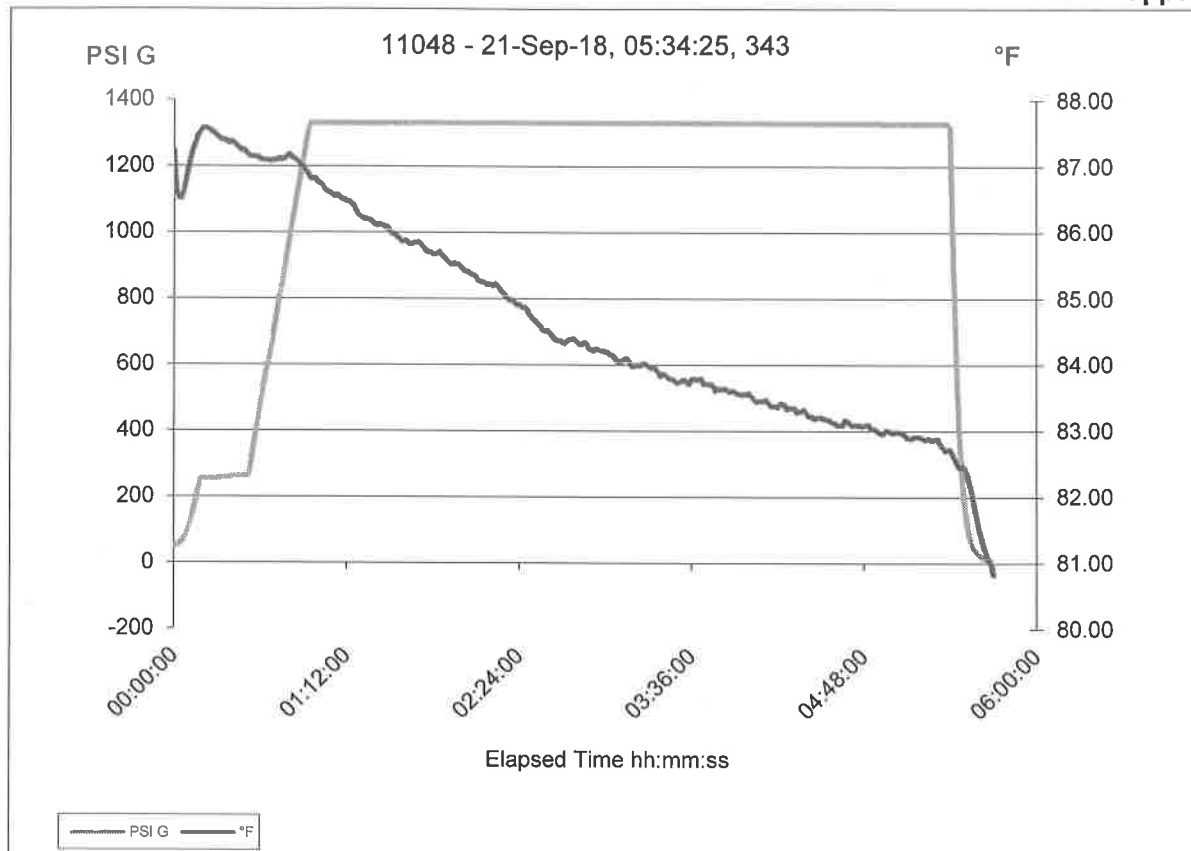
INSPECTOR ACCEPTANCE: [Signature] DATE: 9-21-18

## Data Collection Report

	Chassis	Left Scale	Right Scale
Serial Number	683563	683254	681023
Datatype		Lower	Upper
Units		PSI G	°F

Lower

Upper



	Chassis	Lower Module	Upper Module	BARO Module	Left Scale	Right Scale
Serial Number	683563	683254	681023		683254	681023
Model	NV	10KPSI	RTD100			
Message Store						
Userspan		0.99978	1.00000			
Offset						
Datatype						
Units		PSI G	°F		Lower PSI G	Upper °F
Tare						
Average						
User Factor						
User Offset						
User Resolution						
Firmware Version	R080016	R090009	R100006			
Calibration Due		21-May-19	21-May-19			
Run Index	0					
Run Start Time			21-Sep-18/05:34:25			
Run Duration			5 hours 42 minutes			
Run Tag			11048			
Logging Interval	60.0					

Data Points			
Point #	Time	Left - PSI G	Right - °F
1	00:00:00.0	52	87.23
2	00:01:00.0	53	86.62
3	00:02:00.0	53	86.52
4	00:03:00.0	62	86.51
5	00:04:00.0	75	86.61
6	00:05:00.0	90	86.80
7	00:06:00.0	110	86.97
8	00:07:00.0	133	87.14
9	00:08:00.0	159	87.26
10	00:09:00.0	189	87.36

11	00:10:00.0	223	87.47
12	00:11:00.0	255	87.53
13	00:12:00.0	255	87.57
14	00:13:00.0	255	87.58
15	00:14:00.0	255	87.56
16	00:15:00.0	256	87.55
17	00:16:00.0	256	87.51
18	00:17:00.0	256	87.49
19	00:18:00.0	257	87.46
20	00:19:00.0	257	87.43
21	00:20:00.0	259	87.40
22	00:21:00.0	260	87.40
23	00:22:00.0	260	87.38
24	00:23:00.0	261	87.36
25	00:24:00.0	262	87.38
26	00:25:00.0	263	87.34
27	00:26:00.0	263	87.32
28	00:27:00.0	264	87.28
29	00:28:00.0	264	87.24
30	00:29:00.0	265	87.25
31	00:30:00.0	265	87.22
32	00:31:00.0	265	87.17
33	00:32:00.0	301	87.15
34	00:33:00.0	346	87.15
35	00:34:00.0	393	87.14
36	00:35:00.0	438	87.14
37	00:36:00.0	484	87.11
38	00:37:00.0	526	87.10
39	00:38:00.0	565	87.09
40	00:39:00.0	601	87.09
41	00:40:00.0	634	87.08
42	00:41:00.0	675	87.09
43	00:42:00.0	718	87.09
44	00:43:00.0	762	87.10
45	00:44:00.0	805	87.12
46	00:45:00.0	847	87.10
47	00:46:00.0	890	87.12

48	00:47:00.0	933	87.15
49	00:48:00.0	976	87.18
50	00:49:00.0	1018	87.15
51	00:50:00.0	1060	87.12
52	00:51:00.0	1102	87.10
53	00:52:00.0	1144	87.06
54	00:53:00.0	1186	87.02
55	00:54:00.0	1227	86.99
56	00:55:00.0	1268	86.94
57	00:56:00.0	1309	86.88
58	00:57:00.0	1330	86.82
59	00:58:00.0	1330	86.80
60	00:59:00.0	1330	86.81
61	01:00:00.0	1330	86.76
62	01:01:00.0	1330	86.73
63	01:02:00.0	1330	86.71
64	01:03:00.0	1330	86.65
65	01:04:00.0	1330	86.62
66	01:05:00.0	1330	86.59
67	01:06:00.0	1330	86.57
68	01:07:00.0	1330	86.54
69	01:08:00.0	1330	86.56
70	01:09:00.0	1330	86.53
71	01:10:00.0	1330	86.50
72	01:11:00.0	1330	86.49
73	01:12:00.0	1330	86.47
74	01:13:00.0	1330	86.46
75	01:14:00.0	1330	86.43
76	01:15:00.0	1330	86.41
77	01:16:00.0	1330	86.33
78	01:17:00.0	1330	86.27
79	01:18:00.0	1330	86.23
80	01:19:00.0	1330	86.21
81	01:20:00.0	1330	86.20
82	01:21:00.0	1330	86.19
83	01:22:00.0	1330	86.18
84	01:23:00.0	1330	86.16

85	01:24:00.0	1330	86.12
86	01:25:00.0	1330	86.10
87	01:26:00.0	1330	86.11
88	01:27:00.0	1330	86.10
89	01:28:00.0	1330	86.08
90	01:29:00.0	1330	86.07
91	01:30:00.0	1331	86.03
92	01:31:00.0	1331	85.98
93	01:32:00.0	1330	85.98
94	01:33:00.0	1330	85.93
95	01:34:00.0	1330	85.91
96	01:35:00.0	1331	85.87
97	01:36:00.0	1330	85.87
98	01:37:00.0	1331	85.87
99	01:38:00.0	1330	85.83
100	01:39:00.0	1330	85.82
101	01:40:00.0	1331	85.83
102	01:41:00.0	1331	85.84
103	01:42:00.0	1331	85.85
104	01:43:00.0	1331	85.83
105	01:44:00.0	1331	85.78
106	01:45:00.0	1331	85.72
107	01:46:00.0	1331	85.70
108	01:47:00.0	1331	85.70
109	01:48:00.0	1331	85.67
110	01:49:00.0	1331	85.66
111	01:50:00.0	1331	85.68
112	01:51:00.0	1331	85.70
113	01:52:00.0	1331	85.65
114	01:53:00.0	1331	85.62
115	01:54:00.0	1331	85.57
116	01:55:00.0	1331	85.54
117	01:56:00.0	1331	85.51
118	01:57:00.0	1331	85.53
119	01:58:00.0	1331	85.52
120	01:59:00.0	1331	85.51
121	02:00:00.0	1331	85.46



122	02:01:00.0	1331	85.41
123	02:02:00.0	1331	85.41
124	02:03:00.0	1331	85.39
125	02:04:00.0	1331	85.37
126	02:05:00.0	1331	85.35
127	02:06:00.0	1331	85.32
128	02:07:00.0	1331	85.26
129	02:08:00.0	1331	85.25
130	02:09:00.0	1331	85.24
131	02:10:00.0	1331	85.22
132	02:11:00.0	1331	85.21
133	02:12:00.0	1331	85.21
134	02:13:00.0	1331	85.19
135	02:14:00.0	1331	85.22
136	02:15:00.0	1331	85.18
137	02:16:00.0	1332	85.14
138	02:17:00.0	1332	85.09
139	02:18:00.0	1332	85.06
140	02:19:00.0	1332	85.00
141	02:20:00.0	1332	84.97
142	02:21:00.0	1331	84.98
143	02:22:00.0	1332	84.94
144	02:23:00.0	1332	84.90
145	02:24:00.0	1332	84.91
146	02:25:00.0	1332	84.88
147	02:26:00.0	1332	84.87
148	02:27:00.0	1331	84.84
149	02:28:00.0	1332	84.77
150	02:29:00.0	1332	84.71
151	02:30:00.0	1332	84.68
152	02:31:00.0	1332	84.64
153	02:32:00.0	1332	84.60
154	02:33:00.0	1332	84.57
155	02:34:00.0	1332	84.52
156	02:35:00.0	1332	84.50
157	02:36:00.0	1332	84.51
158	02:37:00.0	1332	84.46

159	02:38:00.0	1332	84.42
160	02:39:00.0	1332	84.38
161	02:40:00.0	1332	84.36
162	02:41:00.0	1332	84.36
163	02:42:00.0	1332	84.34
164	02:43:00.0	1332	84.32
165	02:44:00.0	1332	84.36
166	02:45:00.0	1332	84.38
167	02:46:00.0	1332	84.38
168	02:47:00.0	1332	84.39
169	02:48:00.0	1331	84.35
170	02:49:00.0	1331	84.31
171	02:50:00.0	1331	84.31
172	02:51:00.0	1332	84.33
173	02:52:00.0	1331	84.33
174	02:53:00.0	1332	84.25
175	02:54:00.0	1332	84.23
176	02:55:00.0	1332	84.21
177	02:56:00.0	1332	84.24
178	02:57:00.0	1331	84.23
179	02:58:00.0	1331	84.21
180	02:59:00.0	1331	84.21
181	03:00:00.0	1331	84.20
182	03:01:00.0	1332	84.18
183	03:02:00.0	1331	84.16
184	03:03:00.0	1331	84.14
185	03:04:00.0	1331	84.10
186	03:05:00.0	1331	84.06
187	03:06:00.0	1331	84.04
188	03:07:00.0	1331	84.06
189	03:08:00.0	1331	84.08
190	03:09:00.0	1331	84.10
191	03:10:00.0	1331	84.05
192	03:11:00.0	1331	83.98
193	03:12:00.0	1331	83.98
194	03:13:00.0	1331	84.00
195	03:14:00.0	1331	83.98

196	03:15:00.0	1331	83.99
197	03:16:00.0	1331	84.02
198	03:17:00.0	1331	84.01
199	03:18:00.0	1331	83.98
200	03:19:00.0	1331	83.95
201	03:20:00.0	1331	83.97
202	03:21:00.0	1331	83.94
203	03:22:00.0	1331	83.89
204	03:23:00.0	1331	83.83
205	03:24:00.0	1331	83.86
206	03:25:00.0	1331	83.85
207	03:26:00.0	1331	83.81
208	03:27:00.0	1331	83.79
209	03:28:00.0	1331	83.78
210	03:29:00.0	1331	83.75
211	03:30:00.0	1331	83.73
212	03:31:00.0	1331	83.74
213	03:32:00.0	1331	83.76
214	03:33:00.0	1331	83.77
215	03:34:00.0	1331	83.74
216	03:35:00.0	1331	83.71
217	03:36:00.0	1331	83.78
218	03:37:00.0	1331	83.79
219	03:38:00.0	1331	83.77
220	03:39:00.0	1331	83.78
221	03:40:00.0	1331	83.79
222	03:41:00.0	1331	83.71
223	03:42:00.0	1331	83.72
224	03:43:00.0	1331	83.70
225	03:44:00.0	1331	83.71
226	03:45:00.0	1331	83.69
227	03:46:00.0	1331	83.61
228	03:47:00.0	1331	83.64
229	03:48:00.0	1331	83.63
230	03:49:00.0	1331	83.63
231	03:50:00.0	1331	83.64
232	03:51:00.0	1331	83.61

233	03:52:00.0	1331	83.59
234	03:53:00.0	1331	83.60
235	03:54:00.0	1331	83.60
236	03:55:00.0	1331	83.57
237	03:56:00.0	1331	83.56
238	03:57:00.0	1331	83.55
239	03:58:00.0	1331	83.56
240	03:59:00.0	1331	83.55
241	04:00:00.0	1330	83.57
242	04:01:00.0	1330	83.53
243	04:02:00.0	1331	83.48
244	04:03:00.0	1331	83.44
245	04:04:00.0	1330	83.45
246	04:05:00.0	1331	83.45
247	04:06:00.0	1330	83.45
248	04:07:00.0	1330	83.47
249	04:08:00.0	1330	83.43
250	04:09:00.0	1330	83.38
251	04:10:00.0	1330	83.38
252	04:11:00.0	1330	83.38
253	04:12:00.0	1330	83.36
254	04:13:00.0	1330	83.41
255	04:14:00.0	1330	83.41
256	04:15:00.0	1330	83.40
257	04:16:00.0	1330	83.33
258	04:17:00.0	1330	83.35
259	04:18:00.0	1330	83.34
260	04:19:00.0	1330	83.35
261	04:20:00.0	1330	83.28
262	04:21:00.0	1330	83.29
263	04:22:00.0	1330	83.30
264	04:23:00.0	1330	83.32
265	04:24:00.0	1330	83.26
266	04:25:00.0	1330	83.22
267	04:26:00.0	1330	83.23
268	04:27:00.0	1330	83.19
269	04:28:00.0	1330	83.19

270	04:29:00.0	1330	83.21
271	04:30:00.0	1330	83.21
272	04:31:00.0	1330	83.19
273	04:32:00.0	1330	83.18
274	04:33:00.0	1330	83.17
275	04:34:00.0	1330	83.15
276	04:35:00.0	1330	83.13
277	04:36:00.0	1330	83.11
278	04:37:00.0	1330	83.08
279	04:38:00.0	1330	83.09
280	04:39:00.0	1330	83.08
281	04:40:00.0	1330	83.16
282	04:41:00.0	1330	83.15
283	04:42:00.0	1330	83.11
284	04:43:00.0	1330	83.08
285	04:44:00.0	1330	83.09
286	04:45:00.0	1330	83.08
287	04:46:00.0	1330	83.09
288	04:47:00.0	1330	83.07
289	04:48:00.0	1330	83.08
290	04:49:00.0	1330	83.09
291	04:50:00.0	1329	83.09
292	04:51:00.0	1330	83.04
293	04:52:00.0	1330	83.03
294	04:53:00.0	1330	83.02
295	04:54:00.0	1330	82.98
296	04:55:00.0	1330	82.96
297	04:56:00.0	1329	82.96
298	04:57:00.0	1329	83.01
299	04:58:00.0	1329	83.00
300	04:59:00.0	1329	82.98
301	05:00:00.0	1329	82.97
302	05:01:00.0	1329	82.98
303	05:02:00.0	1329	82.98
304	05:03:00.0	1329	82.98
305	05:04:00.0	1329	82.96
306	05:05:00.0	1329	82.94

307	05:06:00.0	1329	82.90
308	05:07:00.0	1329	82.89
309	05:08:00.0	1329	82.89
310	05:09:00.0	1329	82.91
311	05:10:00.0	1329	82.91
312	05:11:00.0	1329	82.91
313	05:12:00.0	1329	82.90
314	05:13:00.0	1329	82.88
315	05:14:00.0	1329	82.87
316	05:15:00.0	1329	82.89
317	05:16:00.0	1329	82.86
318	05:17:00.0	1329	82.86
319	05:18:00.0	1329	82.88
320	05:19:00.0	1329	82.87
321	05:20:00.0	1329	82.78
322	05:21:00.0	1329	82.75
323	05:22:00.0	1329	82.70
324	05:23:00.0	1329	82.71
325	05:24:00.0	1315	82.72
326	05:25:00.0	1007	82.65
327	05:26:00.0	741	82.57
328	05:27:00.0	528	82.49
329	05:28:00.0	366	82.45
330	05:29:00.0	251	82.47
331	05:30:00.0	176	82.43
332	05:31:00.0	115	82.35
333	05:32:00.0	77	82.21
334	05:33:00.0	55	82.05
335	05:34:00.0	41	81.85
336	05:35:00.0	31	81.68
337	05:36:00.0	24	81.51
338	05:37:00.0	19	81.37
339	05:38:00.0	14	81.24
340	05:39:00.0	11	81.14
341	05:40:00.0	7	81.05
342	05:41:00.0	6	80.97
343	05:42:00.0	-21	80.83



2110 Industrial  
Sapulpa, OK 74066

## PRESSURE PIPING HYDRO TEST REPORT

This vessel was hydrostatically tested and is hereby accepted, in accordance with ASME BPVC B31.3.

This hydro test was performed in accordance with the Pressure Piping Hydro Test Procedure of GasTech Engineering.

GASTECH JOB #: 11048-01 DRAWING #: 11048

CUSTOMER PURCHASE ORDER #: 676280

PIPING DESCRIPTION: Valves for piping

PRESSURE GAUGE CALIBRATION DUE: 6-22-09

PRESSURE GAUGE: 683255

GAUGE TYPE: Crystal vision GAUGE RANGE: 0-10,000

TEMPERATURE GAUGE: Same

WATER PROPERTIES: potable

DESIGN PRESSURE (PSI): 877 TEST PRESSURE (PSI): 1315

HOLD TIME AT TEST PRESSURE: 4 HRS

TESTED BY: [Signature] HYDRO TEST DATE: 9-27-18

### SKETCH



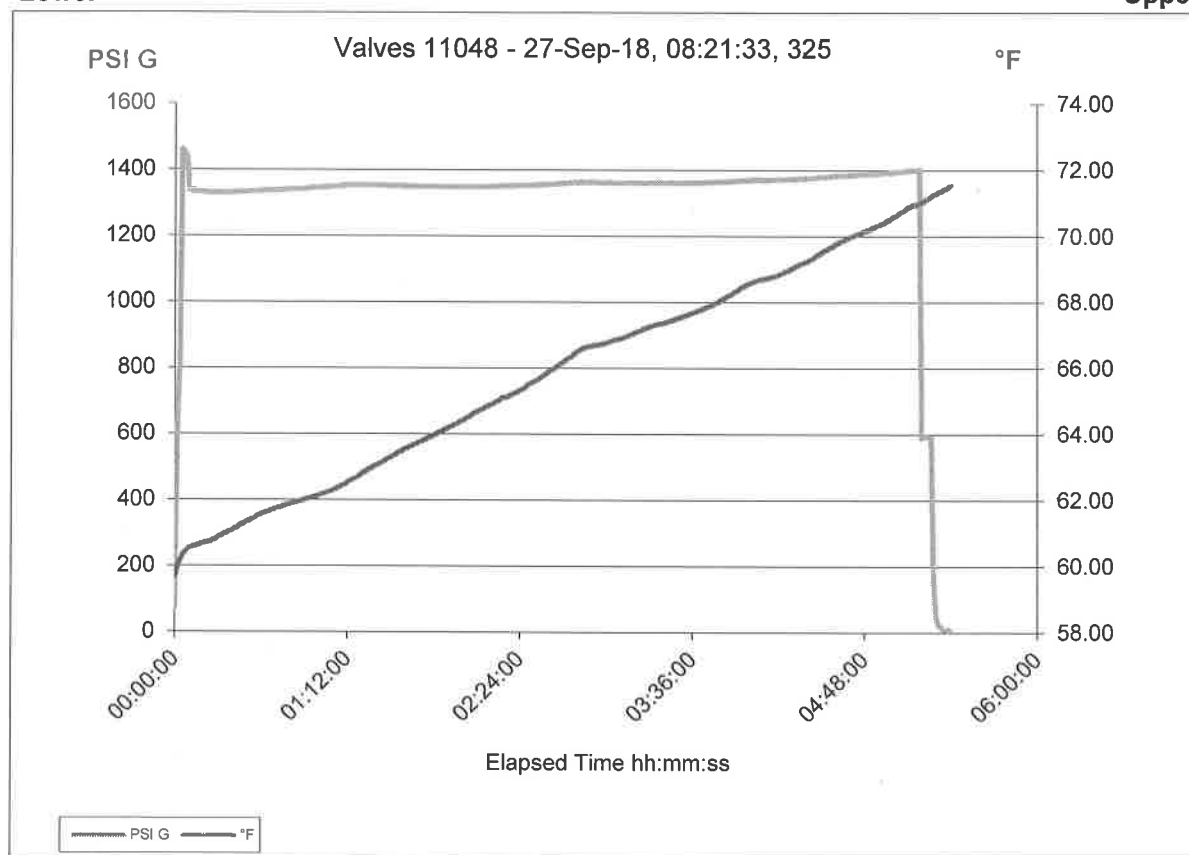
INSPECTOR ACCEPTANCE: [Signature] DATE: 9-27-18

## Data Collection Report

	Chassis	Left Scale	Right Scale
Serial Number	684460	683255	681019
Datatype		Lower	Upper
Units		PSI G	°F

Lower

Upper





	Chassis	Lower Module	Upper Module	BARO Module	Left Scale	Right Scale
Serial Number	684460	683255	681019		683255	681019
Model	NV	10KPSI	RTD100			
Message Store						
Userspan		1.00000	1.00000			
Offset						
Datatype						
Units		PSI G	°F		Lower PSI G	Upper °F
Tare						
Average						
User Factor						
User Offset						
User Resolution						
Firmware Version	R080016	R090009	R100006			
Calibration Due		22-Jun-19	22-Jun-19			
Run Index	0					
Run Start Time			27-Sep-18/08:21:33			
Run Duration			5 hours 24 minutes			
Run Tag			Valves 11048			
Logging Interval	60.0					

Data Points				
Point #	Time	Left - PSI G	Right - °F	
1	00:00:00.0	74	59.69	
2	00:01:00.0	629	59.95	
3	00:02:00.0	818	60.14	
4	00:03:00.0	1462	60.28	
5	00:04:00.0	1454	60.39	
6	00:05:00.0	1437	60.47	
7	00:06:00.0	1337	60.53	
8	00:07:00.0	1336	60.56	
9	00:08:00.0	1335	60.58	
10	00:09:00.0	1334	60.60	

11	00:10:00.0	1334	60.62
12	00:11:00.0	1333	60.66
13	00:12:00.0	1332	60.68
14	00:13:00.0	1332	60.71
15	00:14:00.0	1331	60.72
16	00:15:00.0	1331	60.74
17	00:16:00.0	1331	60.78
18	00:17:00.0	1331	60.81
19	00:18:00.0	1331	60.85
20	00:19:00.0	1331	60.89
21	00:20:00.0	1331	60.93
22	00:21:00.0	1331	60.97
23	00:22:00.0	1331	61.01
24	00:23:00.0	1331	61.04
25	00:24:00.0	1331	61.08
26	00:25:00.0	1332	61.12
27	00:26:00.0	1332	61.16
28	00:27:00.0	1332	61.20
29	00:28:00.0	1333	61.25
30	00:29:00.0	1333	61.29
31	00:30:00.0	1333	61.33
32	00:31:00.0	1334	61.37
33	00:32:00.0	1334	61.41
34	00:33:00.0	1334	61.44
35	00:34:00.0	1335	61.49
36	00:35:00.0	1335	61.52
37	00:36:00.0	1336	61.56
38	00:37:00.0	1336	61.59
39	00:38:00.0	1337	61.61
40	00:39:00.0	1337	61.64
41	00:40:00.0	1337	61.67
42	00:41:00.0	1338	61.70
43	00:42:00.0	1338	61.73
44	00:43:00.0	1339	61.76
45	00:44:00.0	1339	61.77
46	00:45:00.0	1339	61.80
47	00:46:00.0	1340	61.83

48	00:47:00.0	1340	61.85
49	00:48:00.0	1340	61.87
50	00:49:00.0	1341	61.89
51	00:50:00.0	1341	61.91
52	00:51:00.0	1342	61.93
53	00:52:00.0	1342	61.95
54	00:53:00.0	1342	61.98
55	00:54:00.0	1343	62.00
56	00:55:00.0	1343	62.03
57	00:56:00.0	1344	62.04
58	00:57:00.0	1344	62.07
59	00:58:00.0	1345	62.09
60	00:59:00.0	1345	62.11
61	01:00:00.0	1345	62.14
62	01:01:00.0	1346	62.16
63	01:02:00.0	1346	62.18
64	01:03:00.0	1347	62.21
65	01:04:00.0	1347	62.23
66	01:05:00.0	1348	62.26
67	01:06:00.0	1348	62.29
68	01:07:00.0	1349	62.33
69	01:08:00.0	1349	62.36
70	01:09:00.0	1350	62.41
71	01:10:00.0	1351	62.44
72	01:11:00.0	1351	62.48
73	01:12:00.0	1352	62.53
74	01:13:00.0	1353	62.57
75	01:14:00.0	1353	62.61
76	01:15:00.0	1353	62.64
77	01:16:00.0	1353	62.69
78	01:17:00.0	1353	62.74
79	01:18:00.0	1354	62.78
80	01:19:00.0	1353	62.83
81	01:20:00.0	1353	62.88
82	01:21:00.0	1353	62.92
83	01:22:00.0	1353	62.97
84	01:23:00.0	1353	63.01

85	01:24:00.0	1352	63.05
86	01:25:00.0	1352	63.09
87	01:26:00.0	1352	63.12
88	01:27:00.0	1352	63.16
89	01:28:00.0	1352	63.20
90	01:29:00.0	1351	63.25
91	01:30:00.0	1351	63.28
92	01:31:00.0	1351	63.33
93	01:32:00.0	1351	63.37
94	01:33:00.0	1351	63.43
95	01:34:00.0	1351	63.46
96	01:35:00.0	1351	63.50
97	01:36:00.0	1350	63.54
98	01:37:00.0	1350	63.57
99	01:38:00.0	1350	63.61
100	01:39:00.0	1350	63.64
101	01:40:00.0	1350	63.68
102	01:41:00.0	1349	63.71
103	01:42:00.0	1349	63.75
104	01:43:00.0	1349	63.78
105	01:44:00.0	1349	63.81
106	01:45:00.0	1349	63.85
107	01:46:00.0	1349	63.88
108	01:47:00.0	1349	63.91
109	01:48:00.0	1349	63.95
110	01:49:00.0	1349	63.99
111	01:50:00.0	1349	64.03
112	01:51:00.0	1348	64.07
113	01:52:00.0	1348	64.10
114	01:53:00.0	1348	64.14
115	01:54:00.0	1348	64.18
116	01:55:00.0	1348	64.21
117	01:56:00.0	1348	64.25
118	01:57:00.0	1348	64.29
119	01:58:00.0	1348	64.32
120	01:59:00.0	1348	64.37
121	02:00:00.0	1348	64.41

122	02:01:00.0	1349	64.44
123	02:02:00.0	1349	64.48
124	02:03:00.0	1349	64.53
125	02:04:00.0	1349	64.59
126	02:05:00.0	1349	64.63
127	02:06:00.0	1349	64.67
128	02:07:00.0	1349	64.71
129	02:08:00.0	1349	64.75
130	02:09:00.0	1349	64.78
131	02:10:00.0	1349	64.83
132	02:11:00.0	1349	64.85
133	02:12:00.0	1350	64.89
134	02:13:00.0	1350	64.92
135	02:14:00.0	1350	64.97
136	02:15:00.0	1350	65.01
137	02:16:00.0	1351	65.06
138	02:17:00.0	1351	65.12
139	02:18:00.0	1351	65.11
140	02:19:00.0	1351	65.13
141	02:20:00.0	1351	65.17
142	02:21:00.0	1351	65.21
143	02:22:00.0	1352	65.24
144	02:23:00.0	1352	65.28
145	02:24:00.0	1352	65.32
146	02:25:00.0	1352	65.36
147	02:26:00.0	1353	65.42
148	02:27:00.0	1353	65.46
149	02:28:00.0	1353	65.52
150	02:29:00.0	1354	65.55
151	02:30:00.0	1354	65.59
152	02:31:00.0	1354	65.64
153	02:32:00.0	1355	65.68
154	02:33:00.0	1355	65.73
155	02:34:00.0	1356	65.79
156	02:35:00.0	1356	65.84
157	02:36:00.0	1356	65.89
158	02:37:00.0	1357	65.94

159	02:38:00.0	1357	65.99
160	02:39:00.0	1358	66.03
161	02:40:00.0	1358	66.08
162	02:41:00.0	1359	66.14
163	02:42:00.0	1359	66.19
164	02:43:00.0	1360	66.24
165	02:44:00.0	1360	66.29
166	02:45:00.0	1361	66.34
167	02:46:00.0	1361	66.40
168	02:47:00.0	1362	66.44
169	02:48:00.0	1362	66.50
170	02:49:00.0	1363	66.55
171	02:50:00.0	1363	66.59
172	02:51:00.0	1363	66.62
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174	02:53:00.0	1363	66.66
175	02:54:00.0	1363	66.67
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178	02:57:00.0	1362	66.71
179	02:58:00.0	1362	66.74
180	02:59:00.0	1362	66.75
181	03:00:00.0	1362	66.77
182	03:01:00.0	1362	66.80
183	03:02:00.0	1362	66.81
184	03:03:00.0	1361	66.84
185	03:04:00.0	1361	66.86
186	03:05:00.0	1361	66.87
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188	03:07:00.0	1361	66.92
189	03:08:00.0	1361	66.95
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204	03:23:00.0	1361	67.35
205	03:24:00.0	1361	67.37
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207	03:26:00.0	1361	67.42
208	03:27:00.0	1361	67.44
209	03:28:00.0	1361	67.46
210	03:29:00.0	1361	67.49
211	03:30:00.0	1361	67.52
212	03:31:00.0	1361	67.53
213	03:32:00.0	1361	67.57
214	03:33:00.0	1362	67.59
215	03:34:00.0	1362	67.61
216	03:35:00.0	1362	67.65
217	03:36:00.0	1362	67.67
218	03:37:00.0	1362	67.70
219	03:38:00.0	1362	67.73
220	03:39:00.0	1362	67.76
221	03:40:00.0	1362	67.78
222	03:41:00.0	1363	67.82
223	03:42:00.0	1363	67.84
224	03:43:00.0	1363	67.87
225	03:44:00.0	1363	67.90
226	03:45:00.0	1363	67.94
227	03:46:00.0	1364	67.98
228	03:47:00.0	1364	68.02
229	03:48:00.0	1365	68.07
230	03:49:00.0	1365	68.11
231	03:50:00.0	1365	68.16
232	03:51:00.0	1366	68.19

233	03:52:00.0	1366	68.23
234	03:53:00.0	1367	68.28
235	03:54:00.0	1367	68.33
236	03:55:00.0	1368	68.37
237	03:56:00.0	1369	68.43
238	03:57:00.0	1369	68.46
239	03:58:00.0	1369	68.50
240	03:59:00.0	1370	68.54
241	04:00:00.0	1370	68.57
242	04:01:00.0	1370	68.60
243	04:02:00.0	1371	68.63
244	04:03:00.0	1371	68.66
245	04:04:00.0	1371	68.68
246	04:05:00.0	1371	68.69
247	04:06:00.0	1371	68.71
248	04:07:00.0	1371	68.72
249	04:08:00.0	1371	68.74
250	04:09:00.0	1371	68.76
251	04:10:00.0	1372	68.78
252	04:11:00.0	1372	68.80
253	04:12:00.0	1372	68.83
254	04:13:00.0	1372	68.86
255	04:14:00.0	1372	68.89
256	04:15:00.0	1373	68.93
257	04:16:00.0	1373	68.96
258	04:17:00.0	1374	69.00
259	04:18:00.0	1374	69.04
260	04:19:00.0	1374	69.08
261	04:20:00.0	1374	69.12
262	04:21:00.0	1375	69.15
263	04:22:00.0	1375	69.18
264	04:23:00.0	1375	69.20
265	04:24:00.0	1376	69.24
266	04:25:00.0	1376	69.28
267	04:26:00.0	1376	69.31
268	04:27:00.0	1377	69.36
269	04:28:00.0	1377	69.41



270	04:29:00.0	1378	69.46
271	04:30:00.0	1379	69.50
272	04:31:00.0	1379	69.55
273	04:32:00.0	1380	69.59
274	04:33:00.0	1381	69.63
275	04:34:00.0	1381	69.67
276	04:35:00.0	1382	69.72
277	04:36:00.0	1382	69.76
278	04:37:00.0	1383	69.80
279	04:38:00.0	1383	69.83
280	04:39:00.0	1384	69.86
281	04:40:00.0	1384	69.90
282	04:41:00.0	1385	69.93
283	04:42:00.0	1385	69.97
284	04:43:00.0	1386	70.00
285	04:44:00.0	1386	70.03
286	04:45:00.0	1386	70.06
287	04:46:00.0	1387	70.08
288	04:47:00.0	1387	70.11
289	04:48:00.0	1388	70.14
290	04:49:00.0	1388	70.17
291	04:50:00.0	1388	70.19
292	04:51:00.0	1389	70.23
293	04:52:00.0	1389	70.27
294	04:53:00.0	1390	70.30
295	04:54:00.0	1390	70.33
296	04:55:00.0	1391	70.36
297	04:56:00.0	1391	70.40
298	04:57:00.0	1392	70.44
299	04:58:00.0	1392	70.48
300	04:59:00.0	1393	70.53
301	05:00:00.0	1393	70.57
302	05:01:00.0	1394	70.61
303	05:02:00.0	1395	70.66
304	05:03:00.0	1395	70.70
305	05:04:00.0	1396	70.75
306	05:05:00.0	1397	70.80


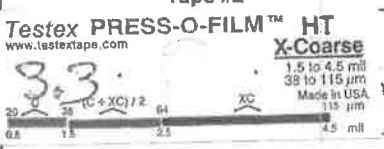
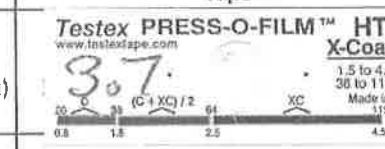
307	05:06:00.0	1398	70.84
308	05:07:00.0	1398	70.89
309	05:08:00.0	1399	70.92
310	05:09:00.0	1399	70.94
311	05:10:00.0	1400	70.96
312	05:11:00.0	1401	70.99
313	05:12:00.0	589	71.02
314	05:13:00.0	591	71.06
315	05:14:00.0	592	71.11
316	05:15:00.0	592	71.15
317	05:16:00.0	590	71.19
318	05:17:00.0	148	71.24
319	05:18:00.0	41	71.28
320	05:19:00.0	23	71.32
321	05:20:00.0	16	71.36
322	05:21:00.0	12	71.40
323	05:22:00.0	10	71.44
324	05:23:00.0	8	71.47
325	05:24:00.0	3	71.52

# QUALITY STEEL COATINGS, INC.

## Project Inspection Report

Job Number: 11048 Customer: GAS TECH  
 Description: 72" SEPARATOR, 2" SPOOL PO 634510

Blast Data SSPC-SP10

Date: <u>09-26</u> -2018			Temperature(°F): <u>72</u> °F			Humidity(%): <u>69</u> %		
<b>Tape #1</b>  Reading #1 (mils) <u>3.4</u> (Gage less 2.0 mils or 50um)			<b>Tape #2</b>  Reading #2 (mils) <u>3.3</u> (Gage less 2.0 mils or 50um)			<b>Tape #3</b>  Reading #3 (mils) <u>3.7</u> (Gage less 2.0 mils or 50um)		

### Paint

<b>Primer Coat</b>		
Time: <u>4:30</u> AM/PM	Surface Temp. (°F): <u>84</u> °F	Color: GRAY
Date: <u>09-26</u> -2018	Brand of Paint: SHERWIN WILLIAMS	Type: MACROPOXY 646
Air Temp. (°F): <u>80</u> °F	Humidity (%): <u>55</u> %	DP (°F): <u>62</u>
Batch No: <u>xm2418WK</u>	Batch No: <u>xm2208CG</u>	DFT(mils): 5-7 MILS
Supplier Part #:	Supplier Part #:	

<b>Intermediate Coat</b>		
Time: <u>8:00</u> AM/PM	Surface Temp. (°F): <u>88</u> °F	Color: GRAY
Date: <u>09-27</u> -2018	Brand of Paint: SHERWIN WILLIAMS	Type: MACROPOXY 646
Air Temp. (°F): <u>85</u> °F	Humidity (%): <u>38</u> %	DP (°F): <u>43</u> °F
Batch No: <u>xm2418WK</u>	Batch No: <u>xm2208CG</u>	DFT(mils): 5-7 MILS
Supplier Part #:	Supplier Part #:	

<b>Finish Coat</b>		
Time: <u>3:45</u> PM	Surface Temp. (°F): <u>90</u> °F	Color: GRAY FSC# 16187
Date: <u>09-27</u> -2018	Brand of Paint: SHERWIN WILLIAMS	Type: HS POLYURETHANE
Air Temp. (°F): <u>87</u> °F	Humidity (%): <u>35</u> %	DP (°F): <u>40</u> °F
Batch No: <u>xm2278ZJ</u>	Batch No: <u>mq2198TN</u>	DFT(mils): 2-3 MILS
Supplier Part #:	Supplier Part #:	

Comments: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Paint Supervisor: EDGAR RODRIGUEZ Date: 09-27-2018

GAS TECH

PO 634510

**Coating Project Definition**Job Number 11048

Drawing No. \_\_\_\_\_

Description 72" SEPARATOR, 2" SPOOLCoating Company QUALITY STEEL COATINGS**Dry Film Testing****MEK Resistance Test Results**Date: 09-27-2018Time: 7:30 AM/PM☐ ACCEPT ☐ REJECT ☒ N/A

# of Sets	1	2	3	Average	
<b>PRIMER COAT DFT READINGS</b>					
1	6.30	6.60	6.40	6.43	
2	5.60	6.10	5.90	5.87	
3	6.80	6.10	6.30	6.40	
4	5.60	5.90	6.50	6.00	
				6.18	TOTAL DFT AVERAGE MILS
<b>INTERMEDIATE COAT DFT READINGS</b> <u>09-27-2018-3:00pm</u>					
1	13.40	13.60	13.00	13.33	
2	12.70	12.90	13.00	12.87	
3	13.70	13.20	13.50	13.47	
4	12.50	12.90	13.00	12.80	
				13.12	TOTAL DFT AVERAGE MILS
<b>FINISH COAT DFT READINGS</b> <u>09-28-2018</u>					
1	15.80	16.40	16.70	16.30	
2	16.50	16.20	15.70	16.13	
3	16.50	16.30	16.80	16.53	
4	15.70	16.00	16.60	16.10	
				16.27	TOTAL DFT AVERAGE MILS

Coating Company Rep EDUARDO RODRIGUEZDate: 09-28 -2018

Customer Inspector \_\_\_\_\_

Date: - -2018

Date: - -2018

# QUALITY STEEL COATINGS, INC.

## Project Inspection Report

Job Number: 11048 Customer: GAS TECH  
Description: VALVES, FLANGES, PIPE PO 634510

Blast Data SSPC-SP10

Date: <u>10-02-2018</u> Temperature(°F): <u>78</u> °F Humidity(%): <u>46</u> %		
<b>Tape #1</b> Testex PRESS-O-FILM™ HT X-Coarse www.testextape.com 3.6 1.5 to 4.5 mil 38 to 115 µm Made in USA 115 µm 4.5 mil	<b>Tape #2</b> Testex PRESS-O-FILM™ HT X-Coarse www.testextape.com 3.4 1.5 to 4.5 mil 38 to 115 µm Made in USA 115 µm 4.5 mil	<b>Tape #3</b> Testex PRESS-O-FILM™ HT X-Coarse www.testextape.com 3.0 1.5 to 4.5 mil 38 to 115 µm Made in USA 115 µm 4.5 mil
Reading #1 (mils) <u>2.8</u> (Gage less 2)	Reading #2 (mils) <u>2.8</u> (Gage less 2)	Reading #3 (mils) <u>2.8</u> (Gage less 2)

<b>Primer Coat</b>		
Time: <u>11:30</u> AM/PM	Surface Temp. (°F): <u>84</u> °F	Color: <u>GRAY</u>
Date: <u>10-02-2018</u>	Brand of Paint: <u>SHERWIN WILLIAMS</u>	Type: <u>MACROPOXY 646</u>
Air Temp. (°F): <u>80</u> °F	Humidity (%): <u>43</u> %	DP (°F): <u>65</u>
Batch No: <u>xm2418wk</u>	Batch No: <u>xm2208cg</u>	DFT(mils): <u>5-7 MILS</u>
Supplier Part #:	Supplier Part #:	

<b>Intermediate Coat</b>		
Time: <u>10:00</u> AM/PM	Surface Temp. (°F): <u>80</u> °F	Color: <u>GRAY</u>
Date: <u>10-03-2018</u>	Brand of Paint: <u>SHERWIN WILLIAMS</u>	Type: <u>MACROPOXY 646</u>
Air Temp. (°F): <u>77</u> °F	Humidity (%): <u>67</u> %	DP (°F): <u>62</u> °F
Batch No: <u>xm2418wk</u>	Batch No: <u>xm2208cg</u>	DFT(mils): <u>5-7 MILS</u>
Supplier Part #:	Supplier Part #:	

<b>Finish Coat</b>		
Time: <u>4:00</u> AM/PM	Surface Temp. (°F): <u>93</u> °F	Color: <u>GRAY FSC#16187</u>
Date: <u>10-03-2018</u>	Brand of Paint: <u>SHERWIN WILLIAMS</u>	Type: <u>HS POLYURETHANE</u>
Air Temp. (°F): <u>89</u> °F	Humidity (%): <u>51</u> %	DP (°F): <u>69</u> °F
Batch No: <u>xm2278ZJ</u>	Batch No: <u>MQ2198TN</u>	DFT(mils): <u>2-3 MILS</u>
Supplier Part #:	Supplier Part #:	

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Paint Supervisor: EDGAR RODRIGUEZ Date: 10-03-2018

GAS TECH

PO 634510

**Coating Project Definition**Job Number 11048

Drawing No. \_\_\_\_\_

Description VALVES, FLANGES, PIPECoating Company QUALITY STEEL COATINGS**Dry Film Testing**Date: 10 - 02 -2018Time: 8:00 AM/PM**MEK Resistance Test Results**
☐ ACCEPT ☐ REJECT ☒ N/A  
 Paint System: 3 COAT

# of Sets	1	2	3	Average	
<b>PRIMER COAT DFT READINGS</b>					
1	6.7	6.2	6.4	6.4	
2	5.3	5.9	6.1	5.7	
3	6.0	5.5	6.3	5.9	
4	7.0	6.8	6.5	6.7	
				6.17	TOTAL DFT AVERAGE MILS
<b>INTERMEDIATE COAT DFT READINGS</b>					
1	12.8	13.1	11.9	12.6	
2	12.3	12.8	13.0	12.7	
3	13.3	12.7	12.5	12.8	
4	13.7	13.4	12.9	13.3	
				12.85	TOTAL DFT AVERAGE MILS
<b>FINISH COAT DFT READINGS</b>					
1	15.0	16.2	15.8	15.6	
2	16.3	16.7	16.4	16.4	
3	15.3	15.9	16.4	15.8	
4	16.1	16.7	15.8	16.2	
				16.0	TOTAL DFT AVERAGE MILS

Coating Company Rep JH

Customer Inspector \_\_\_\_\_

Date: 10 - 04 -2018

Date: \_\_\_\_\_ -2018

Date: \_\_\_\_\_ -2018

PAINT SYSTEM	TEMP. RANGE	EQUIPMENT COVERED	SURFACE PREPARATION	PRIME COAT	INTERMEDIATE COAT	FINISH COAT	TOTAL DFT mils
Williams System 3B per Specification 09 96	Uninsulated < 200°F	Horizontal Cyclone Separator Saddles & Supports Valves, Accessories, Piping	SSPC-SP10 Near White Metal Blast 2 - 4 mil Anchor Profile	Sherwin Williams Macropoxy 646 B58W610/V600 1 ct @ 5 - 7 mils DFT	Sherwin Williams Macropoxy 646 B58W610/V600 1 ct @ 5 - 7 mils DFT	Sherwin Williams Hi Solids Polyurethane S/G B65W351/B60V30 1 ct @ 2 - 3 Mils DFT Color: Gray, FSC 16187	12 - 17

**The following surfaces are not to be painted:**

- Any stainless steel surfaces.
- Galvanized structural steel, ladders, & platforms.
- Valve stems or other surfaces that require cyclic movement.
- Ground lugs on equipment.
- Electrical conduit & associated fittings.
- Name plates and data tags on equipment or accessories.

**The following surfaces are not to be blasted:**


- Accessories are to be chemically cleaned (NOT sandblasted) prior to coating.

Valve bodies should be lightly blasted to bare metal, primed, and painted.

**Note:**

- Please contact the GasTech Engineering Quality Control Department at (918) 663-8383, ext. 294, for inspection hold points and final inspection prior to Shipment to GasTech. No Equipment is to be shipped back to GasTech without an inspection release.

0	9/19/18	KN	KN	KN	For Fabrication
A	9/18/18	KN	KN	KN	For Approval
No.	DATE	BY	CHKD	APPD	DESCRIPTION
REVISIONS					

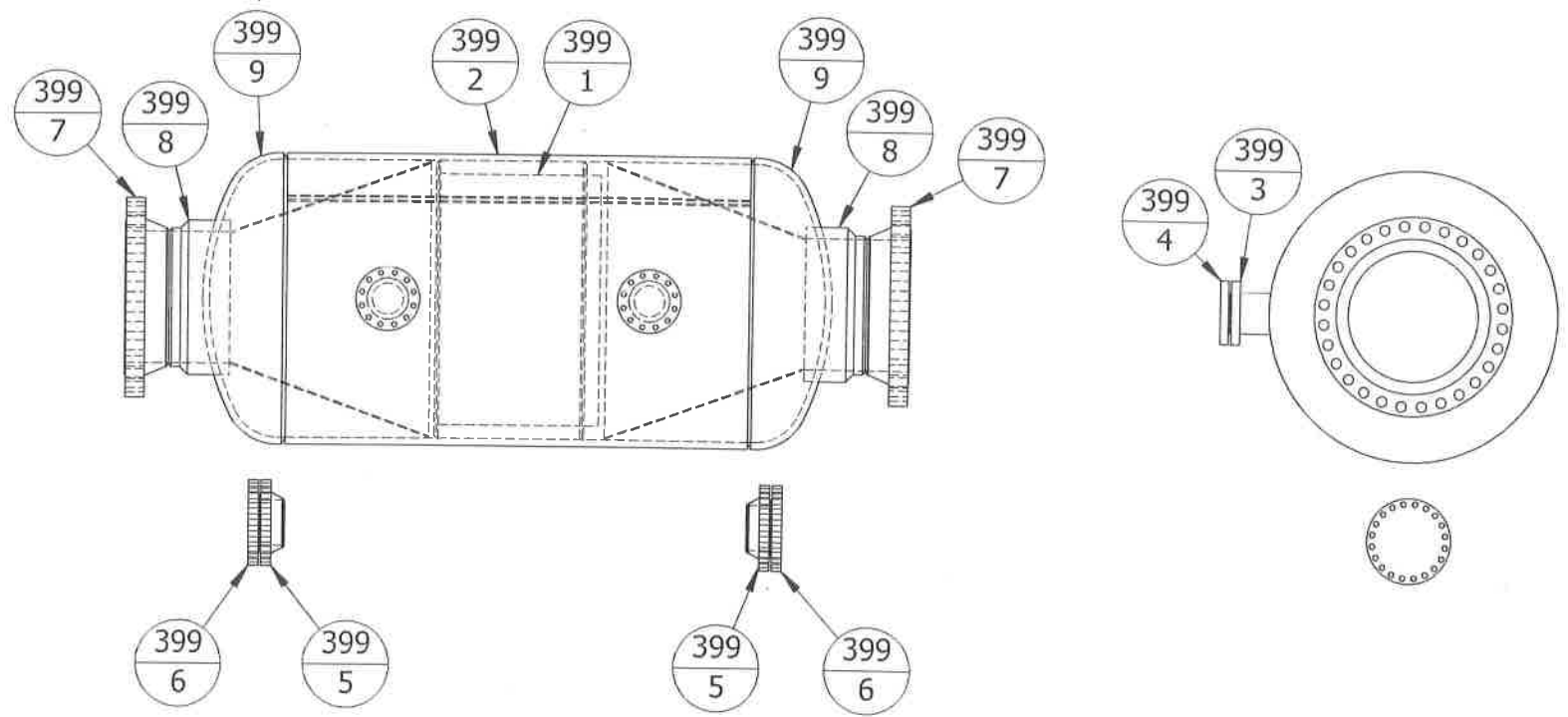
		S.O./CHARGE No. : 11048-41	
		DATE ACCESSED: 09/19/18	REV. No. 0
PAINT MATRIX FOR SO# 11048 - TRANSCONTINENTAL GAS PIPELINE, GULF CONNECTOR STATION 200, CHESTER COUNTY, TX, WO 1185731, VESSEL TAG#V-1414			
FILE No. :	SCALE: N/A	APP'D: KN	DRAWING NUMBER: SP-11048-0599
DRAWN BY: KN	DATE: 09/18/18	CHK'D: KN	SHT. 1 OF 1

REV	ITEM NO.	QTY.	DESCRIPTION	LENGTH	MATERIAL	WEIGHT	TOTAL WT.	NOTES
	1	2	COUPLING, 1" 6000# THREADED	2 3/8"	SA-105	1.90	3.8	7650
	2	4	ELBOW, 2" SCH 160 LR 90°		SA-234 WPB	2.83	11.32	7x1m24 2x1m39
	3	2	FLANGE, 2" 600# RFLWN	9"	SA-105 N	20.06	40.12	CWR
	4	5	FLANGE, 2" 600# RFWN (SCH 160 BORE)		SA-105 N	10.26	51.3	DBO
	5	1	LONG LEAD ITEMS, VESSEL (PER 11048-399 BOM)		SEE BOM	-	0	
	6	2	HINGE AND HANDLE DETAILS FOR 8" 600# FLANGE (PER DWG SP-0049-19)		SEE BOM	9.82	19.64	
	7	2	HINGE AND HANDLE DETAILS FOR 12" 600# FLANGE (PER DWG SP-0049-21)		SEE BOM	9.82	19.64	
	8	1	NAMEPLATE BRACKET, GASTECH STD (PER DWG SP-0034)		SEE BOM	4	4	
	9	1	NAMEPLATE GASTECH STD CODE (PER SP-1018)		SEE BOM	0.46	0.46	
	10	1	PIPE, 12" SCH 60 (BBE)	10'-0"	SA-106B	721.28	721.28	52156
	11	3	PIPE, 2" SCH 160 (BBE)	5 1/4"	SA-106B	3.2	9.6	1016383873
	12	1	PIPE, 2" SCH 160 (BBE)	9 1/4"	SA-106B	5.7	5.7	1016383873
	13	1	PIPE, 2" SCH 160 (BBE)	7 7/16"	SA-106B	4.6	4.6	1016383873
	14	4	PIPE, 2" SCH 160 (BOE)	3 5/16"	SA-106B	2.0	8	1016383873
	15	2	PIPE, 6" SCH XXS (PBE)	1'-6"	SA-106C	78.81	157.62	61617
	16	2	PLATE, 1" THK (PER DETAIL)	10"	SA-36	22.48	44.96	8502289-01
	17	4	PLATE, 1/4" X 1 7/8" (PER DETAIL)	2"	SA-36	0.25	1	18009301
	18	2	PLATE, 1/4" X 4" (PER DETAIL)	4"	SA-36	0.77	1.54	18009301
	19	1	WELDOLET, 2" SCH 160 ON 6" RUN		SA-105	1.463	1.463	50126
	20	1	WELDED ASSEMBLY, SADDLE - HOLES (PER DWG 11048-360)		SEE BOM	852.71	852.71	
	21	1	WELDED ASSEMBLY, SADDLE - SLOTTED (PER DWG 11048-361)		SEE BOM	851.87	851.87	
1	22	2	PIPE, 16" SCH 40 (PBE)		SA-106B	40.16	80.32	802674

RELEASED FOR FAB

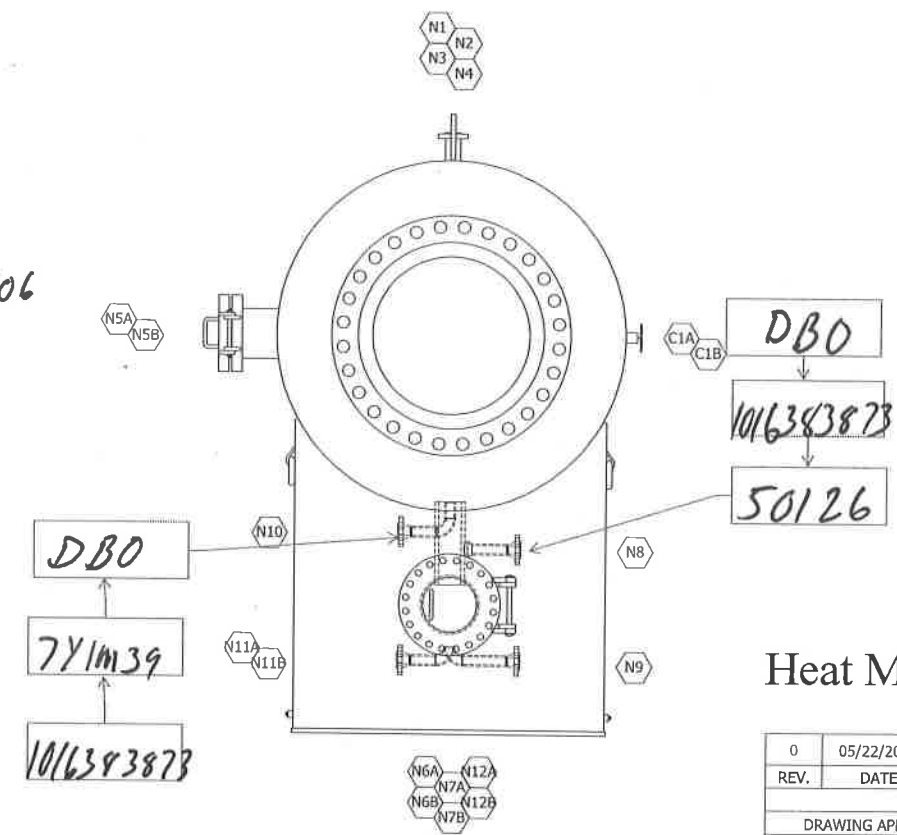
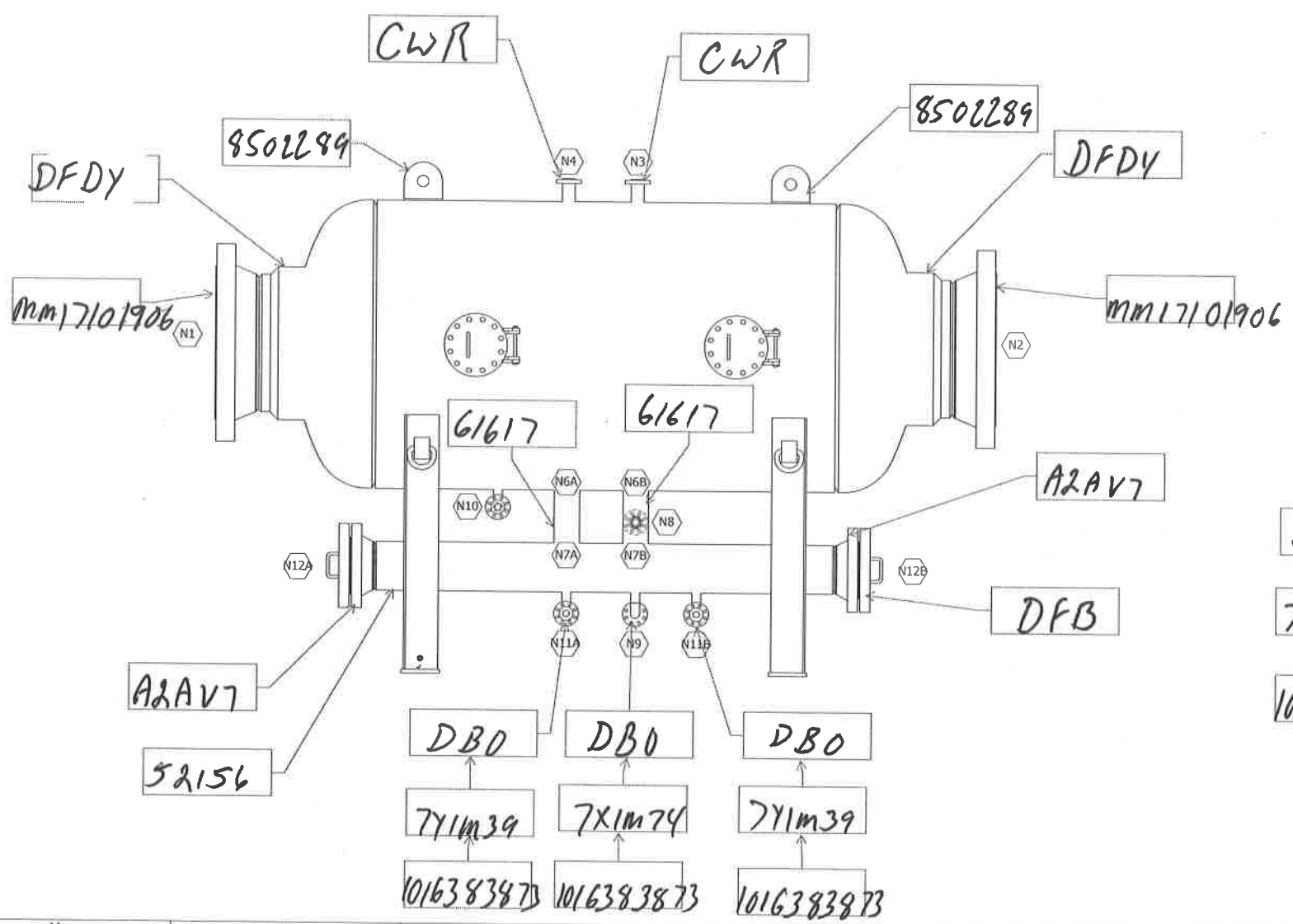
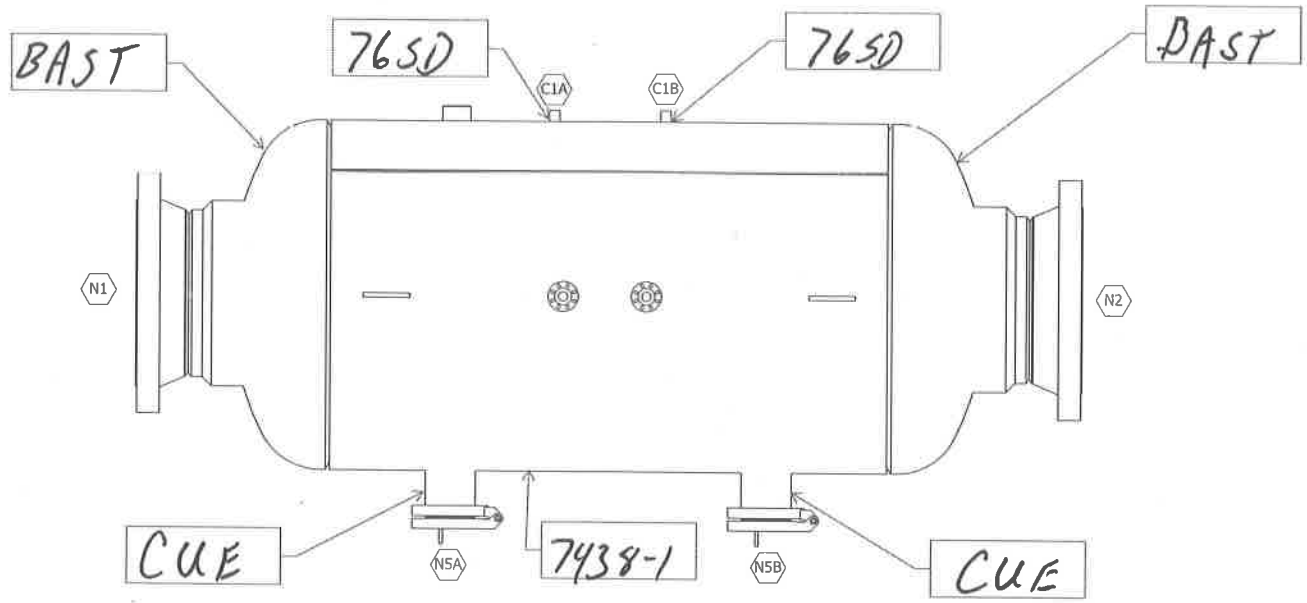


REV	LLI ITEM NO.	ITEM NO.	QTY.	DESCRIPTION	LENGTH	MATERIAL	WEIGHT	TOTAL WT.	NOTES
D	399-0001	1✓	1	INTERNALS, LIQUID-LIQUID COALESCER, VESSEL ID 72", CARBON STEEL INTERNALS BUNDLE, 115-120 CYCLONES, (2) INTERNAL GUIDE CONES C.S.		CS	7077.27	7077.27	D81621
	399-0002	2✓	1	CYLINDER, 6'-0" ID X 1 3/4" THK (BBE)	10'-0"	SA-516-70 N	13769.59	13769.59	7438-1
	399-0003	3✓	2	FLANGE, 8" 600# RFLWN (COPEd)	1'- 1/2"	SA-105 N	210.62	421.24	CUE
	399-0004	4✓	2	FLANGE, 8" 600# RF BLIND		SA-105 N	129.80	259.6	CTO
	399-0005	5✓	2	FLANGE, 12" 600# RFWN (SCH 60 BORE)		SA-105 N	233.54	467.08	A2AV7
	399-0006	6✓	2	FLANGE, 12" 600# RF BLIND		SA-105 N	273.41	546.82	DFB
	399-0007	7✓	2	FLANGE, 36" 600# RFWN SERIES "A" (34" BORE)		SA-350 LF2 CL1 N	1863.64	3727.28	MM17101906
C	399-0008	8✓	2	DETAIL, CUSTOM FORGING (PER DWG 11048-390)		SEE BOM	1300.80	2601.6	DFDY
	399-0009	9✓	2	HEAD, 2:1 ELLIP X 6'-0" ID X 1 3/4" NOM THK (1.625" MIN THK) W/2" SF & 30° BEVEL		SA-516-70 N	3189.21	6378.42	BAST



**11048-399**

RELEASED FOR FAB





Heat Map

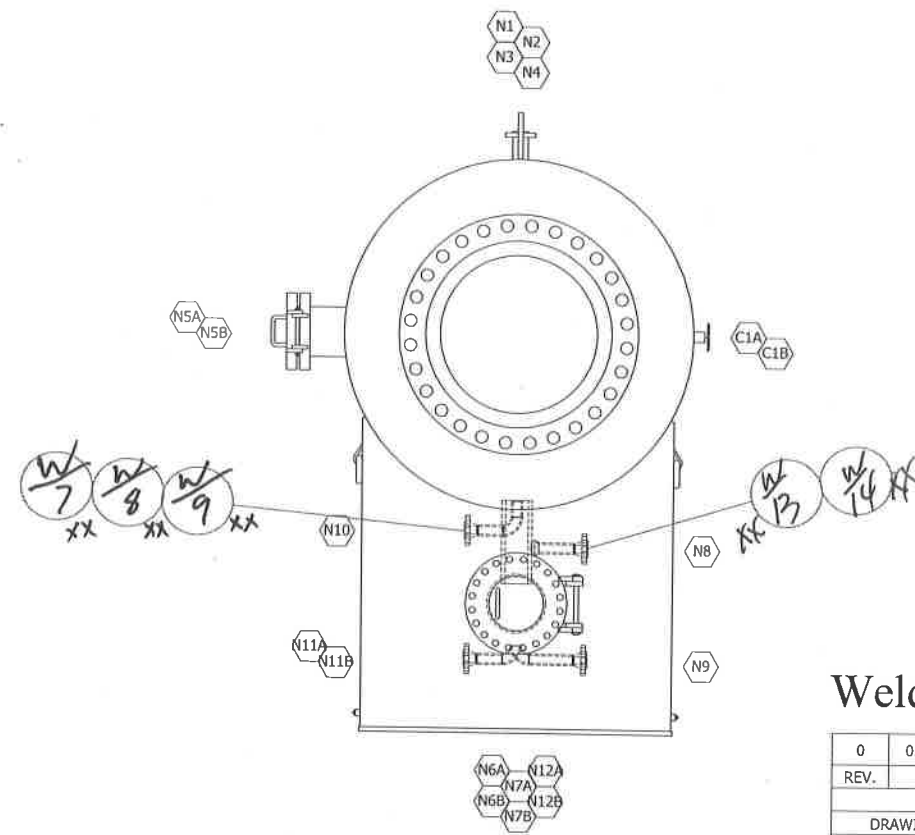
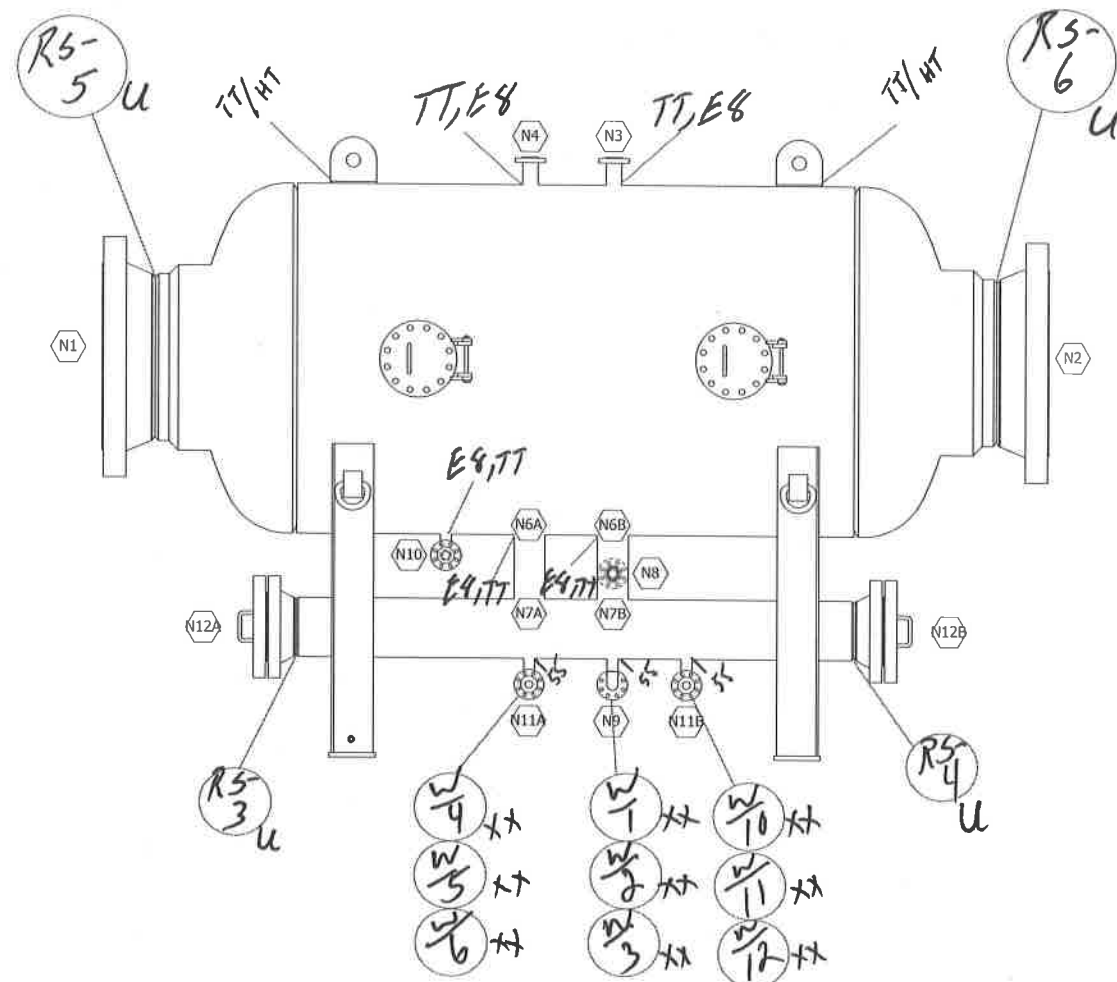
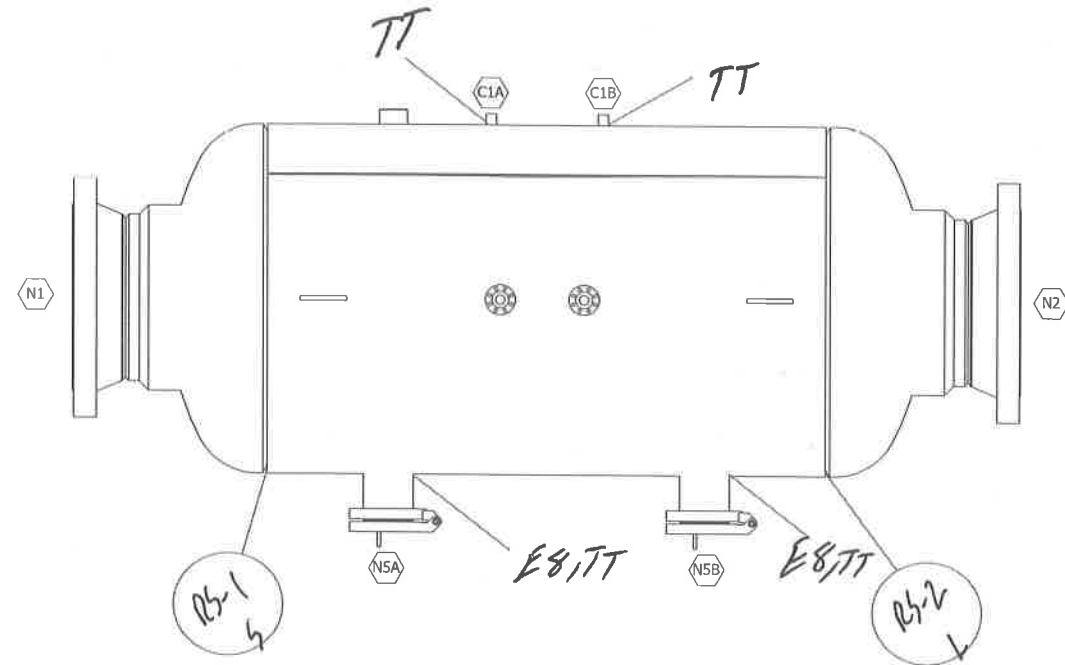
11048-300

CUSTOMER INFO  
WILLIAMS - COMPRESSOR STATION  
200, CHESTER CO, PA

DESIGN INFO  
72" ID X 10'-0" S/S WITH 12" OD X  
10'-0" S/S SLUMP X 860 PSIG @  
-20°F/200°F




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0	05/22/2018	JA	SH	KN	ISSUED FOR FABRICATION	
REV.	DATE	BY	CHKD	APPD	DESCRIPTION	
DRAWING APPROVALS					<div>2110 INDUSTRIAL ROAD SAPULPA, OK 74066 (918) 663-8383</div>	
INITIALS		DATE				
DRAWN	ND	05/22/2018				
CHECKED	SH	05/22/2018				
APPROVED	KN	05/22/2018				
THIRD ANGLE PROJECTION			TITLE			
<div></div>			WELDED ASSEMBLY, VESSEL			
			SIZE	JOB NUMBER	DRAWING NO.	REV
			D	11048	11048-950	0
DIMENSIONS ARE IN INCHES WITH TOLERANCES ±1/8" UNLESS OTHERWISE NOTED				PO#	676280	SHEET 1 OF 2



## Weld Map

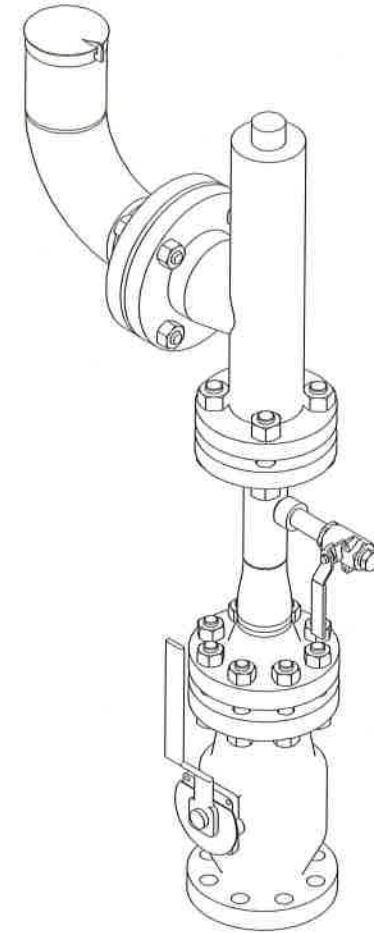
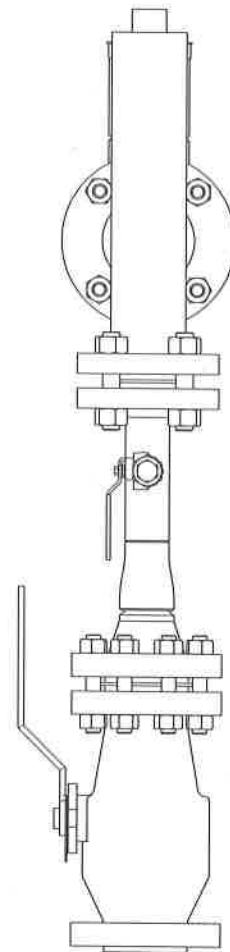
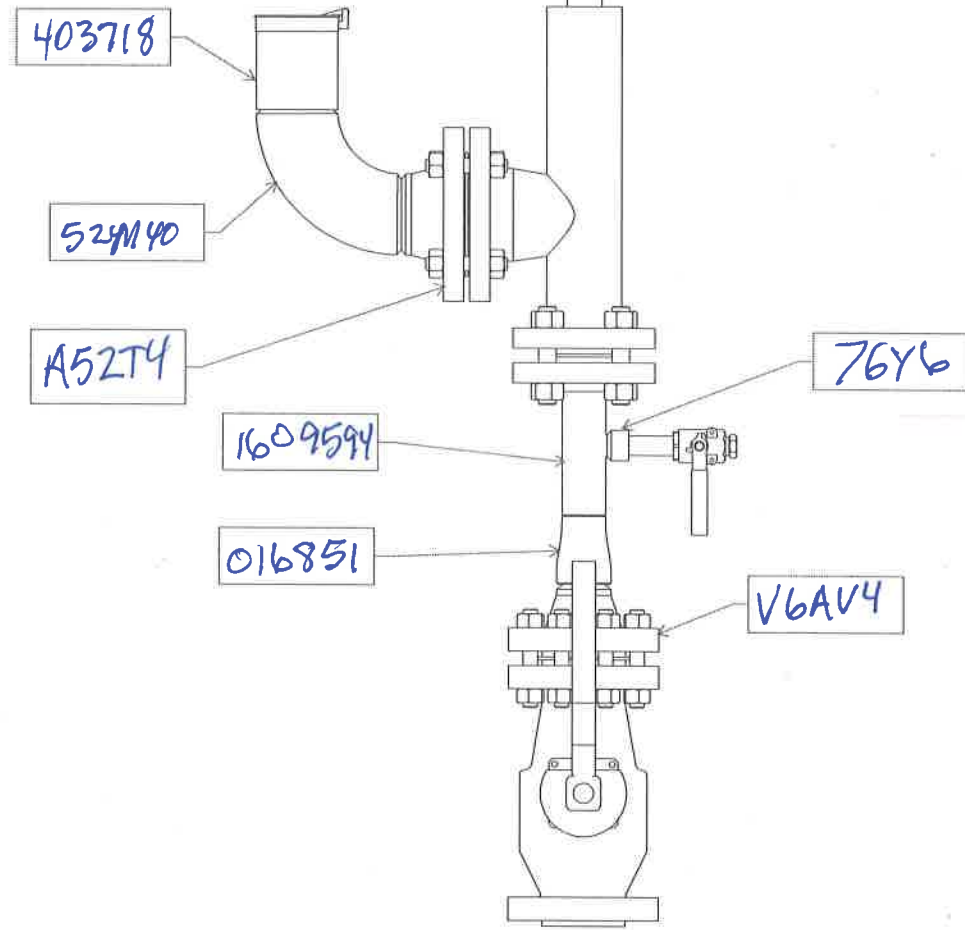
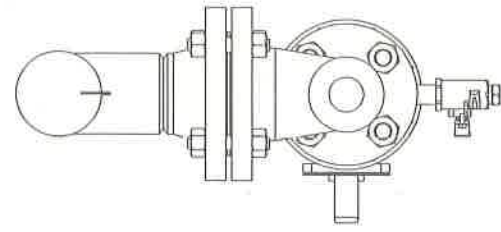
**11048-300**

0	05/22/2018	JA	SH	KN	ISSUED FOR FABRICATION	
REV.	DATE	BY	CHKD	APPD	DESCRIPTION	
REVISION HISTORY						
DRAWING APPROVALS					2110 INDUSTRIAL ROAD SAPULPA, OK 74066 (918) 663-8383	
INITIALS		DATE				
DRAWN	ND	05/22/2018				
CHECKED	SH	05/22/2018				
APPROVED	KN	05/22/2018	TITLE			
THIRD ANGLE PROJECTION			WELDED ASSEMBLY, VESSEL			
						
DIMENSIONS ARE IN INCHES WITH TOLERANCES $\pm 1/8"$ UNLESS OTHERWISE NOTED			SIZE	JOB NUMBER	DRAWING NO.	REV
			D	11048	11048-950	
			FO# 676280		SHEET	1 OF 2

CUSTOMER INFO  
 WILLIAMS - COMPRESSOR STATION  
 200, CHESTER CO, PA

DESIGN INFO  
 72" ID X 10'-0" S/S WITH 12" OD X  
 10'-0" S/S SLUMP X 860 PSIG @  
 -20°F/200°F

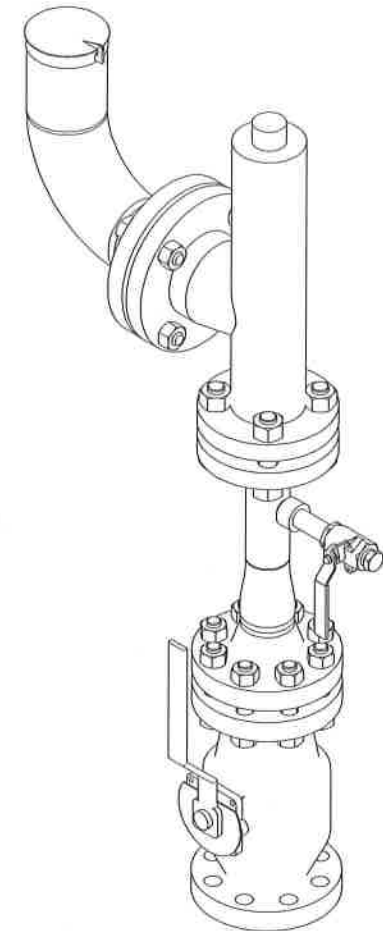
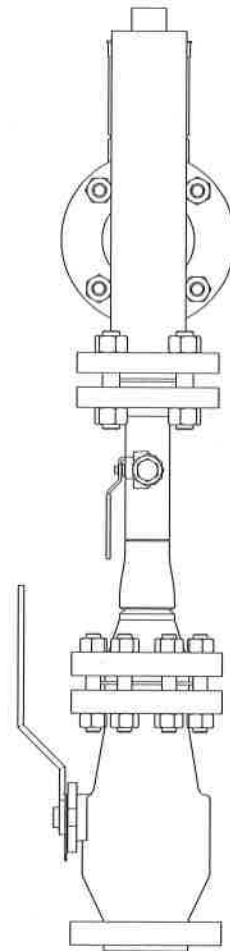
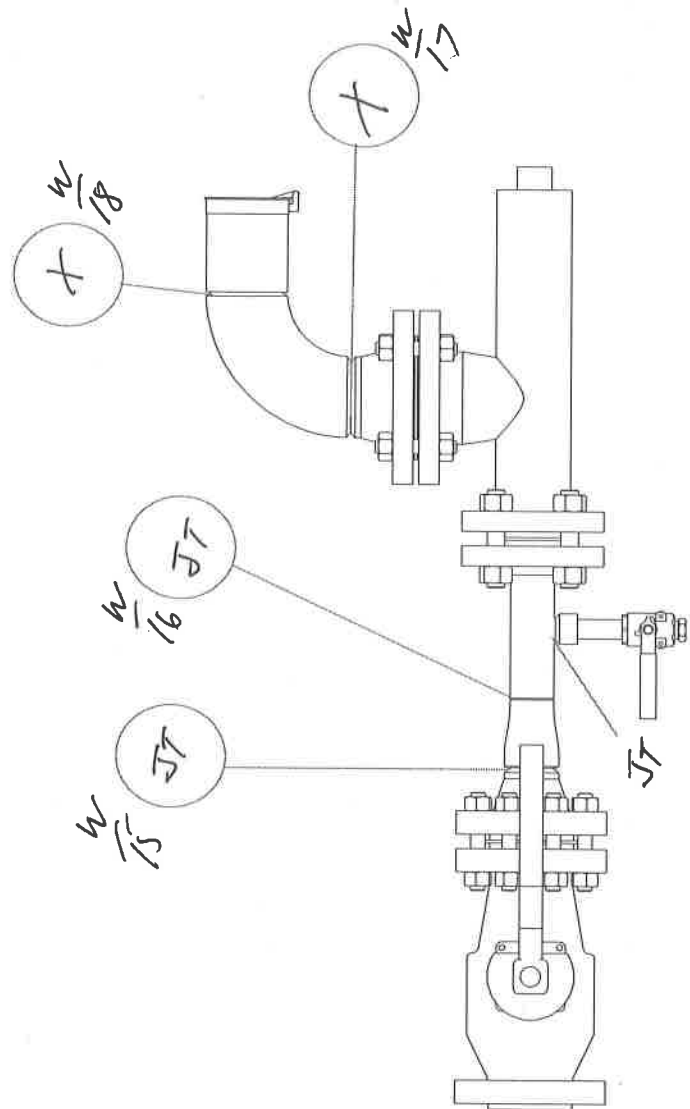
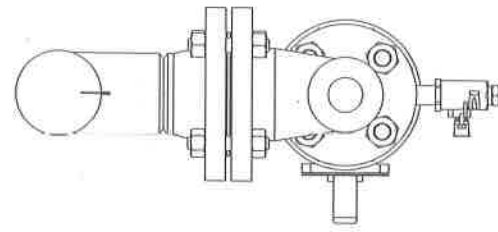
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 ANY OTHER PURPOSE EXCEPT AS SPECIFICALLY PERMITTED IN WRITING FROM GASTECH ENGINEERING LLC.



# Heat Map 11048-601

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		2110 INDUSTRIAL ROAD SAPULPA, OK 74066 (918) 663-8383	
SIZE	JOB NUMBER	DRAWING NO.	REV
D	11048	11048-950	0
PO# 676280	SHEET 2 OF 2		



# Weld Map 11048-601

		2110 INDUSTRIAL ROAD SAPULPA, OK 74066 (918) 663-8383	
SIZE	JOB NUMBER	DRAWING NO.	REV
D	11048	11048-950	0
PO#	676280	SHEET	2 OF 2

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NB 3379

Page 1 of 2

**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 Greens Bayou Pipe Mill 13935 Industrial Road Houston, Texas 77015

(Name and address of Manufacturer)

2. Manufactured for Northshore Supply 13935 Industrial Road, Houston, Texas 77015  
 (Name and address of Purchaser)

3. Location of installation Unknown  
 (Name and address)

4. Type 1 Shell 7438-1   
 (Description of vessel part (shell, two-piece head, tube bundle)) (Manufacturer's serial number) (CRN)  
    
 (National Board number) (Drawing number) (Drawing prepared by) (Year built)

5. ASME Code, Section VIII, Div. 1 2017    
 (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 10'-0"

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	72" ID	10'-0"	SA516-70-N		1.75"	*	1	Full	*					

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)  (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)													

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

9. Impact test Yes - Base, Haz., Weld at test temperature of -20 F  
 (Indicate yes or no and the component(s) impact tested)

10. Hydro., pneu., or comb. test pressure None 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	

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

13. Supports: Skirt No Lugs  Legs  Other  Attached   
 (Yes or no) (Number) (Number) (Describe) (Where and how)

14. Remarks

\*No Design Functions by Greens Bayou Pipe Mill: WPS is qualified with or without PWHT. Formed In Accordance with UG 79, UG 80 and UCS 79.

NB 3379

## FORM U-2A

Page 2 of 2

Manufactured by Greens Bayou Pipe Mill  
Manufacturer's Serial No. 7438-1 CRN                      National Board No.                     

## 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 or PRT Certificate of Authorization no. 42,546 Expires 01/19/2021  
Date 05/03/2018 Name Greens Bayou Pipe Mill Signed                       
(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 Authorized Inspection Associates, LLC of                     

have inspected the pressure vessel part described in this Manufacturer's Data Report on 05/03/2018, 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 or connected with this inspection.

Date 05/03/2018 Signed                      Commissions NR13919AIR  
(Authorized Inspector) (National Board Authorized Inspector Commission number)

(07/17)

PO# 635542

11048-399-2

R. LEE

MAY 15 2018

**North Shore  
Steel Company**

1566 Miles Street

P. O. Box 9940

Houston, Texas 77213-0940

**Phone:** 713.453.3533

**Toll Free:** 877.453.3533

**Fax:** 713.671.5500

**Web:** [www.nssco.com](http://www.nssco.com)

**CERTIFICATE OF COMPLIANCE**

North Shore Steel Company Inc. certifies that all requirements have been met for PO# 635542 SO# 1339294

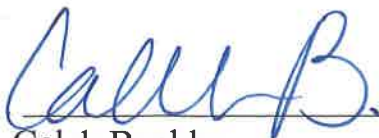
Heat #

Slab #

8500985

02

Per UG-80 & UG-79



Caleb Buckles

DOCUMENTATION INSPECTOR

May 7, 2018

Date

**R. LEE**

**MAY 15 2018**

11048-399-2

PO# 635542





# MAVERICK TESTING LABORATORIES, INC.

10001 Porter Rd, Suite 100 La Porte, Texas 77571

Ph. 281-888-8210 Fax. 281-888-8212

Welding Procedures - Welder Performance - Materials Testing

Where Personal Service & Quality Meet



American Welding Society

Sustaining Company Member



ISO 9001:2008  
Certified  
CERT-0067606

Company: Greens Bayou Pipe Mill  
13935 Industrial Rd  
Houston, Tx 77015

Contact: Pete Cloud

Date Rec'd 04/23/2018

Date Due: 04/24/2018

PO No.: 21953

Quote: 18-0552.0

Lab No.: PD18-197

## 1.750" SA-516 Gr.70N Welded Plate

CVN per ASME Sec. VIII Div.1 UG-84 - Heat No.: 8500986

Job: 7393 7438 W/D 5/3/18

### Post-Weld Heat Treatment

Heat treatment conducted @ 1150°F for 1.75 hours.

Heating rate: 229°F/Hr. (Max) above 800°F to soak Cooling rate: 286°F/Hr. (Max) from soak to 800 °F.

### ASTM A370 Charpy Impact Tests

Size: 10 x 10mm x 2v

Specification: Fig. UG-84.5 Table UG-84.6

Orientation: Transverse

Test Method: ASTM E23

Specimen Type: Type A

Location	Temperature	Impact Value (ft-lbf)				Lateral Expansion (x 0.001")			Percent Shear Fracture		
		Individual			Avg.	77	44	104	90	40	95
WCL-Cap	-20°F	123	47	149	106.3						
WCL 1/4" Outer Side	-20°F	19	31	18	22.7	21	20	20	30	30	30
HAZ 1/3rd T-Cap	-20°F	135	160	127	140.7	89	102	89	95	100	95
HAZ 1/3rd T - Root	-20°F	77	22	21	40.0	59	25	26	75	25	25

Impact specimens removed in accordance with Fig. UG-84.5 & Table UG-84.6.

Maverick Testing Laboratories, Inc. Representative

*Brad Berglan*  
Brad Berglan

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Page 1 of 1  
R. LEE

MAY 15 2018

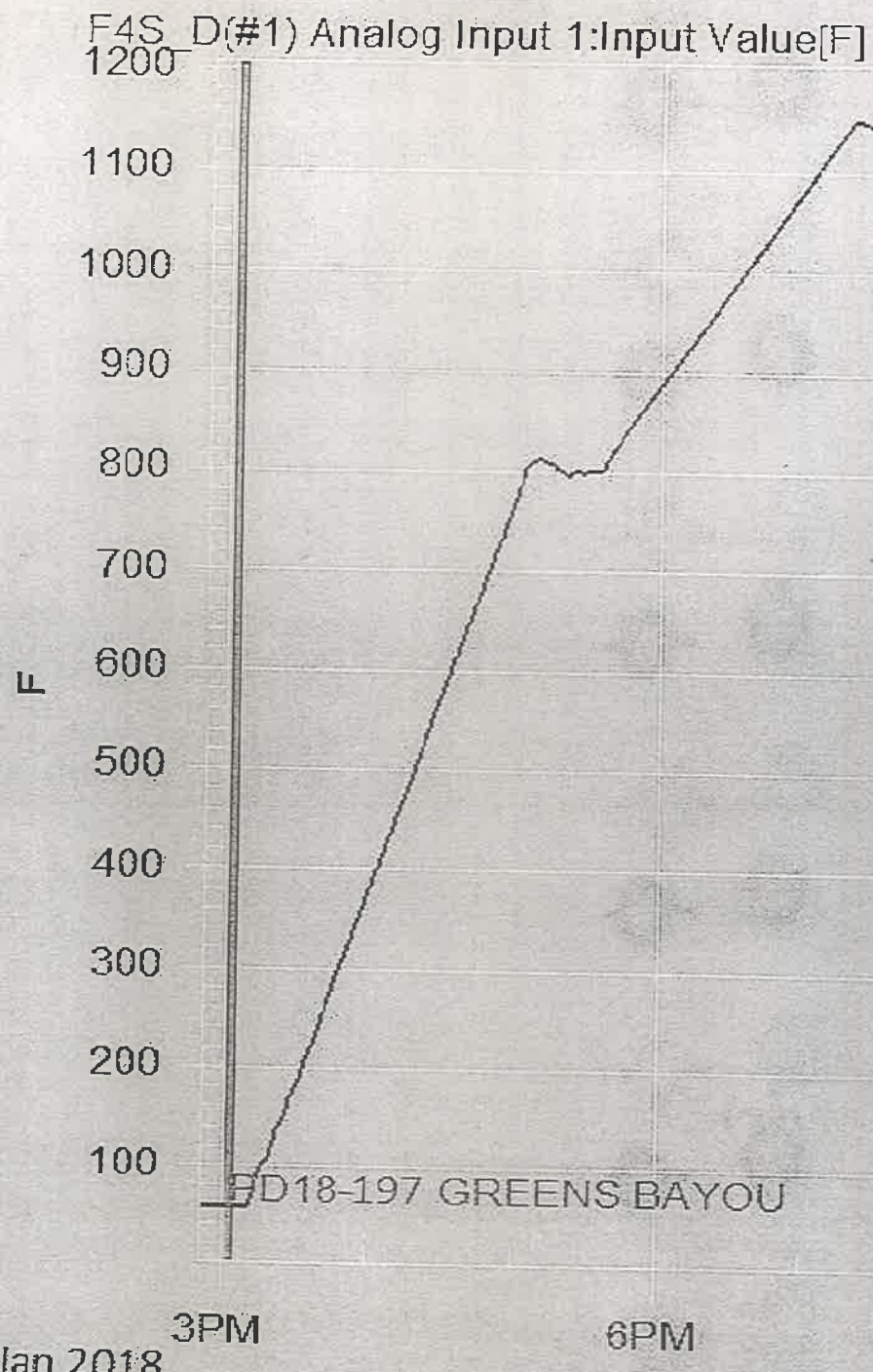
11048-399-2

PO# 635542

MAY 15 2018

11048-399-2

PO#635542



23 Jan 2018

3PM

6PM

9PM

6 Sat

**NUCOR**  
PLATE MILL

P.O.Box 179  
Winton, NC 27986  
(252) 356-3700

# Mill Test Report Page 2

1505 River Rd  
Cofield, NC 27922  
(252) 356-3700

**NUCOR**  
P.O. Box 179  
Winton, NC 27986

LEE  
P.O. Box 179  
Winton, NC 27986

MAY 15 2018

Issuing Date : 02/15/2018 B/L No. : 494729 Load No. 505205 Our Order No. : 154368/11 Cust. Order No. : 297522  
Vehicle No: LW 62182 Sold To: NORTH SHORE STEEL  
PO BOX 9940  
HOUSTON, TX 77213 Ship To: NORTH SHORE STEEL  
C/O GREENS BAYOU PIPE MILL  
PTRA TRACK 2091088 SPUR 910  
13935 INDUSTRIAL RD  
HOUSTON, TX 77015  
Specification: 1.7500" x 121.000" x 480.000"  
ASTM A516 70/65/60/485-17/ASME SA516-70/65/60/485 PVO 2015/2017  
Normalized Plate NACE MR0175 Annex 2.1.2 (2015), MR0103 (2010)  
Section 2.1.2 (2015) 13.1.1, 13.1.2) Compliant

Marking :

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	Ceq	Pcm
8500985	0.22	1.11	0.010	0.000	0.24	0.11	0.09	0.08	0.01	0.034	0.006	0.006	0.003	0.0041	0.0030	0.0002	0.011	0.43	0.29
8500986	0.22	1.09	0.008	0.001	0.21	0.12	0.07	0.06	0.01	0.032	0.006	0.004	0.003	0.00360	0.0040	0.0002	0.012	0.43	0.29

Plate Serial No	Pieces	Tons	Dir.	Tensile Test					Heat Treat			
				Yield (psi)	Tensile (psi)	Elong. % in 2"	Elong. % in 8"	R.A. %	Norm (°F)	Time (min)	Temper (°F)	Time (min)
8500985-02	2	28.82	H-T	47,000	76,000	55.2		57.5	1650		67	
									1650		67	
8500986-02	1	14.41	H-T	50,000	79,000	55.3		55.9	1650		67	
									1650		67	

Plate Serial No	Pieces	Tons	Dir.	Absorbed Energy (Ft-lbs)					Lateral Expansion (in.)					Shear (%)				Min	Temp (°F)	Size
				(ft-lbs)	(ft-lbs)	(ft-lbs)	(ft-lbs)	Ave	(in.)	(in.)	(in.)	(in.)	Ave	(%)	(%)	(%)	(%)			
				1	2	3	Ave	Min	1	2	3	Ave	Min	1	2	3	Ave			
8500985-02	2	28.82	H-L	43.0	71.2	83.9	66.0	18						10.0	20.0	30.0	20.0	-50		10mm
8500986-02	1	14.41	H-L	78.4	37.0	58.5	58.0	18						20.0	10.0	10.0	13.3	-50		10mm

Plate Serial No	BHN
8500985-02	160
8500986-02	153

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate, unless otherwise noted in Specification. For Mexico shipments only: Sales Mktg@Nucor.com  
Yield by 0.5E(0.1) method unless otherwise specified. Ceq = C + (Mn/6) + (Cr+Mo+V)/5 + (Cu/15) (15)  
Pcm = C + Si/30 + (Mn/20) + (Cu/20) + (Ni/60) + (Cr/20) + (Mo/15) + (V/10) + 58  
Melted and Manufactured in the USA. ISO 9001:2008 certified (0010990) by BSI Quality System Registrar (#0985-09). PED 01/20/EC 701 Annex 1 Part 4 is Compliant.  
DIN 90044 3 1.6/EN 10204 3 1B(3.3.4) DIN EN 10204 3 1(2005) compliant. For ABS grades only. Quality Assurance certificate 14 NMPCA 723

We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

*T. A. Deparis*  
T. A. Deparis, Metallurgist

2/15/2018 4:00:20 PM

P.O. 606542 Line: 1 Order: 1339294 Heat: 8500985 Slab: 02 Desor: SA616-70 N

11048-399-2

PO# 635542



TQS, Inc.  
The Quality Source

Phone: (281) 449-5228  
Fax: (281) 449-6699

14610 Sheraton  
Houston, TX 77039

# UT CERTIFIED TEST REPORT

Date Received: 4/5/2018		Specification: SA435 100% Scan		Report #: 180221	
Date Complete: 4/6/2018		Procedure: TQS UT-01 Rev: A		Rev: 1	
Customer: NSSCO		Deviations:		Page: 1 of 1	
Address: 13935 Industrial Road Houston, TX 77015		UT Instrument: RFD2000 Couplant: Water		Serial#: A00212011203 11/30/2018	
		Batch #: N/A		<b>RESULTS</b>	
Description	Dimensions	Tag#	Heat/Slab#	Recordable	Reject
SA516-70 N	1.75"x120x370	030918-33A	8500985 : 02	0	0
				Acceptable	1
<b>CALIBRATION BLOCKS</b>				<b>TRANSDUCERS</b>	
DBS	Cal.	Serial #	Reflector size	Serial #	Brand
<b>LONGITUDINAL</b>				Size	Degree
39	80% FSH	N/A	1/8" FBH	00P9WV	Krautkramer
<b>SHEAR WAVE</b>				Frequency	
N/A	DAC/ Notched Cal Block	N/A	3% Notch	20404	Technisonic
SKETCH: (If applicable)				Technique Used	
Comments: Slab corrected					
<p>All tests are performed using calibrated equipment on samples provided by the customer above, unless noted in the data section. This data applies only to samples tested by TQS Inc. This test report may be reproduced in its entirety without permission from TQS, Inc. All requirements of TQS, Inc. Quality Assurance Program, Rev B, Dated 8/2011 have been fulfilled.</p>					
Signed by: Jarrod Harris		ASNT Level II		Date: 4/9/2018	
Signature:					

R. LEE

PO: 635542 Line: 1 Order: 1339294 Heat: 8500985 Slab: 02 Descr: SA516-70 N

MAY 15 2018

11048-399-2

PO# 635542

PO: 635542 Line: 1 Order: 1339294 Heat: 8500986 Slab: 02 Descr: SA516-70 N

# STRUCTURAL PIPE (CAN) MANUFACTURING TRAVELER

JOB NO: 7438

ROLL LTR: A

CAN #: 1

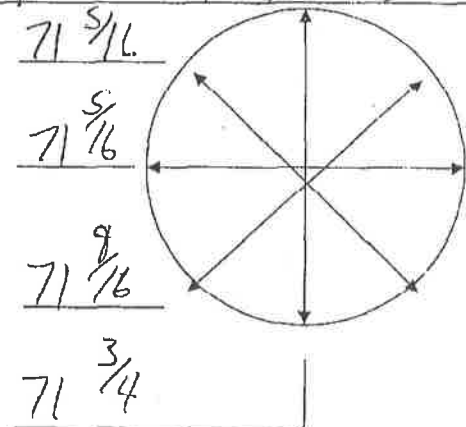
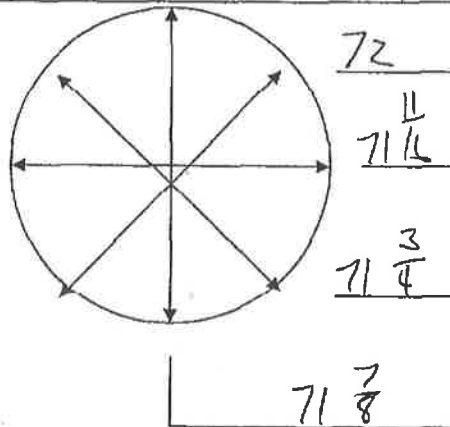
WPS:

GB/X-L42.13 rev.1

ACTIVITY	S / US	QC	DATE
OD <u>75 1/2"</u> W.T. <u>1 3/4"</u>	S	O/R	5-3-18
CAN DIMENSIONS ARE ACCEPTABLE LENGTH <u>10'</u> DIAMETER X <u>72 / 71 9/16</u> DIAMETER Y <u>71 11/16 / 71 5/16</u> OVALITY (%) <u>11/16" max.</u>  END PREPS ARE ACCEPTABLE FOR CANS TO BE SHIPPED.	S	O/R	5-3-18
Welds meet visual inspection criteria	S	O/R	5-3-18

REMARKS 7438-1

LG, FF, FF, FF  
850098502



A

B

Deviation:

5/16

1/4

R. LEE

MAY 15 2018

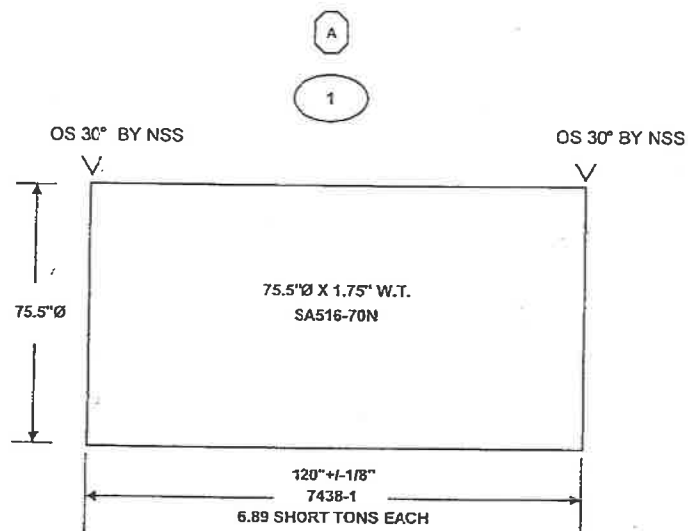
PO# 635542

11048-399-2

PO# 635542

11048-399-2

TOP OF SHELL



NOTE: All Attachment Materials (Run-off Tabs, Bracing) are to be identified as acceptable by marking (Color Code Orange) or by (Stamping "PI")

HARD STAMP THIS INFORMATION ON THE BODY OF EACH SHELL CAN

SYMBOL	DESCRIPTION
O	ROLL LETTER
O	CAN NUMBER
□	LONG SEAMS
V	BEVELS

ASME

PART  
CERTIFIED BY: GBPM  
7438-1  
YEAR BUILT: 2018

U

BILL OF MATERIALS		
ITEM	QUANTITY	DESCRIPTION
1	1	CANS SA516-70N 75.5" O.D. X 1.75" W.T. X 120" LONG

- NOTES:
- CONSTRUCTION PER ASME SECTION VIII DIV. 1 2017
  - P.I.T. REQUIRED
  - WELD PROCEDURES: GBX-L42-13 Rev. 1, GBX-R7 1/S, 13 Rev.1
  - NDE REQUIREMENTS-100% XRAY, DIMENSIONS PER ASME SECTION VIII DIV.1
  - ROUNDNESS TOLERANCE .72", O.D. STRAP 237 3/16" ±1/8"
  - LENGTH TOLERANCE ±1/8", BEVEL TOLERANCE ±1/3"

DESCRIPTION	REV.	DATE	APPR.	CO.	NSS ASME	JOB	7438
AFG	0	18-Apr-18					
	1			STRUCT.	ASME CANS	DWG. NO.	7438-1
	2						
	3			PC. LD.	7438-1		
	4						
	5			FAB.	GREENS BAYOU PIPE MILL	APPROV.	DDS

MAY 15 2018

R. LEE

## MAILING ADDRESS

P.O. Box 1690  
Gray, LA 70359

## PHYSICAL ADDRESS

2249 West Park Ave.  
Gray, LA 70359  
(985) 876-5559

# NVI

## NONDESTRUCTIVE & VISUAL INSPECTION, LLC

QUALITY ON THE MOVE  
DAILY WORK REPORT

REPORT NO. GBPM33685

ALABAMA  
COLORADO  
LOUISIANA  
TEXAS  
PENNSYLVANIA



ONSHORE



OFFSHORE

Client: Greens Bayou Pipemill

Job location: PM

Inspection Date/Time: 05-03-18

Project: 7438

NVI job #2817

Billing Address: North Shore

P.O.# Sec# Single Can Pch 7438-1

OSCG:

NVI Procedure: ASME RT-03 Rev 2

Acceptance Criteria: ASME Sec VIII/1

AD - ACCUMULATIONS OF DISCONTINUITIES

BT - BURST THROUGH

BTA - BURST THROUGH AREA

C - CRACK/CRACKS

CP - CLUSTER POROSITY

E3 - ELONGATED SLAG INCLUSION

EU - EXTERNAL UNDERCUT

ED - EXTERNAL DISCONTINUITIES

IC - INTERNAL CONCAVITY

IP - INCOMPLETE FUSION

IIB - INCOMPLETE FUSION DUE TO COOL LAP

IP - INADEQUATE PENETRATION

IIB - INADEQUATE PENETRATION DUE TO HIGH LOW

IS - ISOLATED SLAG INCLUSION

IU - INTERNAL UNDERCUT

LC - LOW CROWN

MV - HARBOR WELD

P - POROSITY

Job Description: Gamma Ray Inspection (Ir-192)

WELD NO.	PIPE SIZE	RECOMMENDATION			WELD NO.	PIPE SIZE	RECOMMENDATION		
		✓ X	ACCEPT REJECT	REMARKS			✓ X	ACCEPT REJECT	REMARKS
1	A1			SA516-70N (1.75")	31				
2	0-1-2			.125" reinforcement	32				
3	2-3-4				33				
4	4-5-6				34				
5	6-7-8			LG, FF, FF, FF	35				
6	8-9-10				36				
7	10-11-12			8500 985-02	37				
8	12-13-14				38				
9	14-15-16				39				
10	16-17-18				40				
11	18-19-20			1"slag	41				
12					42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

Check Exposure type:

RADIOGRAPHIC SET-UP SFD 20" Thickness 1.75"

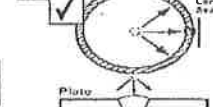
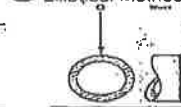
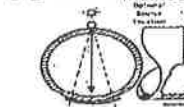
A Contact Method

B Panoramic Method

C Elliptical Method

D Superimposed Method

E Long Seam

Gamma Ray: ☒ Cobalt: ☐ X-ray: ☐ Curles: 100 Ug: .015 Focal Size: .155 No. of Film in Cassette: 1Penetrant-A: ☐ B: ☒ C: ☐ Required wire: .032 Achieved wire: .032 No. of Exposures per weld: 10

Film Delivered to: NVI Client: X No. of welds Inspected: 1 Radiographer: T. Bailey Lvl II

Sheets of Film: 10 Film Type &amp; Size: Agfa D5 4.5" x 17" Assistant: M. Wright

Hours Worked: Travel Time: Mileage: Substistence: Assistant: J. Harris

Generator: Generator Fuel Gal: Darkroom: Assistant:

Comments: Clients Representative: *[Signature]* 5/3/18

10 Spots 4.5" x 17" (ASME)

Report# 1 of 1

ALY WORK REPORT (REVISED) SEPT. 2007

11048-399-2

LEE

MAY 15 2018

PD# 635542



## MAILING ADDRESS

P.O. Box 1690  
Gray, LA 70359

## PHYSICAL ADDRESS

2249 West Park Ave.  
Gray, LA 70359  
(985) 876-5559

# NVI

## NONDESTRUCTIVE & VISUAL INSPECTION, LLC

### QUALITY ON THE MOVE

### DAILY WORK REPORT

REPORT NO. GBPM33686

ALABAMA  
COLORADO  
LOUISIANA  
TEXAS  
PENNSYLVANIA



ONSHORE



OFFSHORE

Client: Greens Bayou Pipemill

Job location: PM

Inspection Date/Time: 05-03-18

Project: 7438

NVI Job #2817

Billing Address: North Shore

P.O.# Sec# Single Can Pct# 7438-1

OSCG:

NVI Procedure: ASME RT-03 Rev 2

Acceptance Criteria: ASME Sec VIII/1

ND - ACCUMULATIONS OF DISCONTINUITIES  
BT - BURN THROUGH  
STA - BURN THROUGH AREA  
C - CRACK/CRACKS  
CP - CLUSTER POROSITY

ISI - ELONGATED SLAG INCLUSION  
EU - EXTERNAL UNDERCUT  
HB - HOLLOW BEAD  
IC - INTERNAL CAVITY  
IF - INCOMPLETE FUSION

IPD - INCOMPLETE FUSION DUE TO COLD LAP  
IP - INADEQUATE PENETRATION  
IPS - INADEQUATE PENETRATION DUE TO HIGH FLOW  
ISI - ISOLATED SLAG INCLUSIONS  
IU - INTERNAL UNDERCUT

KL - KNOCK LAGS  
NW - NARROW WELD  
P - POROSITY

## Job Description: Gamma Ray Inspection (Ir-192)

	WELD NO.	PIPE SIZE	RECOMMENDATION				WELD NO.	PIPE SIZE	RECOMMENDATION		
			✓ X	ACCEPT REJECT	REMARKS				✓ X	ACCEPT REJECT	REMARKS
1	A1 R1	75.5x1.75			SA516-70N (1.75")	31					
2	18-19-20	2 v/ews	✓		.125" reinforcement	32					
3						33					
4						34					
5						35					
6						36					
7						37					
8						38					
9						39					
10						40					
11						41					
12						42					
13						43					
14						44					
15						45					
16						46					
17						47					
18						48					
19						49					
20						50					
21						51					
22						52					
23						53					
24						54					
25						55					
26						56					
27						57					
28						58					
29						59					
30						60					

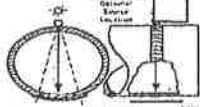
Check Exposure type:

## RADIOGRAPHIC SET-UP

SFD 20"

Thickness 1.75"

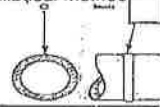
## A Contact Method



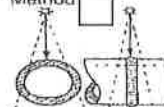
## B Panoramic Method



## C Elliptical Method



## D Superimposed Method



## E

Gamma Ray: ☒ Cobalt: ☐ X-ray: ☐ Curies: 100 Ug: .015 Focal Size: .155 No. of Film in Cassette: 1Penetrometer-A: ☐ B: ☒ C: ☐ Required wire: .032 Achieved wire: .032 No. of Exposures per weld: 2

Film Delivered to: NVI Client: X No. of welds inspected: 1 Radiographer: T. Bailey J. V. II

Sheets of Film: 2 Film Type &amp; Size: Agfa D5 4.5" x 17" Assistant: M. Wright

Hours Worked: Travel Time: Mileage: Subsistence: Assistant: J. Matris

Generator: Generator Fuel Gal: Darkroom: Assistant:

Comments: Clients Representative: *[Signature]* 5/3/18

2 Spots 4.5" x 17" (ASME)

Report# 1 of 1

NVI WORK REPORT REVISION(S) SEPT. 2007

R. LEE

MAY 15 2018

11048-399-2

PO# 635542



Heat # D81621

Dom

3.250 X .120 CS pipe

57042-6



## METAL-MATIC, INC. STEEL TUBING

628 SECOND STREET S.E. MINNEAPOLIS, MINNESOTA 55414

TELEPHONE (612) 378-0411 FAX (612) 805-3498

## Certificate of Compliance and Analysis

Consignee	NATIONAL TUBE SUPPLY CO			MMI Order #	199821	
Address	925 CENTRAL AVENUE UNIVERSITY PARK IL 60466			Bil of Lading #	403648	
				Shipped Via	SHARI MOTOR EXPRES	
				Quantity Shipped	4344 FT	
				Customer Order #	57042	
				Date Shipped	07/25/14	
Item #	339864	Customer P/N	DOM0325001201020-1	Customer Spec 1	ASTM A513 T-5	
Description	3.2500DXJ.010IDX288.000			Customer Spec 2		
Lot Numbers	66129647 66129648 66129649 66129651 66129652 66129653 66129656 66129657 66129660 66129661					
Steel Grade	1020					
Chemistry	Heat Number	Chemical Properties				
	D81621 ✓	C-.200 MN-.440 P-.010 S-.012 AL-.056 SI-.012 V-.001 CR-.020 MO-.005 CB-.001 NI-.010 CU-.020 TI-.001 SN-.003 N-.004				
	M84741 ✓	C-.190 MN-.440 P-.013 S-.009 AL-.046 SI-.016 V-.001 CR-.040 MO-.005 CB-.001 NI-.010 CU-.030 TI-.001 SN-.009 N-.005				
	M84742 ✓	C-.190 MN-.440 P-.015 S-.010 AL-.046 SI-.016 V-.001 CR-.040 MO-.004 CB-.001 NI-.010 CU-.030 TI-.001 SN-.006 N-.004				
Mechanical Properties	Heat Number	Supplier	Tensile Strength	Yield Strength	Elong	Hardness
	D81621	U.S. STEEL (Gary Works)	76400 PSI	66000 PSI	40.0 %	83 HRB
	M84741	U.S. STEEL (Gary Works)	77500 PSI	67900 PSI	40.0 %	84 HRB
	M84742	U.S. STEEL (Gary Works)	85000 PSI	76900 PSI	30.0 %	86 HRB
Tests Passed	CTRY OF ORIGIN - USA EDDY CURRENT TEST					
Special Notes	Melted and Manufactured in the USA					
I Hereby Certify that all tubing was manufactured in the USA and conforms with applicable specification(s) listed above. All tests required by said specifications were successfully performed.						
Signed			Quality Department	7/30/14 Date		




R. LEE

MAY 15 2018

PO#634336

11048-399-1

3.250X.120 MTR# 121711  
 CS Pipe PO/Line# 118228-1  
 TPI Work Test Certificate Heat# P31364

		<b>TUBE INVESTMENTS OF INDIA LIMITED</b> <b>TUBE PRODUCTS OF INDIA - MODULE - 1</b> POST BOX NO.4 & 18, M T H ROAD, AVADI, CHENNAI - 600054											
Customer	: SALEM STEEL NA, LLC	TC No	: PAE/8C1780669										
Order No.	: TP17078 /15-JUN-17	Date	: 28-AUG-17										
Description	: PRECISION STEEL TUBES - CDW	Invoice No	: 3002020000146										
Specification	: ASTM A513 1020 OR	Invoice Date	: 23-AUG-17										
Condition	: SRA	Job /Batch No	: RBCH1708282										
Bundle No's	: TP17078-24-1 (017013911), TP17078-24-3 (017013912), TP17078-24-2 (017013913)												
Cart Part No	:												
Bundle	: CUSTOMER SIZE /CONDITION /QUANTITY /GROSS WEIGHT /TAG MARKING / WO.NO. /SPEC &												
Tagging	: GRADE /DESTINATION / BUNDLE NO /COUNTRY OF ORIGIN.												
Tube Marking	: P.O.NO. /TPI-ED /SIZE /SPEC /CONDITION / TAG MARKING /HEAT NO. /MADE IN INDIA.												
P. Uom	: Inches												
Size	: 3.250 X 3.010 X .120 X 20' / 22' -SRA												
Quantity In : 979.232 Ft													
<b>LADLE ANALYSIS :</b>													
Process	Heat No.	%C	%Mn	%P	%S	%Si	%Al	%Cr	%Ni	%Cu	%Nb		
Min		.18	.3										
Max		.23	.6	.035	.035								
Obs	P31364	.18	.416	.015	.002	.012	.03						
<b>Full Section Longitudinal Tensile Test at Room Temp</b>						<b>Rockwell Hardness</b>		<b>Dimensions in : Inches</b>					
Test	Heat No.	YS	TS	Elong.		Rockwell Hardness	OD	ID	Spec	OD	ID	WT	Len
Min		55000	65000	10		73			Min	3.25	3.001		240
Max						HRB			Max	3.259	3.01		264
Obs	P31364	58948.98	69351.74	22		84			OBS-Min	3.253	3.006	0	249.803
									OBS-Max	3.255	3.004	0	262.913
<b>Technological Tests :</b>						<b>Non-Destructive Tests :</b>							
Test	Spec	Result				Test	Spec	Result					
Crackling						Straightness	0.76/1000MM MAX	0.30 / 1000					
Flaring						Eddy Current	100	100% TESTED OK					
Flattening						Visual		DEFECT FREE					
Flanging						Ultrasonic Test							
Rev. Flang.						Application Testing							
Elong. Gage Len													
This is to certify that the goods are supplied as per the purchase order and specification Requirements													
Prepared by : N. Aravind						for Tube Investments of India Unit: Tube Products of India							
Quality Shift Incharge Signature:						 Mithavan M Mgr-Quality-IDP-TP							

PO#634336

11048-399-1

R. LEE

MAY 15 2018

# TPI Work Test Certificate



TUBE INVESTMENTS OF INDIA LIMITED  
TUBE PRODUCTS OF INDIA - MODULE - 1  
POST BOX NO.4 & 18, MTH ROAD, AVADI, CHENNAI - 600054



Customer : SALEM STEEL NA, LLC  
Order No. : TP17078 /15-JUN-17  
Description : PRECISION STEEL TUBES - CDW  
Specification : ASTM A513 1020 GR  
Condition : SRA  
Bundle No's : TP17078-24-4 (017014035), TP17078-24-5 (017014036)  
Cust Part No :  
Bundle : CUSTOMER SIZE /CONDITION /QUANTITY /GROSS WEIGHT /TAG MARKING / WO.NO. /SPEC &  
Tagging : GRADE /DESTINATION / BUNDLE NO /COUNTRY OF ORIGIN.  
Tube Marking : P.O.NO. /TFL-ED /SIZE /SPEC /CONDITION/ TAG MARKING/ HEAT NO. /MADE IN INDIA.  
P. Uom : Inches  
Size : 3.250 X 3.010 X .120 X 20' / 22' -SRA

TC No : PAE7C1780663  
Date : 28-AUG-17

Invoice No : 3002020000150 ✓  
Invoice Date : 24-AUG-17  
Job /Batch No : RBCH1708282 ✓

Quantity In : 739.206 Ft

## LADLE ANALYSIS :

Process	Heat No.	%C	%Mn	%P	%S	%Si	%Al	%Cr	%Ni	%Cu	%NiO
Mia		.18	.3								
Max		.23	.6	.035	.035						
Obs	P31364	.18	.416	.015	.002	.012	.03				

Full Section Longitudinal Tensile Test at Room Temp			
Test	Heat No	Y.S	T.S
Mia		55000	65000
Max			10
Obs	P31364	PSI	PSI
		63729.12	72135.12

Rockwell Hardness	Roughness
OD	ID
73	
HRB	
84	

Dimensions in : Inches				
Spec	OD	ID	WT	Len
Mia	3.25	3.001		240
Max	3.259	3.01		264
OBS-Mia	3.255	3.006	0	249.803
OBS-max	3.257	3.008	0	262.913

## Technological Tests :

Test	Spec	Result
Crushing		-
Flaring		-
Flattening		-
Flanging		-
Rev. Flang.		-
Elong.Caug.Len		-

## Non-Destructive Tests :

Test	Spec	Result
Straightness	0.76/1000MM MAX	0.30 / 1000
Eddy Current	100	100% TESTED OK
Visual		DEFECT FREE
Ultrasonic Test		-
Application Testing		-

This is to certify that the goods are supplied as per the purchase order and specification Requirements

Prepared by : N. Annamalai  
Quality Shift Incharge Signature:

for Tube Investments of India  
Unit: Tube Products of India

M. H. Mani  
Mgr-Quality-IBP-TP

R. LEE

MAY 15 2018

11048-399-1

PO#634336



**CERTIFICATE OF ANALYSIS**  
**CERTIFIED MATERIAL TEST REPORT (CMTR)**  
**EN10204 Certificate 3.1**  
**Mill Test Report**

**ESAB PART:** 1042F05  
**DESCRIPTION:** 65 035X44#SP  
**TEST No:** 010000051635  
**HEAT No:** 065 414049

**Trade Name** - SPOOLARC  
**Trade Type** - 65  
**Diameter** - 0.035  
**Certifications** - AWS/ASME SFA5.18; ER70S-2 H4

**Chemistry:**

CARBON	%	0.050
MANGANESE	%	1.14
SULPHUR	%	0.006
SILICON	%	0.51
COPPER	%	0.03
MOLYBDENUM	%	0.01
NICKEL	%	0.04
TITANIUM	%	0.120
ALUMINIUM	%	0.07
ZIRCONIUM	%	0.050
CHROMIUM	%	0.04
VANADIUM	%	0.000
PHOSPHORUS	%	0.004

This material is manufactured in USA

This material is certified to be free of any mercury

The ESAB Group, Inc is certified to ISO 9001:2008, ISO 14001:2004 and OSHAS 18001:2007.  
Registered under the following certificate numbers:  
106973-2011-AQ-SWE-SWEDCA/2006-SKM-AE-1093/2008-SKM-AHSO-143.

The undersigned certifies that the product supplied will meet the requirements of the applicable AWS Filler Metal Specification when tested in accordance with that specification

This certificate is produced electronically and is valid without signature.

Please refer any queries to:

ESAB Welding & Cutting Products, 256 Midway Drive, Union, SC, 29379; Ph. 1-800-426-1888  
CUSTOMER QUALITY LEADER - Jerrv Klaes

www.esabna.com

Date: 04/12/2018

Page 1 / 1

**R. LEE**

**MAY 15 2018**

PO#634336

11048-399-1

Unit # 156 7700

Connecter CS plate



200-78 Innovation Drive | Winnipeg, MB | R3T 8C2  
TEL: (204) 480-3333 | FAX: (204) 480-0345 | 1-800-728-7933  
www.itec.mb.ca

### Mechanical Test Laboratory Report

Prepared for: Ms Brenda Smith  
Administration Supervisor  
Russel Metals  
1359 St. James Street, P.O. Box 39  
Winnipeg MB R3C 2G3

Report No: 17187-88  
Date: 5 Dec, 2017  
Phone: (204) 772-0321



Sample Description: See below

Standard/Specification: ASTM E8

Test Methods for Tension Testing of Metallic Materials

Tests accredited by the Standards Council of Canada to ISO/IEC 17025 indicated with ✓.

Note: Samples will be retained for 90 days unless explicit arrangements are made with ITC.

### Test Results

Table 1: Tensile Test Results

Specimen ID	Thickness (in)	Width (in)	Yield Strength (ksi)	Tensile Strength (ksi)	Modulus (Mpsi)	Elongation (%)
1567700-B-147963	0.1835	0.507	86	75	29.0	32.1
1567700-M-147963	0.1840	0.508	86	76	29.9	29.8
Grade 44 W (Transverse)			Min 44	65-80	N/A	Min 21
Grade 50 W (Transverse)			Min 50	65-95	N/A	Min 20

### Comments:

The samples meet the specifications for 44W (Transverse) for the parameters tested.

The samples meet the specifications for 50W (Transverse) for the parameters tested.

End of Report

Prepared by:   
Daniel Godin, C.E.T.  
Project Technologist

Reviewed by:   
Tom Manson, P. Eng.  
Mechanical Engineer

### Notes

- This report is prepared for the exclusive use of the client named herein. The material reflects the Industrial Technology Centre's best judgement in light of the information available to it at the time of preparation. Any use that any third party makes of this report, or any reliance on or decisions taken based upon it are the responsibility of such third party. The Industrial Technology Centre accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.
- Any report refers only to particular subject referred to in said report. No representation is made regarding other similar articles.
- ITC shall not be used in any connection with the advertisement, offer, or sale of any product process or service without written consent.
- Copyright of this report is owned by ITC and may not be reproduced other than in full, except with the prior written approval of ITC.
- ITC Mechanical Test Laboratory is SCC accredited to ISO/IEC 17025 for specific procedures.

Russel Tensile Report Ver. 2016-03-01

An Agency of the Province of Manitoba

Page 1 of 1



R. LEE

MAY 15 2018

PO# 634336

11048-399-1



Heat # M84742 802540

Dom

3.250 X. 120 CS Pipe

57042-L



# METAL-MATIC, INC. STEEL TUBING

629 SECOND STREET S.E. MINNEAPOLIS, MINNESOTA 55414

TELEPHONE (612) 378-0411 FAX (612) 605-3496

## Certificate of Compliance and Analysis

Consignee	NATIONAL TUBE SUPPLY CO			MMI Order #	199821	
Address	925 CENTRAL AVENUE UNIVERSITY PARK IL 60466			BID of Lading #	403648	
				Shipped Via	SHARI MOTOR EXPRESS	
				Quantity Shipped	4344 FT	
				Customer Order #	57043	
Item #	339064	Customer P/N	DOM0325001201020-1	Date Shipped	07/25/14	
Description	3.250ODX1.010IDX286.000			Customer Spec 1	ASTM A513 F-5	
				Customer Spec 2		
Lot Numbers	66129647 66129648 66129649 66129651 66129652 66129653 66129656 66129657 66129660					
Steel Grade	1020					
Chemistry	Heat Number	Chemical Properties				
	D81621 ✓	C-.200 MN-.440 P-.010 S-.012 AL-.056 SI-.012 V-.001 CR-.020 MO-.005				
	M84741 ✓	CB-.001 NI-.010 CU-.020 TI-.001 SH-.003 N-.004				
	M84742 ✓	C-.190 MN-.440 P-.013 S-.009 AL-.046 SI-.016 V-.001 CR-.040 MO-.005				
		CB-.001 NI-.010 CU-.030 TI-.001 SH-.009 N-.005				
		C-.190 MN-.440 P-.015 S-.010 AL-.046 SI-.016 V-.001 CR-.040 MO-.004				
		CB-.001 NI-.010 CU-.030 TI-.001 SH-.006 N-.004				
Mechanical Properties	Heat Number	Supplier	Tensile Strength	Yield Strength	Elong	Hardness
	D81621	U.S. STEEL (Gary Works)	76400 PSI	66000 PSI	40.0 %	83 HRB
	M84741	U.S. STEEL (Gary Works)	77500 PSI	67900 PSI	40.0 %	84 HRB
	M84742	U.S. STEEL (Gary Works)	85000 PSI	76900 PSI	30.0 %	86 HRB
Tests Passed	CTRY OF ORIGIN - USA BODY CURRENT TEST					
Special Notes	Melted and Manufactured in the USA					
<p>I Hereby Certify that all tubing was manufactured in the USA and conforms with applicable specification(s) listed above. All tests required by said specifications were successfully performed.</p> <p>Signed <u>[Signature]</u> Quality Department 7/30/14 Date</p>						

R. LEE

MAY 15 2018

PO#634336

11048-399-1

Mat # 29482 5"rd

encoremetals

## CERTIFICATE OF TEST

Page 01 of 02

Certification Date  
31-AUG-2012

## CUSTOMER ORDER NUMBER

P1384

ENCORE METALS DIVISION OF RMCL  
7805 - 51ST STREET S.E.  
CALGARY AB T2C 2Z3Invoice Number  
S142039

## CUSTOMER PART NUMBER

SOLD TO: APEX METAL INDUSTRIES  
BOX 8, SITE 12, R.R.9  
CALGARY AB T2J 5G5SHIP TO: APEX METAL INDUSTRIES  
BOX 8, SITE 12, R.R.9  
CALGARY AB T2J 5Description: 1018 HR BAR ASTM A576  
5 RD X 20' R/L  
HEAT: 29482

ITEM: 503413

Line Total: 1329.718 LB

## Specifications:

ASTM A576  
ASTM A751  
ASTM E381  
ASTM A255ASTM A29/A29M  
ASTM A370  
ASTM E45 METHOD AEN 10204 3.2  
ASTM E10  
ASTM E112

## CHEMICAL ANALYSIS

C	MN	SI	S	P	CR	NI	CU
0.18	0.67	0.24	0.031	0.011	0.07	0.10	0.22
MO	V	AL	SN	H			
0.0090	0.002	0.027	0.016	0.0001			

RCPT: R115308

COUNTRY OF ORIGIN : UKRAINE

## MECHANICAL PROPERTIES

DESCRIPTION	YLD STR	ULT TEN	%ELONG	%RED	HARDNESS
	PSI	PSI	IN 02 IN	IN AREA	BHN
	34800.0	64500.0	33.0	52.0	129

IDEAL DIAMETER : 0.49 IN GRAIN SIZE : 7 - 5

The above data were transcribed from the manufacturer's Certificate of Test after verification for completeness and specification requirements of the information on the certificate. All test results remain on file subject to examination.

We hereby certify that the material covered by this report will meet the applicable requirements described herein, including any specification forming a part of the description.

The willful recording of false, fictitious, or fraudulent statements in connection with test results may be punishable as a felony under federal statutes.

Material did not come in contact with mercury while in our possession.

PURCHASING MANAGER

AUG 2012 CERT# 8610 LEE

MAY 15 2018

5"rd 1018

11048-399-1

Mat # 29482

PD#634336

LIEBOVICH STEEL  
(510) PLATE SA516 GRADE 70  
1" X 96.0000" X 240.0000"  
PART NO.

1" X 71.25" OD ESP PLATE  
Heat # B7X6838  
SO#

PO/Ref 5378436

5378436-1

Certificate of Mill Test Results

SO CH1-M6458-011

28Feb18

Pg 1/2

**NUCOR**  
NUCOR STEEL TUSCALOOSA, INC.

MILL TEST CERTIFICATE

2700 ROLLY RD N.E.  
Tuscaloosa, AL 35404-1000  
205 700-6204

centralusa@nucorsteel.com

Page: 1 of 2

Load Number	Tally	Mill Order Number	PO NO / Line NO	Part Number	Certificate Number	Prepared
M169668	00000000155407	N-180757-004	CH-10511 4		575940701-1	11/21/2017 14:07
Grade			Customer:			
Order Description:			Sold TO:			
Hot Roll Plate			CHAPEL STEEL BOURBONNAIS IL			
A516 70, 1.0000 TH x 96.000 TH x 240.000 FY			Ship TO:			
Quality Plan Description:			CHAPIL STEEL CHICAGO BOURBONNAIS IL			
ASTM A516-70-18/ASME SA516-70-21M			Sent TO:			
			RESERVE MARINE TERMINAL Chicago IL			

Shipped Item	Heat/Slab Number	Certified By	C	Mn	P	S	Si	Co	Ni	Cr	Mo	Cu	V	Al	Ti	Fe	Ca	Se	CEV	ACI
7K15288A	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288B	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288C	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288D	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288E	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288F	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288G	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288H	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288I	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288J	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288K	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288L	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288M	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288N	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288O	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288P	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288Q	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288R	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288S	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288T	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288U	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288V	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288W	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288X	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288Y	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	
7K15288Z	87X6838-04 ***	87X6838	0.21	1.04	0.015	0.002	0.23	0.13	0.05	0.07	0.033	0.003	0.005	0.028	0.007	0.013	0.0002	0.0001	0.42	

Mercury has not come in contact with this product during the manufacturing process nor has any mercury been used by the manufacturing process. Certified in accordance with EN 10204 3.1. No weld repair has been performed on this material.  
NACE MR0175 ANNEAL 2.1.2 COMPLIANT Fully Killed Fine Grain Manufactured to a fully killed fine grain practice  
ISO 9001:2015 Registered, PED Certified

\*\*\* Indicates Heat treated and Manufactured in the U.S.A.

We hereby certify that the product described above passed all of the tests required by the specifications.

*Quinn Y.*  
Dr. Quinn Y. - Metallurgist

MAY 15 2018

T. LEE



**LIBOVICH STEEL**  
 (S16) PLATE S416 GRADE 70  
 1" X 96.0000" X 240.0000"  
 PART NO.

PO/Ref: 5378436

# Certificate of Mill Test Results

50 CHL-006458-001

2016018  
Pg 2/2

**NUCOR**  
 NUCOR STEEL TUSCALOOSA, INC.

## MILL TEST CERTIFICATE

3700 NORT RD S.E.  
 Tuscaloosa, AL 35400-2006  
 ADR 800-820-0004  
 customer.service@nucorsteel.com

Page: 2 of 2

Load Number	Tally	Mill Order Number	PO NO	Line NO	Part Number	Certificate Number	Prepared
NLE9658	00000000759407	M-160757-004	CHC-10953	4		573940701-1	11/13/2017 10:07
Grade			Customer:				
Order Description: Hot Roll Plate AS16 70, 1.0000 DI x 96.000 DI x 240.000 2# Quality Plan Description: AS16700P: ASTM A516-70-10/ASME S416-70-13AR			Sold TO: CHAPEL STEEL Bourbonnais IL Ship TO: CHAPEL STEEL CHICAGO BOURBONNAIS IL Sent TO: EISSENE MARINE TERMINAL Chicago IL				

Shipped Item	Certified By	Heat/Stub Number	Yield ksi	Tensile ksi	Y/T %	ELONGATION %		Bend OK?	Hard HB	Charpy Impacts (ft-lbs)				Shear S				Test Temp		
						2"	4"			Size	as	1	2	3	Avg	1	2		3	Avg
7K15280A	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280B	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280C	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280D	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280E	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280F	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280G	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280H	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280I	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280J	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280K	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280L	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280M	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280N	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280O	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280P	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280Q	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280R	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280S	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280T	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280U	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280V	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280W	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280X	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280Y	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														
7K15280Z	57K1528FTT	87X6838-04 ***	45.5	73.2	62.2	43.1														

Total: 10 PCS: 10 Weight: 45341 LBS

Mercury has not come in contact with this product during the manufacturing process nor has any mercury been used by the manufacturing process. Certified in accordance with EN 10204 3.1. No weld repair has been performed on this material. NACE MR0175 APPENDIX 2.1.2 COMPLIANT Fully Killed Fine Grain Manufactured in a fully killed fine grain practice. ISO 9001:2015 Registered, PED Certified

We hereby certify that the product described above passed all of the tests required by the specifications.

*Chun Yu*  
 Dr. Chun Yu - Metallurgist

\*\*\* indicates Heats melted and Manufactured in the U.S.A.

R. LEE

MAY 15 2018

11048-399-1

PO#634336



# Sharon Tube

JMC STEEL GROUP

20 Church Street  
Wheatland, PA 18161

## PRODUCT CERTIFICATION

HEAT NUMBER

NLK1568590

SALES ORDER

0005207287

SOLD TO

NATIONAL TUBE SUPPLY CO.  
925 CENTRAL AVENUE  
UNIVERSITY PARK, IL 60466  
USA

SHIP TO

NATIONAL TUBE SUPPLY CO.  
925 CENTRAL AVENUE  
UNIVERSITY PARK, IL 60466  
USA

DOM

3.750 - .250

84423-1

Heat # NLK1568590 3.750 x .25 CS pipe

CUSTOMER P.O. B4423	CUSTOMER PART DOM0375002501026-1	QUANTITY 4,860 FT	BNOLS 17	LADING NO 8545907	SHIPMENT DATE 4/11/16					
<b>SPECIFICATION</b> Grade 1026AK O.D. 3.7500 I.D. 3.2500 Wall .2500 Temp Stress Relieved Random Length Tube ASTM A-513 Type 5 Cold Drawn Electric Weld Carbon Steel Mechanical Tubing										
<b>CERTIFICATION REQUIREMENTS</b>										
Chemical, Ladle Analysis, %										
C .24	Mn .65	P .009	S .002	Si .035	Al .052	Cu .02	Ni .01	Cr .03	Mo .00	V .001
Ca .0030										
Physical Tests										
Melt Mill Novolipetsk		Melt Country Russia		Melt Practice Basic Oxygen		Cast Strand				
Reduction Ratio >6:1		DEFARS Compliant No								
Tubing Mechanical Test Results										
TEST Yield, PSI	UNITS PSI		HIGH 95038		LOW 95038		AVERAGE 95038			

Steven M. Grabert, Manager, Technical Services, being duly sworn according to law, deposes and says that the figures set forth above are correct, as contained in the figures of Sharon Tube Company.

R. LEE

MAY 15 2018

PO#634336

11048-399-1



# Sharon Tube

JMC STEEL GROUP

20 Church Street  
Wheatland, PA 16161

## PRODUCT CERTIFICATION

HEAT NUMBER

NLK1568590

SALES ORDER

0005207287

SOLD TO

NATIONAL TUBE SUPPLY CO.  
926 CENTRAL AVENUE  
UNIVERSITY PARK, IL 60466  
USA

SHIP TO

NATIONAL TUBE SUPPLY CO.  
926 CENTRAL AVENUE  
UNIVERSITY PARK, IL 60466  
USA

CUSTOMER P.O.	CUSTOMER PART	QUANTITY	BNDLS	LADING NO	SHIPMENT DATE
84423	DOM0375002601026-1	4,880 FT	17	85059017	4/11/16
Tensile, PSI	PSI		108739	108739	108739
Elongation, %-2"	%-2"		24.40	24.40	24.40
Yield/Tensile Ratio			.890	.890	0.890
Rockwell B Hardness	HRb		92	92	92

Certified Test Report Type 3.1B in accordance with EN 10204/ISO 10474/DIN 50049. Material has not come in direct contact with mercury, any of its compounds or any mercury bearing devices during the manufactured process, tests or inspections. Material does not contain any polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE).

Cold Drawn Electric Weld Carbon Steel Mechanical Tubing Meeting the Requirements of ASTM A513-16 Type 5. Eddy Current Tested per S8.2.1 or Flux Leakage Tested per S8.4 or Ultrasonic Tested per S8.3. No weld repairs have been performed. Hardness and tensile testing conducted per most current editions of ASTM A513 S5 and ASTM A370. Yield Strength determined @ 0.2% offset. Grain size #5 or finer. All steel fully killed. Manufactured in the U.S.A.

End of Certification

Steven M. Grabert, Manager, Technical Services, being duly sworn according to law, deposes and says that the figures set forth above are correct, as contained in the figures of Sharon Tube Company.

Connector CS plate

PO: 1111091

This Contract Is Subject To The Terms And Conditions Of Sale Shown On The Order Acknowledgement.  
Ce Contrat est Sujet aux Termes et Conditions de Vente Indiqués Sur l'Accusé de Réception de Commande.  
ArcelorMittal Dofasco G.P.  
P.O. Box 2460  
Hamilton, Ontario  
L8N 1J5  
TEST REPORT  
RAPPORT D'ESSAI  
Attention: winnorthap@ruuselmets.com  
Email: winnorthap@ruuselmets.com  
Date: 09/27/2017

Page 1 of 1

-Purchase Order/Bon de Commande-  
51049727-40CT  
-Bill of Lading/Connaissance-  
602058  
-Sold To/Vendu A-  
RUSSEL METALS INC.  
P.O. BOX 19  
WINNIPEG, MB.  
R3C 2G3  
-Customer/Client-  
243000  
-Packing Slip/Bordereau de Charge-  
-Vehicle or Carrier/Vehicule ou Transporteur-  
-Ship To/Expédier A-  
RUSSEL METALS INC.  
1359 ST. JAMES ST.  
WINNIPEG, MB.  
R3H 0K9  
-Vendor/Vendeur-  
Hs2 364699012  
-Spec/Spec et Spec-  
DOFASCO G40.21 44W/50W (01/11)  
STANDARD THICKNESS TOLERANCE  
STANDARD UNEXPOSED SURFACE  
MATERIAL CERTIFICATION REQUIRED  
CODE QIDW 23170-2  
-Material Description/Description du Matériau-  
HOT ROLLED STEEL SHEET  
STRUCTURAL STEEL  
COILS  
MILL EDGE  
PLAIN DRY  
2 1/4  
11810 MIN, 1910 X 60 X COIL  
WEIGHT: 34420 LBS  
-Test Methods/Methods d'Essai-  
ASTM A770, E1019, S415

HEAT	C	Mn	P	S	Si	Cu	Ni	Cr	Sn	Mo	Al	Alt	Cb	V	Ti	Ca	N	H	O
147963	.06	.52	.009	.002	.04	.16	.05	.07	.011	.014	.030	.032	.010	.004	.013	.003	.0073	.0002	

MECHANICAL PROPERTIES/PROPRIÉTÉS MÉCANIQUES  
TEST UNITS KSI  
GAUGE LENGTH 2 INCH  
SERIAL NUMBER LIST # DIR YIELD STRENGTH ULTIMATE STRENGTH 181000  
NOMBRE DE SÉRIE FARDEAU RÉSISTANCE A LA RÉSISTANCE A LA ALLONG  
D'ÉLASTICITÉ TRACTION  
J15947/00 4018530 L 58 60 33 (%)

(1) - Method of elongation calculation: at fracture. / Méthode de calcul de l'allongement: au point de fracture.

051096850

We Certify That The Material Described Herein Conforms To The Specification Shown On This Document  
ArcelorMittal Dofasco G.P. as per John Duric - CMTL Supervisor  
The Results Relate Only To The Items Tested  
This Report Shall Not Be Reproduced Except In Full Without The Express Written Approval Of The CMTL Supervisor.

Heat# 147963

PO# 634336

11048-399-1

R. LEE  
Jan 4-18  
MAY 15 2018

502540



# CERTIFICATE OF TEST

Page 01 of 01

 Certification Date  
29-MAR-2018

**CUSTOMER ORDER NUMBER**

1559

TEAM TUBE DIVISION RMCL

 Invoice Number  
S154292

**CUSTOMER PART NUMBER**

107941

 5039 72ND AVENUE SE  
CALGARY AB T2C 3H3

**SOLD TO:** TECHNOWORX INC  
4788 50 AVE SE  
CALGARY AB T2B3R4

**SHIP TO:** TECHNOWORX INC  
4788 50 AVE SE  
CALGARY AB T2B3R4

 Description: 1026 DOM SRA A513/5  
4.750 OD X 3.750 ID (.500 W) X 20/24' R/L  
HEAT: C83586 ITEM: 107941

Line Total: 27 FT

 Specifications:  
ASTM A513 TP 5 15

ASTM E570

EN 10204 3.1

## CHEMICAL ANALYSIS

C	MN	P	S	SI	NI	CR	MO
0.25	0.73	0.006	0.002	0.02	0.02	0.03	0.01
CU	V	AL	SN	CA	N	TI	B
0.06	0.001	0.03	0.003	0.0021	0.0074	0.001	0.0001
CB							
0.001							

RCPT: R356542

COUNTRY OF ORIGIN : USA

## MECHANICAL PROPERTIES

DESCRIPTION	YLD STR PSI	ULT TEN PSI	%ELONG IN 02 IN	%RED IN AREA	HARDNESS RB
	83900.0	95000.0	16.0		92

The above data were transcribed from the manufacturer's Certificate of Test after verification for completeness and specification requirements of the information on this certificate. All test results remain on file subject to examination.

Material did not come in contact with mercury while in our possession. TERRY GALBRAITH

We hereby certify that the material covered by this report will meet the applicable requirements described herein, including any specification forming a part of the description.

The willful recording of false, fictitious, or fraudulent statements in connection with test results may be punishable as a felony under federal statutes.

 MAY 15 2018  
MANAGER, CORPORATE PURCHASING

PO# 634836

11048-399-1



S02540

DOM 3.250 x .120

PO# 58133-12

R. LEE

MAY 15 2018

<b>GOOD LUCK INDUSTRIES</b> <small>(A UNIT OF GOODLUCK PIPE TUBES LTD.)</small> <small>2-81, SIKANDHARAI INDUSTRIAL AREA,</small> <small>SACCHINBARAI, DISTT. ANUPMAHAR UTTAR PRADESH</small> <small>An ISO/TS 16949, DIN 14001 &amp; ISO 14001 Certified Company</small>		<b>DEPARTMENT- QUALITY ASSURANCE</b>  <b>WORK TEST CERTIFICATE</b>		Doc. No.: GLI-PT-QA-20 Rev. No: 2 REV. Date: 1/4/2012 (Logo) GOODLUCK							
Sr.No.GLI/WTC/0039 Date 09.04.2014 Customer: M/s SALEM STEEL NORTH AMERICA ,LLC Size: 3.250" OD X 3.010" ID X 20'24" L Specification: ASTM A 513/A513M-12 TS 1020 SRA HEAT NO&COIL NO:(E603854)01-14B-0048 Item no.: 25				Purchase Order No.:G14016 R/M Supplier :JSW Invoice No.& Date: GIL/2014-2015/0015/09.04.2014 Container No.:CMAU-8098140 Quantity : 74 PCS (19 X 3, 17 X 1) Bundle No.:G14016-25-1 TO G14016-25-4							
<b>CHEMICAL PROPERTIES</b>				<b>MECHANICAL PROPERTIES</b>							
	C%	Mn%	S%	P%	AP%	SN%	NN%	Tensile Strength (PSI)	Yield Strength (PSI)	EL %	Hardness (HRC)
<b>SPECIFIED</b>	0.18-0.23	0.30-0.60	0.035 max	0.035 max	-	-	-	65000 min	55000 min	10 min	75 min
<b>ACTUAL</b>	0.207	0.620	0.004	0.014	0.051	0.080	0.0059	85369	72564	18%	85-86
Flatt Test : 2/3 % of OD 1/3 % of OD passed. Drift Test : 15 % of ID passed Straightness : 0.030"/3.0" passed				Surface : Satisfactory Eddy Current Test: 100% Tubes tested found satisfactory Material Grade : Fully Killed Final Condition : SRA as per P.O.							
This is to certify that the material supplied confirm to all requirements as specified by the customer. This test certificate confirms to EN 10204-3.1 NOTE: Material compliance to European Environmental Legislation-RoHS Directive 2002/95/EC.											
PREPARED BY: (FOR GOODLUCK INDUSTRIES)				H.O.D. Quality Assurance: (FOR GOODLUCK INDUSTRIES)							

11048-399-1

PO# 634336

SSAB

# Test Certificate

Form TCI: Revision 2: Date 23 Apr 2014

1770 Bill Sharp Boulevard, Muscatine, IA 52761-9412, US

SO 2540  
Heat # A71180

1" thick 516 GR70 plates

Customer: 11EROVICH BROTHERS 2116 PRESTON STREET  ROCKFORD IL 61102		Customer P.O. No.: 5369337		Mill Order No.: 41-515947-01		Shipping Manifest: MT328295												
Product Description: ASTM A516-70(10/15)/ASME SA516-70(17)				Ship Date: 17 Oct 17 Cert Date: 17 Oct 17		Cert No: 061671331 (Page 1 of 1)												
Size: 1.000 X 96.00 X 240.0 (IN)																		
Tested Pieces			Tensiles			Charpy Impact Tests												
Heat Id	Piece Id	Tested Thickness	Tst Loc	YS (KSI)	UTS (KSI)	%RA	Elong % 2in 8in	Tst Dir	Hardness	Abs. Energy(FTLB) 1 2 3 Avg	% Shear 1 2 3 Avg	Tst Temp	Tst Dir	Tst Siz (mm)	ADWTT Tmp %Sur			
A71180	D08	1.001 (DISCRT)	L	61	81		36	T										
Heat Id		Chemical Analysis														ORGN		
		C	Mn	P	S	Si	Tot Al	Sol Al	Cu	Ni	Cr	Mu	Co	V	Ti	S	HW	
A71180		.17	1.19	.010	.003	.23	.027	.025	.30	.15	.11	.03	.020	.003	.009	.0004	.43	USA
<p>KILLED STEEL MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED DURING THE MANUFACTURE OF THIS PRODUCT. KILLED STEEL, PRODUCED TO A FINE GRAIN PRACTICE CEV (IIW) = C + Mn/6 + (Cr+Mo+V)/5 + (Ni+Cu)/15 MTR EN 10204:2004 INSPECTION CERTIFICATE 3.1 COMPLIANT 100% MELTED AND MANUFACTURED IN THE USA. WELD REPAIRING HAS NOT BEEN PERFORMED PRODUCTS SHIPPED: A71180 D08 FCES: 3, LBS: 19602</p>																		
Cust Part # :		WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH, AND MEETS THE REQUIREMENTS OF, THE APPROPRIATE SPECIFICATION										Brian Wales SENIOR METALLURGIST PRODUCT						

R. LEE

MAY 15 2018

11048-309-1

PO# 634336



**CYCLONE STEEL SERVICES, LLC**

**4950 W. GREENS ROAD / HOUSTON, TX 77066**

**PHONE: 713-635-5555 / FAX: 281-537-7144**

The following documents were requested for sales order 188062

Ran on 04/05/18 11:02

DOCUMENT	REFERENCE NUMBER	DATE	TIME
00045745	0036-0.37 S24312 JSW01 18	04/05/18	11:02
00045716	0036-0.37 280312 AHM01 18	04/05/18	11:02

Mill Test Reports furnished by

Cyclone Steel Services, LLC

Order Date....: 03/12/18

Customer.....: JXP SYSTEMS

Customer P.O.: 1108360

Sales Order #: 188062

Item.....: \_\_\_\_\_

PO#  
634336

11048-399-1

R. LEE

MAY 15 2018





JSW Steel (USA) INC.  
5200, East McKinney Road,  
BAYTOWN, TX 77523

## METALLURGICAL TEST REPORT

MET - 04 Rev. No.: 3 Rev. Date: 02/27/2018

3/8/2018

Bulletin	Order Item	Heat	PO No.	Shipping Mode	Order Dimensions	Slab Origin	TC No.
T028494	JSW09694-01	S24312	90565	TRUCK	0.375x96x480		T028494-4312-1
MOD. MNL							
Plates Certified for the Following grades				Specifications	Marking Instructions		
ASTM-A36 AR					Stencil in 1 location(s); X Loc. 18 Y Loc. 30; CUST; MADE IN USA FN PO;		
Hot Rolled Carbon Steel Plates Plates Manufactured In the USA					DIM GRADE; FREIGHT ORDER ITEM PLATE ID SHIPWEEK SLAB ID TRANSMODE		
Sold To: CYCLONE STEEL SERVICES INC. 4950 WEST GREENS RD. HOUSTON, TX 77066							
Ship To: CYCLONE STEEL SERVICES INC. 4950 WEST GREENS RD. HOUSTON, TX 77066							

Test	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Sn	Al	N	V	B	Ti	Nb	Ca	CE
LADLE	0.10	0.99	0.011	0.004	0.19	0.007	0.014	0.023	0.000	0.000	0.031	0.0029	0.005	0.0000	0.001	0.002	0.0026	0.27

Carbon Equivalent CE = C + Mn/5 + (Cr + Mo + V)/5 + (Ni + Cu)/15

PCM = C + Si/30 + Mn/20 + Cu/20 + Ni/60 + Cr/20 + Mo/15 + V/10 + Sb

Plate Tested	Slab Identity	Gauge Tested	Test Cond	Test Dir.	Yield Point	Tensile Stgth.	Elong In 2"	YS/UTS Ratio	Yield Strenght Determined At
1064435	01A	0.3750	AR	T	44	65	40.0%	0.68	0.2%
1064436	01B	0.3750	AR	T	44	64	42.0%	0.69	0.2%

### Plates Certified For The Above Tests

Material	Thick(IN)	Width(IN)	Len(IN)	Wgt(LB)	Material	Thick(IN)	Width(IN)	Len(IN)	Wgt(LB)	Material	Thick(IN)	Width(IN)	Len(IN)	Wgt(LB)
1064444A	0.3750	96.000	480.00	4901	1064444B	0.3750	96.000	480.00	4901					

DIN: EN 10204 2004 3.1 This is to certify that the product described herein was manufactured, sampled, and tested in accordance with the specifications and requirements in such specifications. Fine Grain, Si-Al Fully Killed Steel. We certify that delivery of this product with the requirement of the specification and purchase order received from customer. DRC Conflict Free.



Lorena Barron 281-383-5325 Lorena.barron@jswsteel.us

MAY 15 2018

11048-399-1

PO#634336



# ALTOS HORNOS DE MEXICO

## MILL TEST CERTIFICATE AHMSA: QUALITY WITH THE STRENGTH OF STEEL

PROLONGACION JUAREZ SIN NUMERO COLONIA LA LOMA MONCLOVA COAHUILA 25770

### B118380B

CUSTOMER	DATE OF ISSUED	PAGE	WE HEREBY CERTIFY THAT CHEMICAL AND / OR TEST SHOW IN THIS REPORT ARE CORRECT AS CONTAINED THE RECORDS OF THE COMPANY.  ING. RAMIRO CISNEROS MENCHACA MECHANICAL TESTS AND CERTIFICATION
ADDRESS	16.01.2018	1	
PRODUCT			

STECKEL PLATE

		CHEMICAL COMPOSITION													
HEAT	SPECIFICATION	C	Mn	P	S	Si	Cu	Cr	Ni	Mo	Alt	V	Cb	Ti	
280309	ASTM A36/ASME SA36 ED15	0.180	0.840	0.011	0.007	0.120	0.036	0.025	0.017	0.004	0.045	0.002	0.002	0.002	
280312	ASTM A36/ASME SA36 ED15	0.160	0.860	0.018	0.006	0.120	0.036	0.031	0.018	0.005	0.043	0.002	0.002	0.002	
HEAT	B														
280309	0.0002														
280312	0.0002														

TEST OF THE PRODUCT							
HEAT	SLAB	PLATE NO.	THICKNESS (Inch)	Y. STRENGTH	T. STRENGTH	% ELON.	T. ELONG.
280309	7050	7184026001	0.2500	53.754 (KSI)	72.103 (KSI)	24 (%)	8
280309	7130	7184058001	0.3750	47.817 (KSI)	70.495 (KSI)	25 (%)	8
280309	7140	7184052001	0.3125	49.905 (KSI)	70.454 (KSI)	26 (%)	8
280309	7150	7184055001	0.3750	50.341 (KSI)	71.070 (KSI)	27 (%)	8
280309	7160	7184028001	0.2500	52.352 (KSI)	71.342 (KSI)	27 (%)	8
280312	7130	7182052001	0.7500	44.652 (KSI)	67.815 (KSI)	25 (%)	8
280312	7140	7186052004	0.2500	51.334 (KSI)	72.228 (KSI)	26 (%)	8
280312	7150	7186049001	0.2500	52.050 (KSI)	72.507 (KSI)	24 (%)	8

SHIPPED PRODUCT								
HEAT	PLANCHON	PLATE NO.	THICKNESS (Inch)	WIDTH (Inch)	LARGE (Inch)	ORDER	ITEM	DELIVERY
280309	7070	7188059001	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280309	7070	7188059002	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280309	7070	7188059003	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280309	7070	7188059004	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280309	7070	7188059005	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280309	7070	7188059006	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280309	7070	7188059007	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280309	7070	7188059008	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280312	7090	7188060001	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280312	7090	7188060002	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280312	7090	7188060003	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280312	7090	7188060004	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280312	7090	7188060005	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280312	7090	7188060006	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280312	7090	7188060007	0.3750	96.0000	240.0000	0000209478	000030	1002585246

AHMSA'S COMPROMISE IS ONLY WITH THE CUSTOMER MENTIONED IN THIS CERTIFICATE, AHMSA WILL ONLY ACCEPT THE ORIGINAL DOCUMENT.

ISSUED : S119333

11048-399-1

PO# 634336

MAY 15 2018



ALTOS HORNOS DE MEXICO

MILL TEST CERTIFICATE AHMSA:QUALITY WITH THE STRENGTH OF STEEL  
PROLONGACION JUAREZ SIN NUMERO COLONIA LA LOMA MONCLOVA COAHUILA 25770

B118380B

CUSTOMER	DATE OF ISSUED	PAGE	WE HEREBY CERTIFY THAT CHEMICAL AND/OR TEST SHOW IN THIS REPORT ARE CORRECT AS CONTAINED THE RECORDS OF THE COMPANY.
AHMSA INT/	16.01.2018	2	
ADDRESS	ING. RAMIRO CIBNEROS MENCHACA MECHANICAL TESTS AND CERTIFICATION		
PRODUCT			
STECKEL PLATE			

			SHIPPED PRODUCT					
HEAT	PLANCHON	PLATE NO.	THICKNESS (Inch)	WIDTH (Inch)	LARGE (Inch)	ORDER	ITEM	DELIVERY
280312	7090	7188060008	0.3750	96.0000	240.0000	0000209478	000030	1002585246
HEAT	PLANCHON	PLATE NO.	CUSTOMER ORD.					
280309	7070	7188059001	AHI5238 (V12829) /DIC1					
280309	7070	7188059002	AHI5238 (V12829) /DIC1					
280309	7070	7188059003	AHI5238 (V12829) /DIC1					
280309	7070	7188059004	AHI5238 (V12829) /DIC1					
280309	7070	7188059005	AHI5238 (V12829) /DIC1					
280309	7070	7188059006	AHI5238 (V12829) /DIC1					
280309	7070	7188059007	AHI5238 (V12829) /DIC1					
280309	7070	7188059008	AHI5238 (V12829) /DIC1					
280312	7090	7188060001	AHI5238 (V12829) /DIC1					
280312	7090	7188060002	AHI5238 (V12829) /DIC1					
280312	7090	7188060003	AHI5238 (V12829) /DIC1					
280312	7090	7188060004	AHI5238 (V12829) /DIC1					
280312	7090	7188060005	AHI5238 (V12829) /DIC1					
280312	7090	7188060006	AHI5238 (V12829) /DIC1					
280312	7090	7188060007	AHI5238 (V12829) /DIC1					
280312	7090	7188060008	AHI5238 (V12829) /DIC1					

MTR'S Approved  
Date: 3/9/18  
Initials: [Signature]

All heats and sizes are fully aluminum with fine grain practice. DIN EN10204 3.1 Compliant.

The Material according to standar:  
ASTM A36/ASME SA36/ASTM A709-36  
COUNTRY OF ORIGIN: MÉXICO

END OF DATA

AHMSA'S COMPROMISE IS ONLY WITH THE CUSTOMER MENTIONED IN THIS CERTIFICATE, AHMSA WILL ONLY ACCEPT THE ORIGINAL DOCUMENT.

ISSUED : S119333

CC-03-F-01-A

MAY 15 2018

11048-399-1

PO# 634336

FVC  
an **AFGlobal** Company

# Material Test Report

Heat Code: CUE

Forged Vessel Connections

An AFGlobal Company

13770 Industrial Rd. Houston, TX 77015

Sales: (713) 393-4200

ISO 9001:2008 Certified

NORTH SHORE STEEL	344	PO: 1340034-JG	Sales Order: 166356	Line: 1
PO BOX 9940		Item Code: LWN080600140A002A3	Qty Shipped: 2	
HOUSTON, TX 77213-9940		Item Desc: LWN RF 8"600# SPL SA105N		
Mill Heat: L7293				
Spec: ASTM A105/A105M-(14)/ASME SA 105/SA 105M-(15) Section II Part A - Normalized				

Element	(%wt)	Ladle	Product	EPCRA	CAS#	Element	(%wt)	Ladle	Product	EPCRA	CAS#
C	Carbon	0.17				V	Vanadium	0.02			
Mn	Manganese	1.20		✓	7439-96-5	Cb	Columbium	0.014			
P	Phosphorous	0.010				B	Boron	0.0002			
S	Sulphur	0.004				Ti	Titanium	0.001		✓	7440-02-0
Si	Silicon	0.27				Al	Aluminum	0.023			
Cu	Copper	0.14		✓	7440-50-8	Ca	Calcium	0.0010			
Ni	Nickel	0.06		✓	7440-02-0	C.E.		0.40			
Cr	Chromium	0.06		✓	7440-47-3	CuNiCrMoV		0.303			
Mo	Molybdenum	0.02				CrMo		0.08			

Mechanical Testing			Heat Treat	
Test Lab	AFG		Norm. Temp. (F)	1675
HBW	143 - 148		Norm. (Hrs)	3:15
Elg (%)	34		Norm. Cooling Type	AIR
RA (%)	65		Norm. Location	FVC 519-17
Tensile Specimen Size (in)	.492			
Tensile (ksi)	77		Other	
Yield (ksi)	53.7		Country of Melt	USA
Gauge Length (in)	2		VD	YES
			EF	Y
			Made to Fine Grain Practice	YES

The recording of false, fictitious, or fraudulent statement or entries on this document may be punishable as a felony under federal statute.

EPCRA Supplier Notification: This product may contain one or more toxic chemicals subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-to-Know Act (Title III of the Superfund Amendments and Reauthorization Act of 1986) and 40 C.F.R. Part 372. Potentially reportable chemicals are indicated with a checkmark in the "EPCRA" column and a Chemical Abstract Services (CAS) registry number is provided for each such chemical in addition to the percent by weight of the chemical present in this product. It is your responsibility alone to determine whether your facility is required to submit a Toxic Release Inventory Report under EPCRA Section 313.

Certification No.: 1324316  
 Certification Date: 4/23/2018  
 Issued By: John Saucedo

This report is issued in compliance with the requirements of EN10204 3.1 / ISO 10474 3.1.b

Page 1 of 2

R. LEE

PO#635583

11048-399-3

HT#CUE



**Material Test Report****Heat Code: CUE**

Forged Vessel Connections

An AFGlobal Company

13770 Industrial Rd. Houston, TX 77015

Sales: (713) 393-4200

ISO 9001:2008 Certified

NORTH SHORE STEEL	344	PO: 1340034-JG	Sales Order: 166356	Line: 1
PO BOX 9940		Item Code: LWN080600140A002A3	Qty Shipped: 2	
HOUSTON, TX 77213-9940		Item Desc: LWN RF 8"600# SPL SA105N		
		Mill Heat: L7293		
Spec: ASTM A105/A105M-(14)/ASME SA 105/SA 105M-(15)Section II Part A - Normalized				

Product compliant with NACE MR0175/ISO 15156-2:2015, Annex A (A.2.1.2, A2.1.3).  
 Product compliant with NACE MR0103/ISO 17945:2015, Section 13.1.1 and 13.1.3.

- \* No Weld repair performed.
- \* Ladle Chemical Analysis results are reported from the raw material suppliers MTR.
- \* Tensile taken from a round specimen. Measurement of elongation after fracture.
- \* Yield strength was determined using the .2% offset method, unless otherwise specified.
- \* All material supplied under this order is certified to be free of mercury contamination and no mercury bearing equipment was used in manufacturing, fabrication or testing.
- \* When reported on MTR: Tensile Testing Per ASTM E8; Brinell Hardness Per ASTM E10; Charpy Testing Per ASTM E23
- \* AF Global manufactures materials according to a certified Quality Management System conforming to ISO 9001:2008 and PED 2014/68/EU, Annex 1, Section 4.3

Unless otherwise noted on PO, Dimensions of all standard pipe flanges and flange fittings (NPS 1/2 to NPS 24) per ASME B16.5-2013, large diameter steel flanges (NPS 26 to 60) per ASME B16.47-2011, Orifice flanges per ASME B16.36-2015.

\* FVC FLANGE DIMENSIONS & BOLTING COMPLY - ASME B16.5  
 SELF-REINFORCING NOZZLES COMPLY WITH SPECIFICATION OF SECTION VIII DIV. 1 OR DIV. 2 PER CUSTOMER DESIGN/FVC DESIGN.

The recording of false, fictitious, or fraudulent statement or entries on this document may be punishable as a felony under federal statute.

EPCRA Supplier Notification: This product may contain one or more toxic chemicals subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-to-Know Act (Title III of the Superfund Amendments and Reauthorization Act of 1986) and 40 C.F.R. Part 372. Potentially reportable chemicals are indicated with a checkmark in the "EPCRA" column and a Chemical Abstract Services (CAS) registry number is provided for each such chemical in addition to the percent by weight of the chemical present in this product. It is your responsibility alone to determine whether your facility is required to submit a Toxic Release Inventory Report under EPCRA Section 313.

Certification No.: 1324316  
 Certification Date: 4/23/2018  
 Issued By: John Saucedo

This report is issued in compliance with the requirements of EN10204 3.1 / ISO 10474 3.1.b

  
 Rina Sane - Metallurgical Lab Manager

Page 2 of 2  
**R. LEE**

PO# 635583

11048-399-3

NT# CUE

**COFFER®**  
an **AFGlobal** Company

# Material Test Report

Heat Code: CTO

Coffer Corp.

An AFGlobal Company

13770 Industrial Rd. Houston, TX 77015

Sales: (713) 393-4200

ISO 9001:2008 Certified

NORTH SHORE STEEL	344	PO: 295669	Sales Order: 164355	Line: 9
PO BOX 9940		Item Code: 0603800100-0AW1F	Qty Shipped: 5	
HOUSTON, TX 77213-9940		Item Desc: FLG 08.00 0600 BL RF A105/F42 NRM COFFR		
		Mill Heat: 3073449		
Spec: ASTM A105/A105N-(16) ASME SA 105/SA 105N-(15) / A694/A 694M (14), F42				

Element	(%wt)	Ladle	Product	EPCRA	CAS#	Element	(%wt)	Ladle	Product	EPCRA	CAS#
C	Carbon	0.19				Mo	Molybdenum	0.016			
Mn	Manganese	1.02		16	7439-96-5	V	Vanadium	0.00			
P	Phosphorous	0.010				Cb	Columbium	0.002			
S	Sulphur	0.014				B	Boron	0.0000			
Si	Silicon	0.22				C.E.		0.40			
Cu	Copper	0.25		16	7440-50-8	CuNiCrMoV		0.41			
Ni	Nickel	0.07		16	7440-02-0	CrMo		0.09			
Cr	Chromium	0.07		16	7440-47-3						

Mechanical Testing		Heat Treat	
Test Lab	AFG	Norm. Temp. (F)	1675
Test Bar Size	SACRIFICIAL PIECE	Norm. (Hrs)	4
HBW	156 - 156	Norm. Cooling Type	AIR
Elg (%)	34	Norm. Location	AFG
RA (%)	64		
Tensile Specimen Size (in)	.494	Other	
Tensile (ksi)	79.8	Country of Melt	USA
Yield (ksi)	49	Country of Finish Machining	USA
Gauge Length (in)	2	EF	Y

Product compliant with NACE MR0175/ISO 15156-2:2015, Annex A (A.2.1.2, A2.1.3).  
Product compliant with NACE MR0103/ ISO 17945:2015, Section 13.1.1 and 13.1.3.

- \* No Weld repair performed.
- \* Ladle Chemical Analysis results are reported from the raw material suppliers MTR.
- \* Tensile taken from a round specimen. Measurement of elongation after fracture.
- \* Yield strength was determined using the .2% offset method, unless otherwise specified.
- \* All material supplied under this order is certified to be free of mercury contamination and no mercury bearing equipment was used in manufacturing, fabrication or testing.
- \* When reported on MTR: Tensile Testing Per ASTM E8; Brinell Hardness Per ASTM E10; Charpy Testing Per ASTM E23
- \* AF Global manufactures materials according to a certified Quality Management System conforming to ISO 9001:2008 and PED 2014/68/EU, Annex 1, Section 4.3

Unless otherwise noted on PO, Dimensions of all standard pipe flanges and flange fittings (NPS 1/2 to NPS 24) per ASME B16.5-2013, large diameter steel flanges (NPS 26 to 60) per ASME B16.47-2011, Orifice flanges per ASME B16.36-2015.

The recording of false, fictitious, or fraudulent statement or entries on this document may be punishable as a felony under federal statute.

EPCRA Supplier Notification: This product may contain one or more toxic chemicals subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-to-Know Act (Title III of the Superfund Amendments and Reauthorization Act of 1986) and 40 C.F.R. Part 372. Potentially reportable chemicals are indicated with a checkmark in the "EPCRA" column and a Chemical Abstract Services (CAS) registry number is provided for each such chemical in addition to the percent by weight of the chemical present in this product. It is your responsibility alone to determine whether your facility is required to submit a Toxic Release Inventory Report under EPCRA Section 313.

Certification No.: 1316743  
Certification Date: 2/21/2018  
Issued By: Nancy Loos

This report is issued in compliance with the requirements of EN10204 3.1 / ISO 10474 3.1.b

*Rina Sane*  
Rina Sane - Metallurgical Lab Manager

**R. LEE**

PO: 635583 Line: 2 Order: 1340034 Heat: CTO Slab: Descr: FLG 8 600 RF BLIND

MAY 29 2018

PO# 635583

11048-399-4

HT# CTO

R. LEE

MAY 29 2018

11048-399-5 5-66 11 44#A2AV7

PO#635583

CLIENTE/Customer/Clien

**CERTIFICADO DE INSPECCION**  
 Inspection Certificate - Certificat de Réception
UNE EN 10204:08/3.1  
ISO 10474:15/3.1FECHA:  
Date:

03/01/2018

N.º  
No.

192157

HOJA:  
Page: 1

SGI 1922164



SGI 6000236



SGI 6000047



ULMA FORJA, S.COOP.

Management Systems certified by LRDAE

Certified acc. PED 97/23/EC AD2000-WO

PED 14/00/AUE

by TÜV Rheinland

N.º 01 202 EQ 02 7443

MARCA DEL FABRICANTE

Mark of factory

Marque du fabricant

DEPARTAMENTO

Section

Département

QUALITY ASSURANCE

Section

Département

Bº Zubillaga, 3 - Apdo. 14  
20560 ORATÍ (Gipuzkoa) SPAIN

Tel: 34 - 943 780502

Fax: 34 - 943 781808

E-mail: ulma@ulmapiping.com

Packing 136630

PRODUCTO  
Article - Produit

FLANGES

SU PEDIDO N.º  
Your Order No.

PO-222078

DE  
of - de 06/12/2017

NORMAS APLICABLES

Requirements - Normes Applicables

ASME B16.5-17

MATERIAL CORRESPONDIENTE

Material Correspondant - Qualité

ASME SA105M-17, ASTM A106M-14

MODO DE FUSION (\*)

Steel Making - Elaboration de l'acier

NACE MR0175/ISO 15156-02/03-15 &amp; NACE MR0103/ISO 17495-15

RF = Elec. Y = Código básico

PARTIDA Item Poste	CANTIDAD Quantity Quantité	DESCRIPCION Description Description	OBSERVACIONES Remarks Observations	COLADA N. Heat No N.º Coudle	RESISTENCIA T.Strength Resist Tens N/mm²	UNITE ELAST. Y.Strength 0.2 % N/mm²	ALARGAM. Elongation Allongement LacStress/4% %	ESTRUCION Red. Area Reduction %	RESILIENCIA Impact test Resilience Joules	CHARPY V 10x10mm MEDIA Average Moyenne	DUREZA Hardness Dureté HBW
43	4	WN 14 150LB S120 RF A105N	NE	A06T3	516	304	28,30	59,00			148 150
44	8	WN 14 150LB S160 RF A105N	NE	A06T3	516	304	28,30	59,00			148 150
58	1	SO 8 150LB FF A105N	NE	B75A7	509	316	30,60	66,80			140 146
98	3	THRED 4X2-150LB RF A105N	NE	B16A7	514	308	30,40	61,40			148 152
106	5	LJ 8 150LB A105N	NE	A77A7	520	322	31,00	63,30			162 164
144	50	SO 1/2 300LB RF A105N	NE	A7AV7	508	314	30,40	60,80			146 152
185	100	THR 1/2 300LB RF A105N	NE	A7AV7	508	314	30,40	60,80			146 152
178	18	WN 4 600LB XS/80 RF A105N	NE	C15A7	509	308	31,00	60,00			143 146
186	1	WN 12 600LB S60 RF A105N	NE	A2AV7	512	304	28,80	60,40			146 150
204	16	WN 16 600LB S80 RF A105N	NE	B8AV7	513	299	28,30	59,20			148 152
205	1	WN 16 600LB S100 RF A105N	NE	O8AV5	511	305	29,20	51,70			148 148

COLADA N.  
Heat No  
N.º Coudle

## COMPOSICION QUIMICA - STEEL MAKER'S LADLE ANALYSIS - ANALYSE CHIMIQUE

C %	SI %	Mn %	P %	S %	Cr %	Ni %	Mo %	Nb %	V %	Cu %	Al %	Ti %	B %	CEq %	Origin of Steel
0,180	0,210	1,000	0,008	0,005	0,067	0,140	0,015	0,001	0,003	0,210	0,023	0,001	0,0002	0,40	Spain
0,200	0,160	0,900	0,012	0,011	0,090	0,150	0,030	0,004	0,001	0,400	0,000	0,000	0,0000	0,41	France
0,177	0,262	0,980	0,011	0,001	0,162	0,047	0,007	0,000	0,001	0,085	0,023	0,002	0,0001	0,38	France
0,180	0,190	1,010	0,007	0,002	0,080	0,093	0,034	0,001	0,001	0,239	0,026	0,002	0,0001	0,40	Spain
0,186	0,230	1,020	0,010	0,002	0,140	0,110	0,030	0,007	0,004	0,170	0,022	0,003	0,0001	0,41	Italy
0,200	0,230	1,020	0,008	0,004	0,070	0,070	0,013	0,004	0,003	0,180	0,039	0,011	0,0004	0,40	France
0,200	0,190	0,990	0,013	0,003	0,100	0,080	0,023	0,004	0,007	0,180	0,028	0,001	0,0004	0,41	France
0,180	0,188	1,049	0,011	0,002	0,062	0,038	0,009	0,001	0,001	0,053	0,032	0,001	0,0001	0,37	Italy
0,180	0,180	1,020	0,007	0,003	0,060	0,090	0,016	0,003	0,005	0,160	0,028	0,002	0,0004	0,38	France

OBSERVACIONES:  
Remarks  
Observations

N NORMALIZED AT 900 C AND ALLOWED TO COOL IN STILL AIR.

- Las dimensiones y la condición superficial se hallaron 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.

EL INSPECTOR  
Works Inspector - L'inspecteurULMA FORJA S. COOP.  
Dpto. de Garantía de calidad  
Quality Assurance Dept.



**Material Test Report**

Coffer Corp.

COFFER®  
an AFGlobal Company

Heat Code: DFB

An AFGlobal Company

13770 Industrial Rd. Houston, TX 77015

ISO 9001:2008 Certified

Sales: (713) 393-4200

NORTH SHORE STEEL	344	PO: 295669	Sales Order: 164355	Line: 25
PO BOX 9940		Item Code: 0603912100-0AW1F	Qty Shipped: 20	
HOUSTON, TX 77213-9940		Item Desc: FLG 12.00 0600 BL RF A105/F42 NRM COFFR		
		Mill Heat: MM17107574		
Spec: ASTM A105/A105N-(16) ASME SA 105/SA 105N-(15) / A694/A 694M (14), F42				

Element	(%wt)	Ladle	Product	EPCRA	CAS#	Element	(%wt)	Ladle	Product	EPCRA	CAS#
C	Carbon	0.17				Mo	Molybdenum	0.03			
Mn	Manganese	1.19		16	7439-96-5	V	Vanadium	0.02			
P	Phosphorous	0.009				Cb	Columbium	0.0054			
S	Sulphur	0.005				B	Boron	0.0000			
Si	Silicon	0.21				C.E.		0.42			
Cu	Copper	0.19		16	7440-50-8	CuNiCrMoV		0.43			
Ni	Nickel	0.08		16	7440-02-0	CrMo		0.14			
Cr	Chromium	0.11		16	7440-47-3						

Mechanical Testing		Heat Treat	
Test Lab	AFG	Norm. Temp. (F)	1675
Test Bar Size	SACRIFICIAL PIECE	Norm. (Hrs)	4
HBW	143 - 143	Norm. Cooling Type	AIR
Elg (%)	39		
RA (%)	74		
Tensile Specimen Size (in)	.491		
Tensile (ksi)	74.9		
Yield (ksi)	45.9		
Gauge Length (in)	2		

Product compliant with NACE MR0175/ISO 15156-2:2015, Annex A (A.2.1.2, A2.1.3).  
Product compliant with NACE MR0103/ ISO 17945:2015, Section 13.1.1 and 13.1.3.

- \* No Weld repair performed.
- \* Ladle Chemical Analysis results are reported from the raw material suppliers MTR.
- \* Tensile taken from a round specimen. Measurement of elongation after fracture.
- \* Yield strength was determined using the .2% offset method, unless otherwise specified.
- \* All material supplied under this order is certified to be free of mercury contamination and no mercury bearing equipment was used in manufacturing, fabrication or testing.
- \* When reported on MTR: Tensile Testing Per ASTM E8; Brinell Hardness Per ASTM E10; Charpy Testing Per ASTM E23
- \* AF Global manufactures materials according to a certified Quality Management System conforming to ISO 9001:2008 and PED 2014/68/EU, Annex 1, Section 4.3

Unless otherwise noted on PO, Dimensions of all standard pipe flanges and flange fittings (NPS 1/2 to NPS 24) per ASME B16.5-2013, large diameter steel flanges (NPS 26 to 60) per ASME B16.47-2011, Orifice flanges per ASME B16.36-2015.

The recording of false, fictitious, or fraudulent statement or entries on this document may be punishable as a felony under federal statute.

EPCRA Supplier Notification: This product may contain one or more toxic chemicals subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-to-Know Act (Title III of the Superfund Amendments and Reauthorization Act of 1986) and 40 C.F.R. Part 372. Potentially reportable chemicals are indicated with a checkmark in the "EPCRA" column and a Chemical Abstract Services (CAS) registry number is provided for each such chemical in addition to the percent by weight of the chemical present in this product. It is your responsibility alone to determine whether your facility is required to submit a Toxic Release Inventory Report under EPCRA Section 313.

Certification No.: 1317596  
Certification Date: 2/27/2018  
Issued By: John Saucedo

This report is issued in compliance with the requirements of EN10204 3.1 / ISO 10474 3.1.b

Rina Sane - Metallurgical Lab Manager

R. LEE

PO# 635583

11048-399-6

HT# DFB





## MATERIAL TEST REPORT

FFI-QACON-F0003

Revision: 08, 05/02/2017

## MII Test Report

MIII Test Report				
North Shore Supply	Purchase Order:	1340034-JG2		
PO 80X 9940	Sales Order:	0026250		
Houston, Tx 77213	Line Item:	001	Qty:	2

<b>Item Code:</b>	FFI-FGRFW-00085	<b>Material:</b>	A/SA 350 LF2
<b>Description:</b>	FLG WN RF 36 600 1.0 A		<b>Manufactured in the U.S.A.</b>
<b>FID:</b>	H9057	<b>Heat Code:</b>	MM17101906

Element		Ladle
C	Carbon	0.1200
Mn	Manganese	1.1200
P	Phosphorous	0.0011
S	Sulphur	0.0030
Si	Silicon	0.2200
Cu	Copper	0.3100
Ni	Nickel	0.1100
Cr	Chromium	0.1500

Element	Ladle
N	Nitrogen
Mo	Molybdenum
V	Vanadium
CbNb	Columbium/Niobium
Ti	Titanium
Al	Aluminum
B	Boron
Sn	Tin

### Additional Chemicals

CRMO 0.19 ; NICRMOCUV 0.65

Melting Practice	EAF LR VD	Reduction Ratio	4.3 TO 1
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### Mechanical Test Results

Mechanical Test Results			
Tensile (PSI)	72,300		
Yield (PSI)	50,600		
Elong (%)	37.00		
Red (%)	71.00		
CE	0.3806		
PCM			
HBW	147	to	148
CVN Test Temperature	-50		°F
Ft/Lbs.	112	107	128
Shear (%)	70	70	70
MLE	0.095	0.089	0.098
Tensile Test Size	0.500		
QTC Type & Size	4 X 4 X 12		

### Heat Treatment Information

[illegible]

 Additional Comments

**Lisa Johnson** - Quality Representative

4/16/2018

Date \_\_\_\_\_

Product is compliant with HACE MR0175/ISO 15156:2009. / Product is compliant with HACE MR0103-2012.  
No weld repair is performed.

**The product is free of Mercury contamination.**

The test is taken from round specimen.

**Yield Strength** is determined using 0.2% offset method, unless otherwise specified.

When reported on the MTR: Tensile testing per ASTM E 8, Charpy Impact testing per ASTM E 23 and Brinell Hardness Testing per ASTM E 10.

Federal Flange manufactures products according to a certified QMS conforming to ISO 9001:2008 and PED 2014/68/EU, Annex I, section 4.3.

Products are manufactured in compliance to EN 10304 Type 3.1

Physical Address: 4014 Pinemont Dr | Houston, TX 77018

Telephone: (713) 681-0606 | Fax: (713) 681-3005

R. LEE

MAY 29 2018

PO#635583

11048-399-7

HT# MM/7501906

PO: 635617 Line: 1 Order: 1340400 Heat: DFDY Slab: Descr: CUSTOM FORGINGS SA350LF2CL1-N



# Piping Products, Inc.

**FORGED STEEL FLANGES AND SPECIAL FITTINGS**  
1681 Kress St., Houston, Texas 77020-8126  
Ph: (713) 675-5374, (800) 775-5374, Fax: (713) 675-7910

## \*\*\* MILL TEST REPORT \*\*\*

S NORTH SHORE STEEL  
O PO BOX 9940  
L  
D HOUSTON, TX 77213

S NORTH SHORE STEEL  
H 12945 MARKET ST.  
I  
P HOUSTON, TX 77015

CUST #: NOR01  
CUST PO: 1340400-JG  
DATE: 05/02/18  
PPI S/O #: 282437  
TAG #:

ITEMS COUNTRY OF MANUF: USA

ITEM	DESCRIPTION
10	CUSTOM FORGINGS PR DWG- 11048-399-0008 SA350LF2-CL1-

### CHEMICAL PROPERTIES

ITEM	HEAT NO.	C	SIL	MN	PHOS	SUL	CR	NI	MO	N	CO	CU	V	AL	NB	C/EQ
10	DFDY	0.180	0.200	1.110	0.012	0.007	0.110	0.070	0.030	0.000	0.000	0.070	0.031	0.027	0.001	0.409

### PHYSICAL PROPERTIES

ITEM	YIELD STRENGTH	TENSILE STRENGTH	ELONG. % IN 2"	RED. AREA	BHN HARDNESS	CHARPY TEST	Forge Country Of Origin
10	51,000	73,500	33.80	71.20	142-142	V.NOTCH -50F 72/69/72	MEXICO

### ITEM NOTES

10 NORM @ 1675F 1/2 HR INCH. +1 HR AIR COOLED

### ORDER NOTES

USA, CANADA, JAPAN OR W. EUROPE- MUST BE MARKED  
Additional Notes or Comments:

We hereby certify that all test results and process information contained herein are correct and true as contained in the records of the company.

Quality Assurance Asst. Mgr.

R. LEE

MAY 17 2018

PO: 635617 Line: 1 Order: 1340400 Heat: DFDY Slab: Descr: CUSTOM FORGINGS SA350LF2CL1-N

HT#DFDX

11048-399-8

PO#635617

## ArcelorMittal Burns Harbor Plate

QUALITY ASSURANCE  
REPORT OF TEST AND ANALYSES

US HWY 12 Burns Harbor, Indiana

SHIPMENT NO. 803-30894		DATE SHIPPED 03-11-18		CAR OR VEHICLE NO. CSS-CHGO-BNSF		TTPX 080226		PAGE 2				
S O L D T O PRESCOR INC PO BOX 9856 TULSA OK 74157-0856				S H I P T O PRESCOR INC 8601 STATE HWY 66 TULSA OK 74131								
N O T E	SERIAL NUMBER	PAT NO.	HEAT NUMBER	NO. PCS.	SIZE AND QUANTITY				YIELD POINT	TENSILE STRENGTH	AF FRAC. ELONG.	RED.
					THICKNESS	WIDTH OR DIA.	LENGTH	WEIGHT				
					INCHES	INCHES	INCHES	POUNDS	PSI	PSI	IN	%

QUALITY STEEL MELTED &amp; MANUFACTURED IN THE U. S. A.

PLATES - ASTM A516-06 GR 70 PVQ KLD FINE  
GRAIN PRAC, ASME SA516 GR 70 PVQ  
2015 EDITION --- GAS CUT 4 SIDES  
MILL TEST PCS NORM 1650F FOR 1HR/IN  
AIRCL --- TEST CERTS ARE PREPARED  
IN ACCORD WITH PROCEDURES OUTLINED  
IN EN 10204:2004 TYPE 3.1

NO WELD REPAIR WAS PERFORMED ON BELOW PLATE(S)  
MFST - MFST MFST MILL SERIAL# & PATTERN# MFST PPI  
0073686- 0001 MFST TEST CERTS ARE PREPARED IN  
ACCORD WITH PROCEDURES OUTLINED IN EN MFST  
10204:2004 TYPE 3.1

- LIFT MAX 10 TON UNLDG

FORK LIFT-SIDE

CO# MM17511 GH 888-4316A

TEST SPECIMENS LABORATORY HEAT TREATED AND YIELD STRENGTH @ .5% E.U.L.  
MERCURY IN ANY FORM HAS NOT BEEN USED  
IN THE PRODUCTION OF THIS ORDER

J046052	812A34680	1	1	3/4	120	240	BAST	14293	48500	74800	2	34
J046053	812A34680	1	1	3/4	120	240	BASV	14293	49800	75600	2	33

Q-QUENCH TEMPERATURE

T-TEMPER TEMPERATURE

N-NORMALIZE TEMPERATURE

SERIAL NUMBER	PAT NO	HEAT NUMBER	HARD BHN	BEND	THICKNESS INCHES	TYPE	SIZE	DIR	TEST TEMP. F	CHARPY IMPACT								
										ENERGY FT LBS			SHEAR(%)			LAT. EXP MILS		
										1	2	3	1	2	3	1	2	3

HEAT NUMBER	CHEMICAL ANALYSIS																MOULD GRAIN SIZE
	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Ti	Al	B	Co	N	Sn	
812A34680	.18	1.09	.010	.004	.311	.026	.01	.13	.080	.001	.002	.032	.0002	.002	.004	.004	

I certify that the above results are a true and correct copy of actual results contained in records maintained by ArcelorMittal Burns Harbor and are in full compliance with the requirements of the specification cited above. This test report cannot be altered and must be transmitted intact with any subsequent third party test reports, if required.

BHPLTRPT.TIF

SUPV. QUALITY ASSURANCE

ANDREW SMITH

PER

ELJ

R. LEE

JUN 28 2018

PO#635592

11048-399-9

H# BAST  
BASV

# METALLURGICAL SERVICES, L.L.C.

10882 W. 71st Street South  
P.O. Box 908 • Sapulpa, OK 74067  
Phone: 918-224-7221 • Fax: 918-224-7231

Lab No. 18-26266

Page 1 of 1

P.O. 194474

## Mechanical Test Report

Organization PRESCOR Contact JULANA CLAY  
Address P.O. BOX 9856 TULSA, OKLAHOMA 74157  
Base Metal Type SA516-70 TO N/A  
HT: BAST  
Coupon Thickness 1-3/4" PWHT 1 HR. 10 MINUTES @ 1750° F.  
WPS No. N/A PQR No. N/A  
Weld Process N/A Filler N/A  
Welder's Name N/A I.D. No. N/A

### Bends

Specimen Number	Bend Type	Results / Comments
1	NONE	
2		
3		
4		

### Tensile Tests (Transverse)

Specimen Number	Specimen Size	Specimen Area sq. in.	Load at Failure PSI	Yield 2% offset PSI	Ultimate Tensile PSI	Break Location	Percent Elongation In 2 inches
1	NONE x						
2	x						
3	x						
4	x						

### Hardness In BHN

Material 1			Heat Affected Zone			Weld Metal		
1	2	3	1	2	3	1	2	3
NONE								
Material 2			Heat Affected Zone					
1	2	3	1	2	3			

### Charpy V-Notch Impact Testing

Specimen Number	Specimen Type	Specimen Size	Temp. F.	Value FL/Lbs.	Lateral Expansion	Percent Shear
1	BM	10mm x 10mm	-50° F	42	21	20
2	BM	10mm x 10mm	-50° F	40	18	20
3	BM	10mm x 10mm	-50° F	37	15	20
4						
5						
6						
7						
8						
9						
10						
11						
12						

OTHER TESTS PERFORMED: NONE

All tests performed in accordance to methods specified in ASME SA-370 & ASTM A-370.

Signature [Signature]

Date 5/16/2018

LCC

JUN 28 2018

PO#635592

11048-399-9

HT# BAST  
BASV



# GLOBE X-RAY SERVICES, INC.

8441 South Union Tulsa, OK 74132

Certification 121725-1

## Report of Ultrasonic Examination

Customer: Prescor P. O.   
Address:  Job # 194474

### Ultrasonic Examination

Test Instrument: Sonatest D-20 S/N: I013300  
Surface Condition: Smooth Procedure #: GXS-II-B Rev: 1-18  
Couplant: Sonix Search Unit Cable: RG-174 Co-Axial, 6FT. Long with BNC to BNC Connectors  
Beam Angle: 0 Degrees Search Unit 1" x 2.25 MHz S/N: 77153  
Scanning Pattern: 100% Reference Level: 38 Db  
Calibration Reference: Backwall Technique: Contact, Manual Scan  
Scanning Surface: One major surface

### Reference Standard:

ASTM/ASME A-578/SA-578 LEVEL A(1)  
 ASTM/ASME A-578/SA-578 LEVEL B(2) √ ASTM/ASME A-435/SA-435  
 ASTM/ASME A-578/SA-578 LEVEL C(3)

Notes: Before Forming

Quantity/Item#	Part Identification	Heat Number/Code	Accept	Reject
2 pcs.	1-3/4" Thk x 92-3/4" OD	BAST	√	

Unless otherwise noted by an \* following the item number, there were no recordable indications observed.

Examination By: Colter Moyer Qualification Level: II  
Date: 6/5/2018 Time: NA AM/PM

GLOBE XRAY ASSUMES NO RESPONSIBILITY FOR THE INTEGRITY OF THE STRUCTURE OR ANY LOSSES OF ANY KIND DUE TO ANY KIND OF INTERPRETATION

R. LEE

JUN 28 2018

Ht# BAST  
BASV

PO#635592

11048-399-9



**Capitol Manufacturing**  
1125 Capitol Avenue  
Crowley, LA 70526

**Phoenix \* Capitol \* Camco**  
**CapProducts**

*Commanding a Higher Standard<sup>sm</sup>*

**Certified Mill Test Report**

Printed: 2/21/2018  
Customer  
INDUSTRIAL PIPING SPECIALISTS  
P.O. BOX 581270  
TULSA, OK 74158

Certified: 02/20/2018  
P.O. TP564628  
Tag

Material ASTM A105-2014 / ASME SA105-2015 Edition

Heat No 76SD(76S8)  
Heat Code 76SD  
Phoenix Order # 1335207

Part Number  
12302010.4L

Description  
1" 6M TOE CPLG 4" LONG

**Chemical Properties**

C	Mn	P	S	Si	Cu	Ni	Cr	C Eq. Long	
0.1600	0.8300	0.0070	0.0270	0.2100	0.1700	0.0730	0.1370	0.3531	
Mo	V	Co	Al	Cb	N	Pb	Sn	Ta	Ti
0.0210	0.0350		0.0020	0.0040					

**Additional Chemical Properties**

					Cr + Cu + Ni	
					0.3800	

**Mechanical Properties**

Tensile (PSI)	Yield (PSI)	Elong. % in 2 in. or 4D	R of A	HBW	HBW2
72,500	46,300	34.0%	64.0%	153	159

**Charpy Minimum Impact - ft/lbs**

Test 1	Test 2	Test 3	Average	Test Temp.
N/A	N/A	N/A	N/A	N/A

We hereby certify that these parts were manufactured, sampled, tested, and inspected in accordance with the product specifications stated and were found to meet the requirements. We further certify that this material was inspected using independent inspectors conforming to the requirements of EN 10204 3.1. These products meet the requirements of the latest editions of NACE MR0103 and ISO 15156. No weld repair has been performed on these products. This material was not exposed to mercury or any other metal alloy that is liquid at ambient temperatures during processing or while in our possession.

Meets ASME SA-181-70 2013 Edition. Manufactured in the USA.

**R. LEE**

JUN 05 2018

HT# 76SD

11048-300-1MR

PO# 636386



**Capitol Manufacturing**  
1125 Capitol Avenue  
Crowley, LA 70526

**Phoenix \* Capitol \* Camco**  
**CapProducts**

**Certified Mill Test Report**

*Commanding a Higher Standard<sub>sm</sub>*

Printed: 3/14/2018

**Customer**

INDUSTRIAL PIPING SPECIALISTS

P.O. BOX 581270

TULSA, OK 74158

Certified: 03/12/2018

P.O. HP291522

Tag

Material ASTM A105/A105M-96, ASME SA105 Latest ed.

Heat No 178058

Heat Code 76UQ

Phoenix Order # 1352874

**Part Number**

12302010

**Description**

1 FS 6M THD COUPLING

**Chemical Properties**

C	Mn	P	S	Si	Cu	Ni	Cr	C Eq. Long	
0.2100	0.9700	0.0100	0.0220	0.2300	0.1900	0.0740	0.1290	0.4267	
Mo	V	Co	Al	Cb	N	Pb	Sn	Ta	Ti
0.0230	0.0350		0.0030	0.0030					

**Additional Chemical Properties**

					Cr + Cu + Ni	
					0.3930	

**Mechanical Properties**

Tensile (PSI)	Yield (PSI)	Elong. % in 2 in. or 4D	R of A	HBW	HBW2
83,500	62,700	25.0%	48.0%	156	159

**Charpy Minimum Impact - ft/lbs**

Test 1	Test 2	Test 3	Average	Test Temp.
N/A	N/A	N/A	N/A	N/A

We hereby certify that these parts were manufactured, sampled, tested, and inspected in accordance with the product specifications stated and were found to meet the requirements.

We further certify that this material was inspected using independent inspectors conforming to the requirements of EN 10204 3.1. These products meet the requirements of the latest editions of NACE MR0175, NACE MR0103, and ISO 15156. No weld repair has been performed on these products. This material was not exposed to mercury or any other metal alloy that is liquid at ambient temperatures during processing or while in our possession.

Manufactured in the USA.

R. LEE

MAY 23 2018

PD#636175

11048-300-1

Ht# 76UQ

**Awaji****ASK****INSPECTION CERTIFICATE**

EN 10204 3.1 : 2004

**AWAJI MATERIA (THAILAND) CO.,LTD.**

Factory : 81 MOO 4, PRAKASA ROAD, TAMBOL BANGMUANG AMPHUR MUANG

SAMUTPRAKARN, THAILAND 10270, Tel : (662) 701-5226

Head Office : 4-2, KAMIGAMO, SUMOTO CITY, HYOGO, 656-0015, JAPAN

Tel : (81)799-22-1731 : FAX (81) 799-22-1730

ISO 9001 :2008 Manufacturing Company  
Certified by BV. Certificate No. TH008428Material manufacturer QMS acc.  
PED 97/23/EC, Annex1, Par4.3/AD2000W0  
Certified by Lloyd's Register  
Certificate No. 50207/1

Date : NOVEMBER 16, 2017

Certificate No. : T17-Y1824

Purchaser : Industrial Piping Specialists

Order No.		Job No.		Product		MADE FROM SEAMLESS STEEL PIPE																	
HP277049/2				CARBON STEEL BUTT WELDING FITTINGS																			
Inspection Standard		Material Standard		Visual		Dimension		*4 UT Inspection		Magnetic Particle Test													
ASME B16.9-12, ASME B16.25-12 ASTM A960-16 NACE MR-0175/ISO 15156-2 Annex A-15, SS Region3 MR-0103-15		ASTM A234-17, WPB ASME SA234-17, Sec. II, Part A except nuclear usage CSA Z245.11-13, GR241 CAT. I -SS		GOOD		GOOD		W.T. INSPECTED		-													
Manufacturing No. (Heat code.)		Product Code		Material		Article & Size				Quantity		Note.											
7X1M74		FJ216090		WPB		S160 90 LONG RADIUS ELBOW 2"				75 Pcs.													
Specification		*1 Chemical Composition (%)																*2 Mechanical Test			Hardness		
		C	Si	*3 Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	Ti	B	Ca	N	Al	C.E.	Y.S.	T.S.		E	
		Min.	X100	X100	X100	X1000	X1000	X100	X100	X100	X100	X100	X100	X100	X10000	X10000	X1000	X1000	X100	MPa		%	HB
		Max.	-	10	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	240		415	30
Heat No.		30	-	135	50	58	40	40	40	15	8	2	-	-	-	-	-	50	-	-	-	197	
175308		L	17	21	69	12	6	8	4	4	5	1	1	0	4	16	8	13	31	302	451	39	128
		P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	126

$CE = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$

\*1 Equivalent for A234 WPB  
\*2 Y.S.= Yield Strength (0.2% offset), T.S. = Tensile Strength, E = Elongation (in 50mm) : Longitudinal  
\*3 As per foot note D of ASME SA234 Table 1.  
L = Ladle Analysis, P = Product Analysis  
Weld repair is not applied to our products.  
Steel Making by Vacuum degassed, fully silicon aluminium killed & fine grain.

\*4 UT = Ultrasonic thickness inspection

ELBOW / Forming temperature: 850°C - 945°C and cooled in still air

AT-24(2)27

TEE, REDUCER &amp; CAP / Normalizing (cold Forming) : 910°C (Holding Time : (Nominal Wall Thickness/1mm) x 1.5 min.)

We certify that the fitting was manufactured, sampled, tested and inspected  
in accordance with the specification and was found to meet the requirements.

Surveyor to

QA, GM, /Work Inspector S. MAEKAWA

Maekawa@awaji.co.th

[ 636175 ] [ 7X1M74 ] [ LN: 15 ] T0415291-1 FJ216090

PO# 636175

11048-300-2

H# 7X1M74

MAY 23 2018

R. LEE



**Awaji**



# INSPECTION CERTIFICATE

EN 10204 3.1 : 2004

**AWAJI MATERIA (THAILAND) CO.,LTD.**

Factory : 81 MOO 4, PRAKASA ROAD, TAMBOL BANGMUANG AMPHUR MUANG

SAMUTPRAKARN, THAILAND 10270, Tel : (662) 701-5226

Head Office : 4-2, KAMIGAMO, SUMOTO CITY, HYOGO, 656-0015, JAPAN

Tel : (81)799-22-1731 : FAX (81) 799-22-1730

ISO 9001 :2008 Manufacturing Company  
Certified by BV. Certificate No. TH008428

Material manufacturer QMS acc.  
PED 97/23/EC, Annex I, Part 4.3/AD2000W0  
Certified by Lloyd's Register  
Certificate No. 50207/1

Date : **NOVEMBER 24, 2017**

Certificate No. : **T17-Y2496/1**

Purchaser : **Industrial Piping Specialists**

Order No. HP278743/3		Job No. -		Product CARBON STEEL BUTT WELDING FITTINGS		MADE FROM SEAMLESS STEEL PIPE																	
Inspection Standard ASME B16.9-12, ASME B16.25-12 ASTM A960-16 NACE MR-0175/ISO 15156-2 Annex A-15, SS Region3 MR-0103-15		Material Standard ASTM A234-17, WPB ASME SA234-17, Sec. II Part A except nuclear usage CSA Z245.11-13, GR.241 CAT. I-SS		Visual GOOD		Dimension GOOD																	
*4 UT Inspection W.T. INSPECTED		Magnetic Particle Test -																					
Manufacturing No. (Heat code) 7Y1M39	Product Code FJ216090	Material WPB	Article & Size S160 90 LONG RADIUS ELBOW 2"				Quantity 249 Pcs.																
Note.																							
Specification		*1 Chemical Composition (%)																*2 Mechanical Test			Hardness		
Min.		C	Si	*3 Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	Ti	B	Ca	N	Al	C.E.	Y.S.	T.S.	E	HB	
Max.		X100	X100	X100	X1000	X1000	X100	X100	X100	X100	X100	X100	X1000	X10000	X10000	X1000	X1000	X100	MPa		%	HB	
Heat No.		30	-	135	50	58	40	40	40	15	8	2	-	-	-	-	-	50	240	415	30	-	
175308		L	17	21	69	12	6	8	4	4	5	1	1	0	4	16	8	13	31	302	451	39	128
		P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	131	

$C.E. = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$

\*4 UT = Ultrasonic thickness inspection

\*1 Equivalent for A234 WPB  
 \*2 Y.S.= Yield Strength (0.2% offset), T.S. = Tensile Strength, E = Elongation (in 50mm) : Longitudinal  
 \*3 As per foot note D of ASME SA234 Table 1.  
 L = Ladle Analysis, P = Product Analysis  
 Weld repair is not applied to our products.  
 Steel Making by Vacuum degassed, fully silicon aluminium killed & fine grain.

ELBOW / Forming temperature 850°C-945°C and cooled in still air

AT-24(2)27

TEE, REDUCER & CAP / Normalizing (cold Forming) : 910°C (Holding Time : (Nominal Wall Thickness/1mm) x 1.5 min.)

"We certify that the fitting was manufactured, sampled, tested and inspected in accordance with the specification and was found to meet the requirements."

Surveyor to

QA. GM. /Work Inspector **S. MAEKAWA**  
Maekawa@awaji.co.th

[ 636175 ] [ 7Y1M39 ] [ LN: 15 ] [ T0415291-1 ] [ FJ216090 ]

P0#636175

11098-300-2

H# 7Y1M39

MAY 23 2018

R. LEE

FVC  
an **AFGlobal** Company

# Material Test Report

Heat Code: CWR

Forged Vessel Connections

An AFGlobal Company

13770 Industrial Rd. Houston, TX 77015

Sales: (713) 393-4200

ISO 9001:2008 Certified

Industrial Piping	IPS0003	PO: HP270636	Sales Order: 161298	Line: 70
P. O. Box 581270		Item Code: LWN020600090A002A1	Qty Shipped: 51	
Tulsa, OK 74158		Item Desc: LWN, SA105N, 600#, 2"x9", RF		
			Mill Heat: A174521	
Spec: ASTM A105/A105M-(14)/ASME SA 105/SA 105M-(15) Section II Part A - Normalized				

Element	(%wt)	Ladle	Product	EPCRA	CAS#	Element	(%wt)	Ladle	Product	EPCRA	CAS#
C	Carbon	0.19				V	Vanadium	0.04			
Mn	Manganese	1.05		✓	7439-96-5	Cb	Columbium	0.000			
P	Phosphorous	0.008				B	Boron	0.0003			
S	Sulphur	0.004				Ti	Titanium	0.000		✓	7440-02-0
Si	Silicon	0.24				Al	Aluminum	0.028			
Cu	Copper	0.15		✓	7440-50-8	Ca	Calcium	0.0020			
Ni	Nickel	0.08		✓	7440-02-0	C.E.		0.42			
Cr	Chromium	0.15		✓	7440-47-3	CuNiCrMoV		0.447			
Mo	Molybdenum	0.03				CrMo		0.18			

Mechanical Testing		Heat Treat	
Test Lab	AFG	Norm. Temp. (F)	1675
HBW	144 - 145	Norm. (Hrs)	5:50
Elg (%)	32	Norm. Cooling Type	AIR
RA (%)	71	Norm. Location	FVC 477-17
Tensile Specimen Size (in)	.495		
Tensile (ksi)	74.6		
Yield (ksi)	45.7		
Gauge Length (in)	2		
</			

Product compliant with NACE MR0175/ISO 15156-2:2015, Annex A (A.2.1.2, A2.1.3).  
Product compliant with NACE MR0103/ISO 17945:2015, Section 13.1.1 and 13.1.3.

YIELD STRENGTH CALCULATED AT 0.2% OFFSET.

FVC STANDARD MANUFACTURING PRACTICES:

- 1) FLANGE DIMENSIONS & BOLTING COMPLY - ASME B16.5
- 2) SELF-REINFORCING NOZZLES COMPLY WITH SPECIFICATION OF SECTION VIII DIV. 1 OR DIV. 2 PER CUSTOMER DESIGN/FVC DESIGN
- 3) MATERIAL SPECIFICATION COMPLIES WITH ASME SECT. II PART A
- 4) ALL FVC MATERIAL MANUFACTURED PER FINE GRAIN PRACTICE
- 5) ALL FVC MATERIAL CERTIFIED PER EN 10204 TYPE 3.1 UNLESS OTHERWISE SPECIFIED
- 6) CERTIFICATE OF INSURANCE AVAILABLE UPON REQUEST

The recording of false, fictitious, or fraudulent statement or entries on this document may be punishable as a felony under federal statute.

EPCRA Supplier Notification: This product may contain one or more toxic chemicals subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-to-Know Act (Title III of the Superfund Amendments and Reauthorization Act of 1985) and 40 C.F.R. Part 372. Potentially reportable chemicals are indicated with a checkmark in the "EPCRA" column and a Chemical Abstract Services (CAS) registry number is provided for each such chemical in addition to the percent by weight of the chemical present in this product. It is your responsibility alone to determine whether your facility is required to submit a Toxic Release Inventory Report under EPCRA Section 313.

Certification No.: 1301889

Certification Date: 10/17/2017

Issued By: John Saucedo

This report is issued in compliance with the requirements of EN10204 3.1 / ISO 10474 3.1.

  
Rina Sane - Metallurgical Lab Manager

R. LEE

MAY 23 2018

PO# 636175

11048-300-3

HT# CWR

COFFER®  
an **AFGlobal** Company

# Material Test Report

Heat Code: DBO

ISO 9001:2008 Certified

Coffer Corp.  
An AFGlobal Company  
13770 Industrial Rd. Houston, TX 77015  
Sales: (713) 393-4200

Industrial Piping	ips0003	PO: HP284757	Sales Order: 164338	Line: 10
P. O. Box 581270		Item Code: 0601200196-0AW1F	Qty Shipped: 50	
Tulsa, OK 74158		Item Desc: FLG 02.00 0600 WN RF 160 A105/F42 NRM COFFR		
			Mill Heat: 3074670	
Spec: ASTM A105/A105N-(16) ASME SA 105/SA 105N-(15) / A694/A 694M (14), F42				

Element	(%wt)	Ladle	Product	EPCRA	CAS#	Element	(%wt)	Ladle	Product	EPCRA	CAS#
C	Carbon	0.19				Mo	Molybdenum	0.015			
Mn	Manganese	1.03		✓	7439-96-5	V	Vanadium	0.00			
P	Phosphorous	0.010				Cb	Columbium	0.002			
S	Sulphur	0.015				B	Boron	0.0000			
Si	Silicon	0.23				C.E.		0.40			
Cu	Copper	0.25		✓	7440-50-8	CuNiCrMoV		0.40			
Ni	Nickel	0.07		✓	7440-02-0	CrMo		0.08			
Cr	Chromium	0.06		✓	7440-47-3						

Mechanical Testing		Heat Treat	
Test Lab	AFG	Norm. Temp. (F)	1675
Test Bar Size	SACRIFICIAL PIECE	Norm. (Hrs)	4
HBW	156 - 156	Norm. Cooling Type	AIR
Elg (%)	26	Other	
RA (%)	46		
Tensile Specimen Size (in)	.494		
Tensile (ksi)	78.8	Country of Melt	USA
Yield (ksi)	47.6	EF	Y
Gauge Length (in)	2		

Product compliant with NACE MR0175/ISO 15156-2:2015, Annex A (A.2.1.2, A2.1.3).  
Product compliant with NACE MR0103/ ISO 17945:2015, Section 13.1.1 and 13.1.3.

- \* No Weld repair performed.
- \* Ladle Chemical Analysis results are reported from the raw material suppliers MTR.
- \* Tensile taken from a round specimen. Measurement of elongation after fracture.
- \* Yield strength was determined using the .2% offset method, unless otherwise specified.
- \* All material supplied under this order is certified to be free of mercury contamination and no mercury bearing equipment was used in manufacturing, fabrication or testing.
- \* When reported on MTR: Tensile Testing Per ASTM E8; Brinell Hardness Per ASTM E10; Charpy Testing Per ASTM E23
- \* AF Global manufactures materials according to a certified Quality Management System conforming to ISO 9001:2008 and PED 2014/68/EU, Annex 1, Section 4.3

Unless otherwise noted on PO, Dimensions of all standard pipe flanges and flange fittings (NPS 1/2 to NPS 24) per ASME B16.5-2013, large diameter steel flanges (NPS 26 to 60) per ASME B16.47-2011, Orifice flanges per ASME B16.36-2015.

The recording of false, fictitious, or fraudulent statement or entries on this document may be punishable as a felony under federal statute.

EPCRA Supplier Notification: This product may contain one or more toxic chemicals subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-to-Know Act (Title III of the Superfund Amendments and Reauthorization Act of 1986) and 40 C.F.R. Part 372. Potentially reportable chemicals are indicated with a checkmark in the "EPCRA" column and a Chemical Abstract Services (CAS) registry number is provided for each such chemical in addition to the percent by weight of the chemical present in this product. It is your responsibility alone to determine whether your facility is required to submit a Toxic Release Inventory Report under EPCRA Section 313.

Certification No.: 1314213  
Certification Date: 1/30/2018  
Issued By: John Saucedo

This report is issued in compliance with the requirements of EN10204 3.1 / ISO 10474 3.1.b

*Rina Sane*  
Rina Sane - Metallurgical Lab Manager

**R. LEE**

MAY 23 2018

PO# 636175 11048-300-4 HT# DBO

**NUCOR**  
PLATE MILL

P.O.Box 279  
Winton, NC 27986  
(252) 356-3700

# Mill Test Report

Page 1

1505 River Rd  
Cofield, NC 27922  
(252) 356-3700

**NUCOR**  
It's Our Nature.

R. LEE

JUN 05 2018

Issuing Date : 05/18/2018 B/L No. : 502373 Load No. : 512224 Our Order No. : 155360/6 Cust. Order No. : 107145  
Vehicle No: TSH 9832 Sold To: PORT CITY METALS SERVICES INC A DIVISION OF METALS USA 3101 CHARLES BLVD TULSA, OK 74127 (2) Ship To: PORT CITY METALS SERVICES INC A DIVISION OF METALS USA 3101 CHARLES BLVD TULSA, OK 74127 (2)  
Specification: 0.7500" x 120.000" x 480.000" ASTM A36-14/ASTM A709 Grade 36-17/ASME SA36 2015/2017 .05 Max SI  
Marking : 107145

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	Ceq	Pcm
8502410	0.17	0.87	0.010	0.005	0.05	0.22	0.08	0.09	0.01	0.023	0.004	0.002	0.001		0.0018	0.0001	0.009	0.36	0.24
8502411	0.16	0.83	0.009	0.007	0.01	0.24	0.09	0.07	0.02	0.029	0.004	0.001	0.001		0.0014	0.0001	0.010	0.34	0.22

Plate Serial No	Pieces	Tons	Dir.	Tensile Test			
				(psi) Yield	(psi) Tensile	Elong. % in 2"	Elong. % in 8"
8502410-04	2	12.25	T	41,100	67,200		26.3
			T	41,600	68,400		26.4
8502411-02	1	6.12	T	39,000	65,300		27.3
			T	41,000	67,300		26.0

GASTECH ENGINEERING HT# 8502410  
PO# 636200  
SO# 354444 ITM# 1, 2

HT# 8502410

11048-300-6A; 6B

PO# 636200

PO# 107145  
05-24-2018

Q.A. APPROVED  
Date 5/24/18

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification. For Mexico shipments: nhc-SalesMX@Nucor.com  
Yield by 0.5EUL method unless otherwise specified. Ceq = C+(Mn/6)+((Cr+Mo+V)/5)+((Cu+Ni)/15)  
Pcm = C+(Si/30)+(Mn/20)+(Cu/20)+(Ni/60)+(Cr/20)+(Mo/15)+(V/10)+58  
Melted and Manufactured in the USA. ISO 9001:2008 certified (#010940) by SRI Quality System Registrar (#0985-09). PED 97/23/EC 7/2 Annex 1, Para. 4.3 Compliant.  
DIN 50049 3.1.8/EN 10204 3.1B(2004), DIN EN 10204 3.1(2005) compliant. For ABS grades only, Quality Assurance certificate 14-MMPQA-723

We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

T. A. Depretis  
T. A. Depretis, Metallurgist

5/18/2018 2:32:42 PM



**NUCOR**  
PLATE MILL

P.O.Box 279  
Winton, NC 27986  
(252) 356-3700

# Mill Test Report

Page 1

1505 River Rd  
Cofield, NC 27922  
(252) 356-3700

**NUCOR**  
It's Our Nature.

Issuing Date : 04/13/2018 B/L No. : 499802 Load No. : 509835 Our Order No. : 155358/1 Cust. Order No. : 107146  
Vehicle No: ALY 91755 Sold To: PORT CITY METALS SERVICES INC A Ship To: PORT CITY METAL SERVICES, INC.  
Specification: 1.0000" x 96.000" x 480.000" DIVISION OF METALS USA JUNCTION 12  
ASTM A36-14/ASTM A709 Grade 36-17ASME SA36 2015/2017 SI .15-.25 TULSA,OK 74127 (2) HALE,OK 74127

Marking :

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	Ceq	Pcm
8502289	0.18	0.83	0.009	0.002	0.19	0.17	0.06	0.07	0.01	0.032	0.003	0.001	0.001		0.0028	0.0001	0.009	0.34	0.24

Plate Serial No	Pieces	Tons	Tensile Test				
			Dir.	(psi) Yield	(psi) Tensile	Elong. % in 2"	Elong. % in 8"
8502289-01	4	26.13	T	41,800	69,100	27.2	
			T	42,100	68,200	26.2	

GASTECH HT#8502289  
PO#636200  
SO#354444 ITEM#3 4PCS  
4 4PCS  
5 2PCS

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification. For Mexico shipments: nho-SalesMX@Nucor.com

Yield by 0.5EUL method unless otherwise specified. Ceq = C+(Mn/6)+(Cr+Mo+V)/5+((Cu+Ni)/15)

Pcm = C+(Si/30)+(Mn/20)+(Cu/20)+(Ni/60)+(Cr/20)+(Mo/15)+(V/10)+5B

Melted and Manufactured in the USA. ISO 9001:2008 certified (#010940) by SRI Quality System Registrar (#0985-09). PED 97/23/EC 7/2 Annex 1, Para. 4.3 Compliant. DIN 50049 3.1.B/EN 10204 3.1B(2004), DIN EN 10204 3.1(2005) compliant. For ABS grades only. Quality Assurance certificate 14-MMPQA-723

We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

*T. A. Depretis*  
T. A. Depretis, Metallurgist

4/13/2018 2:28:29 PM

Q.A. APPROVED

By *[Signature]* Date *4/13/2018*

R. LEE

JUN 05 2018

HT# 8502289

11048-300-7A, 7B, 16

PO# 636200

[ 636175 | 52156 | LN: 14 | T0415291-1 | FSPET1260 ]

FSPET1260


R. LEE

MAY 23 2018

HT # 52156

11048-300-10

PO# 636175

<b>Manufacturer:</b> ArcelorMittal Tubular Products Roman S.A. STEFAN CEL MARE ST, 15A/1 ROMAN, NEAMT COUNTY, ROMANIA		<b>MILL TEST CERTIFICATE</b> according to EN 10204/3.1/2004				Page 1/2 B 5774/1 31.01.2015		 <b>ArcelorMittal</b>	
<b>Buyer:</b> ARCELORMITTAL INTERNATIONAL AMERICA, LLC 1 SOUTH DEARBORN STREET, 13TH FLOOR CHICAGO, IL 60603-9888 USA		SEAMLESS STEEL PIPES				Total weight: 3.877 tons 8 547 lbs	Total Length: 35.60 meters 116.79 feet	Pieces 3	Bundles -
<b>Standard:</b> API 5L-ed.45-2012- PSL I; ASTM A106/A 106M-2014;ASTM A 53/A53M- 2012; ASME SA 106/SA 106M-2013; ASME SA 53/SA 53M-2013 NACE MR 0103-2012; NACE MR 0175/ISO 15156-1&2/2009									
<b>Buyer's reference</b> AMI ORDER: 10090082 PO NUMBER : HR058069 <b>Contract</b> 50001999		Dimensions: 323.80 x 14.27 mm 12.750 x 0.562 inch		Schedule: 60		Length: 11.00 - 12.80 m 36.09 - 41.99 feet			
Item	Item Client	Hydro Test:	Bar	PSI	MPa	Time(sec)	Steel Grade: GrB/X42/GrC		
I	-		205	2970	20.5	5			

Chemical Analysis(%)

Heat	Bulletin No.	Product Req.	Max	C	Mn	Si	S	P	Cr	Ni	Cu	Mo	V	Nb	Ti	B
			Min	0.23	1.06	-	0.030	0.030	0.40	0.40	0.40	0.15	-	-	-	0.0010
				-	0.29	0.10	-	-	-	-	-	-	-	-	-	-
52156		Heat analysis		0.19	1.03	0.25	0.003	0.007	0.06	0.06	0.13	0.03	0.011	0.001	0.001	0.0002
52156	15-153	Product analysis		0.19	1.05	0.24	0.004	0.009	0.06	0.06	0.13	0.03	0.006	0.002	0.000	0.0000
52156	15-153	Product analysis		0.19	1.05	0.23	0.004	0.008	0.06	0.06	0.13	0.03	0.007	0.002	0.000	0.0000

Chemical Analysis(%)

Heat	Bulletin No.	Product Req.	Max	Nb + V	Nb + Ti + V	Cr + Mo + Ni + Cu + V	CE IIW
			Min	0.060	0.150	1.000	0.41
				-	-	-	-
52156		Heat analysis		0.012	0.013	0.291	0.39
52156	15-153	Product analysis		0.008	0.008	0.286	0.40
52156	15-153	Product analysis		0.009	0.009	0.287	0.40

$$CE_{pcm} = C + Si/30 + Mn/20 + Cu/20 + Ni/60 + Cr/20 + Mo/15 + V/10 + 5B$$

$$CE_S = C + Mn/6$$

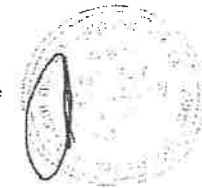
$$CE_{Iw} = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$$


Tensile Test

Heat	Orientation	Length		Width/Diameter		Thickness		Section		Mechanical test Bulletin No.	YS MPa	YS (PSI:1000)	UTS MPa	UTS (PSI:1000)	E %	YS/UTS max: -
		mm	inch	mm	inch	mm	inch	mm <sup>2</sup>	inch <sup>2</sup>							
52156	Longitudinal Flat	50.8	2	40.00	1.575	14.00	0.551	560.0	22.047	15-195	376.00	54.5	564.00	81.8	51.40	0.67

We state on our sole responsibility that the delivered products are in conformity with the order requirements.

Quality Control Representative  
Eng. Iesanu Cristian



<b>Manufacturer:</b> ArcelorMittal Tubular Products Roman S.A. STEFAN CEL MARE ST, 15A/1 ROMAN, NEAMT COUNTY, ROMANIA		<b>MILL TEST CERTIFICATE</b> according to EN 10204/3.1/2004				Page 2/2 B 5774/1 31.01.2015		 <b>ArcelorMittal</b>	
<b>Buyer:</b> ARCELORMITTAL INTERNATIONAL AMERICA, LLC 1 SOUTH DEARBORN STREET, 13TH FLOOR CHICAGO, IL 60603-9888 USA		SEAMLESS STEEL PIPES				Total weight: 3.877 tons 8 547 lbs	Total Length: 35.60 meters 116.79 feet	Pieces 3	Bundles -
<b>Buyer's reference:</b> AMI ORDER: 10090082 PO NUMBER : HR058069 <b>Contract:</b> 50001999		<b>Standard:</b> API 5L-ed.45-2012- PSL 1; ASTM A106/A 106M-2014; ASTM A 53/A53M- 2012; ASME SA 106/SA 106M-2013; ASME SA 53/SA 53M-2013 NACE MR 0103-2012; NACE MR 0175/ISO 15156-1&2/2009							
		Dimensions: 323.80 x 14.27 mm 12.750 x 0.562 inch		Schedule: 60		Length: 11.00 - 12.80 m 36.09 - 41.99 feet			
		Hydro Test:	Bar 205	PSI 2970	MPa 20.5	Time(sec) 5	Steel Grade: GrB/X42/GrC		

### Hardness Test

Heat	Hardness Test Bulletin No.	HB max.-	HV 10 max.-	HV 10 max.-					HRC max.22
				OD	Midwall	ID	End A	End B	
52156	15-213	-	-	-	-	-	-	-	<22

### Technological/Microstructure Test

Heat	Flattening Test Bulletin No.	Flattening Test
52156	15-126	OK

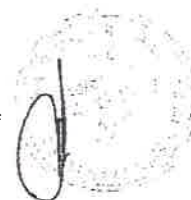
### Heat

Heat	Pieces	Length (m)	Weight (kg)
52156	3	-	-

**Remarks** Manufacturing process – hot rolling.  
 Hot finished, steel is fully killed , fine grained and produced by electric furnace , Arcelor Mittal Hunedoara S A – Piata Iancu de Hunedoara, nr.1  
 –Hunedoara .  
 Hydrostatic test hold for 5 sec. no leakage noticed.

We state on our sole responsibility that the delivered products are in conformity with the order requirements.

Quality Control Representative  
 Eng. Iesanu Cristian



**voestalpine Tubulars GmbH & Co KG**

Alpenstrasse 17  
8662 Kindberg-Aumuehl  
T. +43/060304/23-0  
F. +43/060304/63-532  
www.voestalpine.com/tubulars

Legal Structure: Limited Partnership  
Location: Kindberg/Austria  
Company Registry Number 165400k  
Commercial Court of Leoben  
DPR 0592664, VAT Nr. ATU 43630406

General Partner: voestalpine Tubulars GmbH  
Legal Structure: Limited Liability Company  
Location: Linz, Company Registry Number 108933f  
Commercial Court of Linz

*FSVAT 2160 PSL2*

**MILL TEST CERTIFICATE 3.1**

(according to EN 10204)

**ABNAHMEPRUEFZEUGNIS 3.1**

(gem. EN 10204)

**CERTIFICAT DE CONTROLE DES PRODUITS PAR L'USINE 3.1**

(selon EN 10204)

Hersteller: voestalpine Tubulars GmbH & Co KG, Austria  
Manufacturer:  
Producteur:

Besteller: VOEST-ALPINE TUBULAR CORPORATION  
Purchaser: USA-77077 HOUSTON, TEXAS  
Archeteur: INDUSTRIAL PIPING SPECIALISTS, INC.  
TULSA OK 74158-1270, US

Pruefgegenstand: Line Pipe  
Object of tests: LP-USA-02-PSL2  
Epreuve: LINEPIPE-01.0  
non upset ends (API 5 D + 5 L) - non upset  
UV coating

Werkstoff: GRADE B / GRADE BN / GRADE X42N / GRADE C  
Material:  
Matières:

Anforderungen: Grade B acc. to ASTM A 53 / A 53M-2012  
Requirements: ASME SA 53-2015  
Exigence: Grade B acc. to ASTM A 106 / A 106M-2015,  
ASME SA 106-2015  
GRADE BN/X42N acc. to API 5 L, 45.edt.-2012 (PSL2)  
NACE MR 0175 / ISO 15156-2015  
NACE MR 0103-2015  
LINEPIPE-01.0; LP-USA-02-PSL2

Ausführung: NU, PLAIN END, PE, both ends bevelled acc. to API/ASTM (30°)  
Condition:  
Cond. de livraison:

Wärmebehandlung: NORMALIZED ROLLED  
Heat treatment:  
Traitement de chaleur:

Coupl.die stamped:  
Coupl.paint stencilling:

Coupl.Colour coding: Fully painted: Bands:

Tube die stamped:  
Tube paint stencilling: va SPEC 5L-0033 "API" 07.2016 2.375" x 0.344" BN X42N PSL2 SMLS 2970 PSI Length FT Heat No. Lot No. A/SA 53  
Grade B S A/SA 106 Grade B Sched.160 PO# HR068855 MADE IN AUSTRIA

Tube Colour coding: Fully painted: Bands: purple

Label: PO No.: HR068855, DAT Port of Houston TX

Remarks: \*) Grade C without marking on tubes  
\*) SI units have been converted to US customary units  
\*) (Nb+V) <= 0,06%

Kindberg, 12.08.2016

Page 1 of 8

No. 122471

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No. 122471 Rev.: 0

Auftrags-Nr.: 21600 / 4  
Our works order No.:  
No usine:

Bestellnr.: HR068855/VATC PO#  
Your order No.: 605620

No de la commande:

Zeichen des Lieferwerks: va

Marking of producer:

Marque du fabricant:

Erschmelzungsart: BOF

Melting process: fully killed, produced to  
Procédé d'élaboration: fine grain practice

voestalpine Tubulars GmbH & Co KG  
Qualitätsstelle / Quality Department

WEITZER

Abnahmebeauftragter  
authorized inspection representative  
représentant autorisé du controle

**voestalpine**

ONE STEP AHEAD

*R. LEE*

1016383873

MAY 23 2018

11048-300-11,12,13,14

PO#636175



**voestalpine Tubulars GmbH & Co KG**

**Umfang der Lieferung / Volume of delivery / Contenu de la livraison:**

Versandanzeige: Dispatch advice No. Avis d'expédition:	Pos.: Pos.:	Abmessung: Dimension: Dimension:	Bundnr.: Bundle No.: Nombre Fret:	Stückzahl: Number Of: Pièces:	Länge: Length: Longueur:	Gewicht: Weight: Poids:	Los: Lot: Lot:
LS-075772	4	2.375 in x 0.344 in; 7.48 lbs/ft SCHED.160	1-11	271	10833,782 ft	36842,50 kg	

**Volume of delivery**

Heat	Lot	Remark
1016383873	208016 -- 01	
1016488178	208015 -- 01	

Kindberg, 12.08.2016

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No. 122471

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authorized inspection representative  
représentant autorisé du contrôle

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**R. LEE**

PO#636175

11048-300-11,12,13,14

1016383873

MAY 23 2018

**voestalpine Tubulars GmbH & Co KG**

**Additional tests and inspections performed on pipe**

- 1 Begeversuch/Bend test: bestanden/passed
- 2 Dimensionskontrolle/ Dimensional inspection: bestanden/passed
- 3 Streuflussprüfung gem. ASTM E 570 / Flux Leakage testing acc. ASTM E 570: bestanden/passed
- 4 Ultraschallprüfung gem. Norm (Wanddicke - 100 % Umfang)/Ultrasonic inspection acc. to standard (wallthickness - 100 % circumference): bestanden/passed
- 5 Visuelle Inspektion/ Visual inspection: bestanden/passed
- 6 Wasserinnendruckversuch/Hydrostatic test: bestanden/passed, Mindestprüfdruck/min test pressure: 2970 PSI, min. Haltezeit/min duration: 5 sec
- 7 Streuflussprüfung/Diluted flux acc. API 5 L (old version - SR 4) OD + ID, longitudinal 12.5 %: bestanden/passed

**Test remarks**

Wir bestätigen, dass die gelieferten Erzeugnisse den Anforderungen der Bestellung entsprechen.  
We hereby certify that the goods delivered are in compliance with the requirements of the order.

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**R. LEE**

1016383873 - - MAY 23 2018

PO#636175 11048-300-11, 12, 13, 14

[ | 636175 | | | 1016383873 ] | [ LN: 8 ] | T0415291-1 | FSVAT2160PSL2 |

# voestalpine Tubulars GmbH & Co KG

## Tensile testing

Lot No	Test Type	Heat treatment	Loc. Temp	Specimen	Yield Strength	Tensile Strength	Elong. gage length	Reduct. R <sub>t</sub> /R <sub>m</sub> in area
[°F] No. Type Dimension [Inch]					[ PSI ]	[ PSI ]	[ % ]	[ Inch ]
					Requ. from	42061	60190	24.00
					Requ. to	71793	94999	0.93
208015	-- 01	Standard	normalized rolled	Rear 68 1 Strip-long 0.75 x 0.36	Rt0.50	58450	77450	35.00 2
208016	- 01	Standard	normalized rolled	Rear 68 1 Strip-long 0.76 x 0.34	Rt0.50	59755	80060	33.30 2
					yield strength:	Requ. from - to		
					GR B/ BN / X42N:	42100 PSI - 71800 PSI		
					Gr C:	40000 PSI		
					tensile strength:	Requ. from - to		
					GR B/ BN / X42N:	60200 PSI - 95000 PSI		
					Gr C:	70000 PSI		

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1016393873 - MAY 23 2018

PO#636175 11048-300-11,12,13,14

**voestalpine Tubulars GmbH & Co KG**

**Hardness testing**

Lot No	Test Type	Heat treatment	Specimen Test				Hardness from	Number to	Mean Hardness Number		Variation	
			Loc.	No.	Location	Method			from	to		
Requ.:										99.50		
208015	-- 01	Standard	normalized rolled	Rear	1	Body	HRB	84.60	85.90	84.87	85.23	0.37
208016	-- 01	Standard	normalized rolled	Rear	1	Body	HRB	85.00	86.30	85.43	85.63	0.20

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11048-300-11,12,13,14

1016383873 - - MAY 23 2018

PO#636175

**voestalpine Tubulars GmbH & Co KG**

**Impact testing**

Requirement:	Length [Inch]	Width [Inch]	Height [Inch]	Specimen Orientation	Type	Temp. [°F]	Single [ft-lbs]	Average [ft-lbs]	Factor
	2.165	.394	.295	long.	CH-V	- 20		-1	
Lot No	Test Type	Heat Treatment	Loc. No.	No. long.	Imp. Values:	Single1	Single2	Single3	Average Unit
208015 - 01	Standard	normalized rolled	Rear 1			107	103	104	105 ft-lbs
Werte Informativ					Including Factor:				
					Shear-Area [%]:				
					Lateral Expansion (un-/broken):				
					Lateral Expansion: [Inch]				H: .295 [Inch]
Lot No	Test Type	Heat Treatment	Loc. No.	No. long.	Imp. Values:	Single1	Single2	Single3	Average Unit
208016 - 01	Standard	normalized rolled	Rear 1			109	107	111	109 ft-lbs
Kerbschlagwerte Informativ					Including Factor:				
					Shear-Area [%]:				
					Lateral Expansion (un-/broken):				
					Lateral Expansion: [Inch]				H: .295 [Inch]

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PO# 636175 11048-300-11, 12, 13, 14

1016383873 - MAT 2 3 2016

# voestalpine Tubulars GmbH & Co KG

## Chemical testing

### Heat analysis

C	Si	Mn	P	S	Cr	Ni	Cu	Al	Ti	Mo	V	Sh	B	N2	Nb	Ca	CEQ
---	----	----	---	---	----	----	----	----	----	----	---	----	---	----	----	----	-----

min. Requ.

0.0000	0.1000	0.2900															
--------	--------	--------	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

max. Requ.

0.2300	0.4000	1.0800	0.0260	0.0150	0.3000	0.3000	0.4000		0.0400	0.1500	0.0800		0.0010		0.0500		0.4000
--------	--------	--------	--------	--------	--------	--------	--------	--	--------	--------	--------	--	--------	--	--------	--	--------

1016383873

0.1762	0.2452	0.9639	0.0107	0.0042	0.0598	0.0143	0.0205	0.0312	0.0017	0.0028	0.0012	0.0008	0.0003	0.0047	0.0400	0.0018	0.3519
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

1016486178

0.1795	0.2570	0.9624	0.0144	0.0050	0.0325	0.0144	0.0155	0.0280	0.0023	0.0031	0.0018	0.0004	0.0004	0.0059	0.0395	0.0011	0.3493
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

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No. 122471

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1016383873 - MAY 23 2018

PO# 636175  
11048-300-11, 12, 13, 14

# voestalpine Tubulars GmbH & Co KG

## Chemical testing

### Product analysis

C	Si	Mn	P	S	Cr	Ni	Cu	Al	Ti	Mo	V	Sn	B	N2	Nb	Ca	CEQ
Lot No. 208015 -- 01		1	Standard		Heat No. 1016486178												
0.1704	0.2348	0.9301	0.0130	0.0071	0.0329	0.0186	0.0167	0.0240	0.0023	0.0027	0.0029	0.0012	0.0005	0.0033	0.0330	0.0000	0.3353
Lot No. 208015 -- 01		2	Standard		Heat No. 1016486178												
0.1632	0.2279	0.8632	0.0125	0.0055	0.0325	0.0163	0.0150	0.0241	0.0022	0.0024	0.0027	0.0015	0.0005	0.0031	0.0341	0.0000	0.3333
Lot No. 208016 -- 01		1	Standard		Heat No. 1016383873												
0.1768	0.2294	0.8315	0.0098	0.0046	0.0370	0.0164	0.0204	0.0284	0.0019	0.0032	0.0030	0.0019	0.0004	0.0024	0.0358	0.0000	0.3431
Lot No. 208016 -- 01		2	Standard		Heat No. 1016383873												
0.1696	0.2227	0.8412	0.0092	0.0042	0.0365	0.0163	0.0199	0.0283	0.0017	0.0029	0.0027	0.0017	0.0004	0.0004	0.0343	0.0000	0.3373

Kindberg, 12.08.2016

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No. 122471

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voestalpine

R. LEE

ONE STEP AHEAD.

MAY 23 2016

11048-300-11,12,13,14

1016383873

PO#636175





**Tenaris**

## INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1: 2013)

Number / Número:

**757557**

Page / Página:

**1 / 6**

Date / Día: **January 20, 2014**

Edición 1.0  
Origen: A. 1010 01/06  
18/06/04 (A. 1010) 01/06  
Edición: A. 1010 01/06  
18/06/04 (A. 1010) 01/06  
18/06/04 (A. 1010) 01/06

Customer / Cliente: <b>INDUSTRIAL PIPING SPECIALISTS</b>		Customer's Order Item / Orden Cliente - Item: <b>HR049129-00003</b>		Customer's Reference / Ref. del Cliente: <b>N/A</b>		Manufacturer's Works Order N° / Confirmación de Venta: <b>51086/03</b>	
Manufacturing Process / Proceso de Manufactura: <b>SEAMLESS HOT ROLLED</b>		Product Type / Tipo de Producto: <b>SMLS LINE PIPE</b>				Surface / Superficie: <b>INT BARE /EXT VARNISHED</b>	
Standard or Specification / Normas o Especificaciones: <b>SPEC.5L ED.45+A/SA 53/106 +NACE MR0175/ISO15156+NACE MR0103</b>				Steel Grade / Grado de acero: <b>B/L245 X42/L.290/B/C</b>		Ends / Extremos: <b>BEVEL AT 30 DEG.API5L/ISO</b>	
Dimensions / Dimensiones: <b>6,625 X 0.864 INCH 168.30 X 21.95 MM</b>		Schedule / Cédula: <b>N/A</b>		Length / Longitud: <b>11.6/12.8 m</b>		Quantity / Cantidad: <b>52 Pcs/pz</b> <b>2176.05 FT 114164 LB 663.26 MTS 51784 KG</b>	
						Nominal Weight / Peso Nominal: <b>53.21 LB/FT 79.22 KG/M</b>	

## TENSILE TEST / ENSAYO DE TENSION

Heat N° Colada N°	Sample N° Muestra N°	Zone Zona	Pipe N° Tubo N°	Specimen condition Condición de la probeta				Specimen dimensions Dimensiones de la probeta		Test temp Temp. ensayo	Y.S. Eul 0.50 %		U.T.S. Req.		Elongation / Alargamiento		
				LS	Sc	Type Tipo	On	Size Tamaño	Area Sección		Min: 42 Max: —	Min: 70 Max: —	Lo 2"	Min.	Obl.		
in	in <sup>2</sup>	°C	ksi	ksi	mm	%	%										
32982	2254871	M	1	B	AM	Ss	L	0.975 x 0.837	0.821	RT	51.1	74.1	50.8	29.5	37.8		
61617	2254869	M	1	B	AM	Ss	L	0.97 x 0.861	0.839	RT	49.1	73.8	50.8	29.5	36.3		

AM: As manufactured / Según proceso de fabricación

B: Body / Cuerpo

L: Longitudinal / Longitudinal

Lo: Initial length / Longitud inicial

L: Location of sample / Ubicación de la muestra

M: Middle / Medio

Max: Maximum / Máximo

Min: Minimum / Mínimo

Obl: Obtained / Obtenido

Ori: Orientation / Orientación

Req: Required / Requerido

RT: Room temperature / Temperatura ambiente

Sc: Specimen condition / Condición de la probeta

Ss: Strip specimen / Muestra rectangular

U.T.S: Ultimate tensile strength / Resistencia

Y.S: Yield strength / Fluencia

## CHEMICAL COMPOSITION / COMPOSICION QUIMICA

Heat N° Colada N°					Sample N° Muestra N°					Lot N° Lote N°					Pipe N° Tubo N°					Composición % / Composición %																																							
																				X 100										X 1000										X 10000										X 10000									
																				C	Mn	Si	Cr	Mo	Al sol	Cu	P	Ni	V	Al	Sn	As	Nb	Bi	Pb	Sb	Co	S	Zr	Bi	Ca	B	Ni	Mg	W	F-1	F-2	F-3											
																				H	Max	Min	H	Max	Min	H	Max	Min	H	Max	Min	H	Max	Min	H	Max	Min	H	Max	Min	H	Max	Min	H	Max	Min	H	Max	Min	H	Max	Min							
32982					2254871					1					H					16	109	25	5	3	3	9	12	45	29	27	8	3	1	2	1	1	7	11	20	22	13	2	75	3	20	25.4	5												

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FOR03171

R. LEE

MAY 23 2018

HT# 61617

11048-300-15

DO#636175

[ 636175 | 61617 | [ LN: 13 ] | T0415291-1 | FSSID6XXH ]





# INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1: 2013)

Number / Número:

757557

Page / Página:

2 / 6

Date / Dia: January 20, 2014

Dirección: S.A. 10  
 De: Jorge A. Díaz 1050  
 Teléfono: 454-1050  
 Buenos Aires, Argentina  
 Fax: 454-1050  
 E-mail: jorge.diaz@comcast.com

Customer / Cliente: <b>INDUSTRIAL PIPING SPECIALISTS</b>		Customer's Order Item / Orden Cliente - Item: <b>HR049129-00003</b>		Customer's Reference / Ref. del Cliente: <b>N/A</b>		Manufacturer's Works Order N° / Confirmación de Venta: <b>51085/03</b>	
Manufacturing Process / Proceso de Manufactura: <b>SEAMLESS HOT ROLLED</b>		Product Type / Tipo de Producto: <b>SMLS LINE PIPE</b>				Surface / Superficie: <b>INT BARE /EXT VARNISHED</b>	
Standard or Specification / Normas o Especificaciones: <b>SPEC.SL ED.45+A/SA 53/106 +NACE MR0175/ISO15156+NACE MR0103</b>				Steel Grade / Grado de acero: <b>B/L245 X42/L 290/B/C</b>		Ends / Extremos: <b>BEVEL AT 30 DEG.API5L/ISO</b>	
Dimensions / Dimensiones: <b>6.625 X 0.864 INCH 168.30 X 21.95 MM</b>		Schedule / Cédula: <b>N/A</b>		Length / Longitud: <b>11.6/12.8 m</b>		Quantity / Cantidad: <b>52 Pcs/pz</b> <b>2176.05 FT 114164 LB 663.26 MTS 51784 KG</b>	
						Nominal Weight / Peso Nominal: <b>53.21 LB/FT 79.22 KG/M</b>	

## CHEMICAL COMPOSITION / COMPOSICIÓN QUÍMICA

				H		Composition % / Composición %																											
						x 100								x 1000								x 10000								x 10000			
						C	Mn	Si	Cr	Mo	Al sol	Cu	P	Ni	V	Al	Sn	As	Nb	Ti	Pb	Sb	Co	S	Zr	Bi	Ca	B	N	Mg	W	F.1	F.2
Heat N° Colada N°	Sample N° Muestra N°	Lot N° Lote N°	Pipe N° Tubo N°	Max	25	120	—	40	15	—	40	30	400	80	—	—	—	—	—	—	—	—	300	—	—	—	10	—	—	—	100	6	15
				Min	29	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
32982	2254871	0	1	P	17	110	28	7	3	—	9	13	48	28	28	8	3	1	3	2	2	7	18	20	22	12	2	76	2	20	26.6	2.9	3.2
				P	17	109	25	7	3	—	9	12	45	27	26	8	3	1	3	2	2	7	19	20	22	12	2	76	2	20	26.2	2.8	3.1
61617	2254872	0	1	H	18	110	24	9	3	2	6	14	27	29	24	7	2	1	2	1	1	7	27	20	22	18	2	92	3	20	23.6	3	3.2
				P	18	111	24	9	3	—	6	14	26	27	22	7	3	1	3	2	2	7	29	20	22	18	2	95	2	20	23.5	2.8	3.1
61617	2254869	0	1	P	17	110	24	9	3	—	6	14	26	27	22	7	3	1	3	2	2	7	29	20	22	18	2	92	2	20	23.5	2.8	3.1
				P	17	110	24	9	3	—	6	15	28	26	22	7	3	1	3	2	2	7	30	20	22	16	2	91	2	20	23.4	2.7	3
61617	2254870	0	1	P	17	110	24	9	3	—	6	15	28	26	22	7	3	1	3	2	2	7	30	20	22	16	2	91	2	20	23.4	2.7	3
				P	17	110	24	9	3	—	6	15	28	26	22	7	3	1	3	2	2	7	30	20	22	16	2	91	2	20	23.4	2.7	3

F1: CR+Cu+MO+HNY	F3: NB+Y+T	Max. Maximum / Máximo	P: Product / Producto
F2: NB+Y	H: Heat / Calada	Min. Minimum / Mínimo	

SUPERFICIAL HARDNESS / DUREZA SUPERFICIAL

Heat N° Colada N°	Sample N° Muestra N°	Zone Zona	Lot N° Lote N°	Pipe N° Tubo N°	Ls	External / Externa	
						Scale / Escala: HBW/10/3000 Req. Min. = Req. Max. 237	
32982	2254871	M	0	1	B	156	

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FOR03171

11

MAY 23 2018

44-#61617

11048-300-15

EO#636175





## INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1: 2013)

Number / Número:

757557

Page / Página:

3 / 6

Date / Día: January 20, 2014

By: [Signature]  
Orlando A. Silva  
[Signature]  
Buenos Aires, Argentina  
(54) 911 475 1100  
[Signature]

Customer / Cliente: INDUSTRIAL PIPING SPECIALISTS		Customer's Order Item / Orden Cliente - Item: HR049129-00003		Customer's Reference / Ref. del Cliente: N/A		Manufacturer's Works Order N° / Confirmación de Venta: 51086/03	
Manufacturing Process / Proceso de Manufactura: SEAMLESS HOT ROLLED		Product Type / Tipo de Producto: SMLS LINE PIPE		Surface / Superficie: INT BARE / EXT VARNISHED			
Standard or Specification / Normas o Especificaciones: SPEC.SL ED.45+A/SA 53/106 +NACE MR0175/ISO15156+NACE MR0103				Steel Grade / Grado de acero: B/L245 X42/L290/B/C		Ends / Extremos: BEVEL AT 30 DEG.API5L/ISO	
Dimensions / Dimensiones: 6,625 X 0.864 INCH 168.30 X 21.95 MM		Schedule / Cédula: N/A		Length / Longitud: 11.6/12.8 m		Quantity / Cantidad: 52 Pcs/pz 2176.05 FT 114164 LB 663.26 MTS 51784 KG	
						Nominal Weight / Peso Nominal: 53.21 LB/FT 79.22 KG/M	

### SUPERFICIAL HARDNESS / DUREZA SUPERFICIAL

B: Body / Cuerpo	LS: Location of sample / Ubicación de la muestra	M: Middle / Medio
------------------	--	-------------------

### FLATTENING TEST / ENSAYO DE APLASTAMIENTO

Standard / Norma:				Standard / Norma:			
Heat N° Colada N°	Sample N° Muestra N°	LS	Result Resultado	Heat N° Colada N°	Sample N° Muestra N°	LS	Result Resultado
32982	2254871	B	Good / Bueno	61617	2254869	B	Good / Bueno

B: Body / Cuerpo	LS: Location of sample / Ubicación de la muestra
------------------	--

### HYDROSTATIC TEST / PRUEBA HIDRÁULICA

Pressure / Presión		Time / Tiempo		Results / Resultado
Unit / Unidad	Value / Valor	Seconds / Segundos		
psi	2.800	5		Satisfactory / Satisfactorio

### SPECIAL REQUIREMENTS / REQUERIMIENTOS ESPECIALES

Condition / Condición	Description / Descripción
Pipe residual magnetism / Magnetismo remanente de tubo	30 GAUSS

This certificate is issued by a computerized system and it is valid with electronic signature. On the original certificate the track 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 into account the responsibility for any alteration or modification. Any alteration or modification will cause the certificate to be void.

Este certificado se emite mediante sistema computarizado y es válido con firma electrónica. El certificado original posee impreso el logo "Tenaris" color verde. En caso de que el poseedor del certificado entregue una copia, deberá garantizar la conformidad con el original haciéndose responsable por cualquier uso irregular o modificación. Cualquier alteración o modificación hará que el certificado no sea válido.

FOR03171

Y. LEE

MAY 23 2018

HT #61617

11048-300-15

P0#636175

[ 636175 | 61617 | [ LN: 13 ] | T0415291-1 | FSSID6XXH ]





**Tenaris**

## INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1: 2013)

Number / Número:

**757557**

Page / Página:

**4 / 6**

Date / Día: **January 20, 2014**

Sección S.A.C.  
Or. Jorge A. Bernal 250  
+519804241401 Comodoro  
Barranca, Piura, Perú  
(P.A. 91899 4703140100)  
P.A. 91899 4703140100

Customer / Cliente: <b>INDUSTRIAL PIPING SPECIALISTS</b>		Customer's Order Item / Orden Cliente - Item:	Customer's Reference / Ref. del Cliente:	Manufacturer's Works Order N° / Confirmación de Venta:
		<b>HR049129-00003</b>	<b>N/A</b>	<b>51086/03</b>
Manufacturing Process / Proceso de Manufactura:		Product Type / Tipo de Producto:		Surface / Superficie:
<b>SEAMLESS HOT ROLLED</b>		<b>SMLS LINE PIPE</b>		<b>INT BARE /EXT VARNISHED</b>
Standard or Specification / Normas o Especificaciones:			Steel Grade / Grado de acero:	Ends / Extremos:
<b>SPEC.5L ED.45+A/SA 53/106 +NACE MR0175/ISO15156+NACE MR0103</b>			<b>B/L245 X42/L290/B/C</b>	<b>BEVEL AT 30 DEG.API5L/ISO</b>
Dimensions / Dimensiones:	Schedule / Cédula:	Length / Longitud:	Quantity / Cantidad: <b>52 Pcs/pz</b>	Nominal Weight / Peso Nominal:
<b>6,625 X 0.864 INCH</b>	<b>N/A</b>	<b>11.6/12.8 m</b>	<b>2176.05 FT</b>	<b>53.21 LB/FT</b>
<b>168.30 X 21.95 MM</b>			<b>663.26 MTS</b>	<b>79.22 KG/M</b>

### SPECIAL REQUIREMENTS / REQUERIMIENTOS ESPECIALES

Condition / Condición	Description / Descripción
End protectors / Protector de extremo	CLOSED LIFTABLE PLASTIC PROTECTOR FOR FLAT / BEVELED PIPES DIAMETER >= 139.7 MM. SUPPLI

### SUPPLEMENTARY INFORMATION / INFORMACION SUPLEMENTARIA

Supplementary Information Información Suplementaria	
<p>"MELTED AND MANUFACTURED BY TENARIS SIDERCA - ARGENTINA"</p> <p>"ACIERAGE PROCESS"</p> <p>STEEL MAKING PROCESS: E.A.F./L.F. AND CONTINUOUS CASTING - FULL ALUMINIUM KILLED AND FINE GRAIN PRACTICE.</p> <p>THE L.F. PRACTICE INCLUDES ARGON RINSE AND A FINAL INJECTION OF CALCIUM SILICIDE WIRE FOR MICROINCLUSION SHAPE CONTROL.</p> <p>MATERIAL FREE FROM MERCURY CONTAMINATION.</p> <p>"ROLLING PROCESS"</p> <p>MANUFACTURING PROCESS : SEAMLESS HOT ROLLED.</p> <p>"CONTROLES"</p> <p>VISUAL AND DIMENSIONAL INSPECTION : SATISFACTORY.</p> <p>"MATERIAL CONDITIONS"</p> <p>NOT REPAIRED BY WELDING.</p> <p>"STANDARDS"</p> <p>EDITION OF REGULATION: API 5L, 45" Edition December 2012</p> <p>EDITION OF REGULATION: ASTM A53/A 53M 2012</p> <p>EDITION OF REGULATION: ASTM A 108/A 108M-2011</p>	<p>"FUNDIDO Y FABRICADO POR TENARIS SIDERCA - ARGENTINA"</p> <p>"PROCESO DE ACERACIÓN"</p> <p>FABRICACIÓN DE ACERO: FUNDICIÓN POR ARCO ELECTRICO Y COLADO CONTINUO - ACERO CALMADO AL ALUMINIO Y PRACTICA DE GRANO FINO</p> <p>LA PRACTICA DE AFINO EN EL HORNO - CUCHARA INCLUYE AGITACION POR ARGON Y UNA INYECCION FINAL DE UNA VARILLA DE SILICIO DE CALCIO PARA OBTENER UNA FORMA GLOBULAR DE EVENTUALES MICROINCLUSIONES.</p> <p>MATERIAL LIBRE DE CONTAMINACION DE MERCURIO.</p> <p>"PROCESO DE LAMINACIÓN"</p> <p>FABRICACIÓN DE TUBO: LAMINADO EN CALIENTE Y SIN COSTURA.</p> <p>"CONTROLES"</p> <p>CONTROL VISUAL Y DIMENSIONAL: SATISFACTORY.</p> <p>"CONDICIONES DEL MATERIAL"</p> <p>NO REPARADO POR SOLDADURA.</p> <p>"NORMAS"</p> <p>EDICION DE LA NORMA: API 5L45" Edition Diciembre 2012</p> <p>EDICION DE LA NORMA: ASTM A53/A 53M - 2012</p> <p>EDICION DE LA NORMA: ASTM A 108/A 108M-2011</p>

This certificate is issued by a computerized system and it is valid with electronic signature. On the original certificate the face mark green color "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 unlawful or not allowed use. Any alteration and/or falsification will be subjected to the law.

Este certificado se emite mediante sistema computarizado y es válido con firma electrónica. El certificado original posee impreso al logo "Tenaris" color verde. En caso de que el poseedor del certificado entregara una copia, deberá garantizar la conformidad con el original haciendo responsable por cualquier uso ilegal o indebido. Cualquier alteración o falsificación estará sujeta a la ley.

FOR03171

R. LEE

MAY 23 2018

H7 #6/6/17

11048-300-15

PO#636175

[ 636175 | 61617 | LN: 13 | T0415291-1 | FSSID6XXH ]





# Tenaris

## INSPECTION CERTIFICATE

(BS EN 10204 3.1: 2004 - ISO 10474 3.1: 2013)

Number / Número:

757557

Page / Página:

5 / 6

Date / Día: January 20, 2014

Boston, MA 02110  
 College Avenue  
 617-552-1234  
 617-552-1234  
 617-552-1234

Customer / Cliente: <b>INDUSTRIAL PIPING SPECIALISTS</b>		Customer's Order Item / Orden Cliente - Item: <b>HR049129-00003</b>		Customer's Reference / Ref. del Cliente: <b>N/A</b>		Manufacturer's Works Order N° / Confirmación de Venta: <b>51088/03</b>	
Manufacturing Process / Proceso de Manufactura: <b>SEAMLESS HOT ROLLED</b>		Product Type / Tipo de Producto: <b>SMLS LINE PIPE</b>				Surface / Superficie: <b>INT BARE /EXT VARNISHED</b>	
Standard or Specification / Normas o Especificaciones: <b>SPEC.SL ED.45+A/SA 53/106 +NACE MR0175/ISO15156+NACE MR0103</b>				Steel Grade / Grado de acero: <b>B/L245 X42/L290/B/C</b>		Ends / Extremos: <b>BEVEL AT 30 DEG.API5L/ISO</b>	
Dimensions / Dimensiones: <b>6,625 X 0.864 INCH 168.30 X 21.95 MM</b>		Schedule / Cédula: <b>N/A</b>		Length / Longitud: <b>11.6/12.8 m</b>		Quantity / Cantidad: <b>52 Pcs/pz</b> <b>2176.05 FT 114164 LB 663.26 MTS 51784 KG</b>	
						Nominal Weight / Peso Nominal: <b>53.21 LB/FT 79.22 KG/M</b>	

## SUPPLEMENTARY INFORMATION / INFORMACIÓN SUPLEMENTARIA

Supplementary Information Información Suplementaria	
-EDITION REGULATION: ASME SA 53/ 2010 -EDITION REGULATION: ASME SA 106/ 2010 -EDITION OF REGULATION: NACE MR-01-03 EDITION 2012. -EDITION OF REGULATION: NACE MR 01-75 - ISO 15158-2 : 2009	-EDICIÓN DE LA NORMA: ASME SA 53/2010 -EDICIÓN DE LA NORMA: ASME SA 106/ 2010 - EDICIÓN DE LA NORMA: NACE MR-01-03 EDITION 2012 -EDICIÓN DE LA NORMA: NACE MR 01-75 - ISO 15158-2 : 2009
Additional Information Información Adicional	Additional Information Información Adicional
HEAT TREATMENT: AS ROLLED. NON DESTRUCTIVE TEST: SATISFACTORY.	INSPECTION METHODS: E.M.I. LONG. (EXT.) NOTCH 5% + M.P.I LONG. (EXT./INT.); ENDS. PURPLE RINGS ON BOTH ENDS.

**MARKING / MARCACION**

<p>Marking Marcación</p> <p>- &amp; = Monogramas / Monogram SIDERCA          - NNNNN = Número de tubo / Nbr of pipe          - LLL = Longitud / Length          - PPP = Peso / Weight</p>	<p>Marking Marcación</p> <p>- &amp; = Monogramas / Monogram API          - MM.YY = Mes / Año / Month / Year          - Y/T = Año / Trimestre / Year / Quarter          - HXXXXX = Colada / Heat</p>
<p>Stencilling (Pipe) Estacado (Tubo)</p> <p>TENARIS SD API SPEC 5L D098 @ MM.YY ASTM/ASME A/SA 53/106 B,025 0.864 B-245/042-L290/B/C PSL1</p>	<p>Stencilling (Pipe) Estacado (Tubo)</p> <p>SMLS 2800PSI NDE 6 X53.21 IPS PO HR049129 MADE IN ARGENTINA HNDXXXX NNNNN LLL PPPPP</p>

This certificate is issued by a computerized system and is valid with an electronic signature. On the original certificate the trademark green colored "Eurasia" is stamped. If and the owner of the original certificate would reuse a copy of it, he must attach its (or family 30 0) original one taking upon himself the responsibility for any unlawful or not allowed use. Any alteration and/or falsification will be subjected to the law.

Este certificado se emite mediante sistema computarizado y es validado con firma y electrónica. El certificado original posee impreso el logo de la Universidad de la Amazonia. En caso de que el poseedor del certificado entregue una copia, deberá garantizar la conformidad con el original habiéndose responsable por cualquier uso ilegal e indebido. Cualquier alteración o falsificación estará sujeta a la ley.

FOR03171

MAY 23 2018

44#61617

11048-300-15

PO #636175







P.O.Box 279  
Winton, NC 27986  
(252) 356-3700

# Mill Test Report

Page 1

1505 River Rd  
Cofield, NC 27922  
(252) 356-3700



Issuing Date : 04/13/2018 B/L No. : 499802 Load No. : 509835 Our Order No. : 155358/1 Cust. Order No. : 107146  
Vehicle No: ALY 91755 Sold To: PORT CITY METALS SERVICES INC A Shp To: PORT CITY METAL SERVICES, INC.  
Specification: 1.0000" x 96.000" x 480.000" DIVISION OF METALS USA JUNCTION 12  
ASTM A36-14/ASTM A709 Grade 36-17ASME SA36 2015/2017 SI .15-.25 3101 CHARLES BLVD HALE,OK 74127  
TULSA,OK 74127 (2)

Marking :

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	Ceq	Pcm
8502289	0.18	0.83	0.009	0.002	0.19	0.17	0.06	0.07	0.01	0.032	0.003	0.001	0.001		0.0028	0.0001	0.009	0.34	0.24

Plate Serial No	Pieces	Tons	Tensile Test			
			Dir.	(psi) Yield	(psi) Tensile	Elong. % in 2" Elong. % in 8"
8502289-01	4	26.13	T	41,800	69,100	27.2
			T	42,100	68,200	26.2

GASTECH HT#8502289  
PO#636200  
SO#354444 ITEM#3 4PCS  
4 4PCS  
5 2PCS

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification. For Mexico shipments: nco-SalesMX@Nucor.com  
Yield by 0.5EUL method unless otherwise specified. Ceq = C+(Mn/5)+((Cr+Mo+V)/5)+((Cu+Ni)/15)  
Pcm = C+(Si/30)+(Mn/20)+(Cu/20)+(Ni/60)+(Cr/20)+(Mo/15)+(V/10)+5B  
Melted and Manufactured in the USA. ISO 9001:2008 certified (#010940) by SRI Quality System Registrar (#0985-09). PED 97/23/EC 7/2 Annex 1, Para. 4.3 Compliant.  
DIN 50049 3.1 B/EN 10204 3.1B(2004), DIN EN 10204 3.1(2005) compliant. For ABS grades only. Quality Assurance certificate 14-MMPQA-723

We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

*T. A. Depretis*  
T. A. Depretis, Metallurgist

4/13/2018 2:28:29 PM

Q.A. APPROVED  
By *[Signature]* Date *4/13/2018*

CD  
9-11-18  
HT# 8502289  
11048 300-16  
PO# 636200



PO#636200



"Nondestructive Testing Specialist"



Cert #L16-380

**Friedman Industries**

P.O. Box 214

Armored, AR 72310

**March 26, 2018**

Lab No: L7830

**Attention:** Mr. Terry Eveland

241x72

**Subject:** Tensile, Yield and Elongation Test Results

**REPORT OF TEST**

<u>Sample #</u>	<u>Heat Number</u>	<u>Yield</u>	<u>Tensile</u>	<u>Elongation %</u>
1294406-F	1177159	46,294	69,704	25
1294406-M	1177159	45,821	69,682	26
17111041-03-F	N/A	51,216	71,387	26
17111041-03-M	N/A	53,112	72,224	25
18009301-05-F	N/A	53,982	74,622	27
18009301-05-M	N/A	53,846	74,943	26

The above samples do meet the physical requirements A36.

(Tested in accordance with ASTM A370-12)

Respectfully Submitted

AIT, LLC 127

*William E. Jackson*  
William E. Jackson

Q.A. APPROVED

By                      Date 4/2/18

5101 Wilfong Road \* Memphis, TN 38134 \* Phone: 901-373-6992 \* Fax: 901-373-5825

**R. LEE**

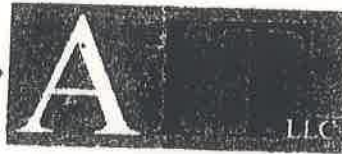
PO#636200

11048-300-17.18

HT#18009301

JUN 05 2018





"Nondestructive Testing Specialist"



PJLA  
Cert #L16-380

Friedman Industries  
P.O. Box 214  
Armored, AR 72310

March 15, 2018  
Lab No: L7803

241x72

Attention: Mr. Terry Eveland

Subject: Tensile, Yield and Elongation Test Results

**REPORT OF TEST**

<u>Sample #</u>	<u>Heat Number</u>	<u>Yield</u>	<u>Tensile</u>	<u>Elongation %</u>
18009301-01-F	N/A	52,523	72,322	30
18009301-01-M	N/A	52,989	72,710	30
18017501-03-F	N/A	53,326	73,142	29
18017501-03-M	N/A	53,151	72,974	29

The above samples do meet the physical requirements A36.

(Tested in accordance with ASTM A370-12)

Respectfully Submitted  
AIT, LLC

*William E. Jackson*  
William E. Jackson

Q.A. APPROVED

By *[Signature]* Date *4/2/18*

5101 Wilfong Road \* Memphis, TN 38134 \* Phone: 901-373-6992 \* Fax: 901-373-5825

R. LEE

JUN 05 2018

P0#636200

11048-300-17, 18

HT# 18009301



CERTIFICATE OF COMPLIANCE

DATE: APRIL 13, 2018

SUBJECT: NACE

GENTLEMEN:

I HEREBY CERTIFY THAT THE MATERIAL LISTED HEREIN HAS BEEN INSPECTED AND TESTED IN ACCORDANCE WITH PRESCRIBED METHODS IN THE GOVERNING SPECIFICATIONS AND BASED UPON THE RESULTS OF SUCH INSPECTION AND TESTING DOES CONFORM TO THE REQUIREMENTS OF NACE MR 01-75.

PLATE: SAE 1018

SIZE: 1/4" NOMINAL

MILL CERTIFIED: BRS

HEAT: 18009301

SLAB:

Specification: NACE MR 01-75

Hardness, HRC

Results

Hardness, BHN

Results

172, 165, 165

WE HEREBY CERTIFY THE ABOVE INFORMATION IS CORRECT.

A handwritten signature in black ink, appearing to read "Marty L. Eubanks", is written over a horizontal line.

MARTY L. EUBANKS

QUALITY ASSURANCE MANAGER

(918) 583-2222

R. LEE

JUN 05 2018

PO #636200

11048-300-17,18

HT #18009301

**CERTIFIED MILL TEST REPORT**

**The Best Value -  
Price, Quality, Service  
All The Time.**

LOG NO. F00000000098969

Page 1 of 10

BONNEY FORGE CORPORATION

P.O. BOX 330 • 14498 CROGHAN PIKE • MOUNT UNION, PA 17086-0330

(814) 542-2545 • (800) 345-7546 • FAX (814) 542-4908

www.bonneyforge.com

CUSTOMER: INDUSTRIAL PIPING SPECIALISTS

DATE 08/25/2017

CUSTOMER

BONNEY ORDER NO. B000227219

ORDER NO.: TP554851

SHIP TO: INDUSTRIAL PIPING SPECIALISTS

(TULSA)

606 NORTH 145TH EAST AVENUE

TULSA OK 74116

United States

ITEM	QUANTITY	LOT NO.	GRADE OR SPECIFICATION NO. CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS:
1	25	50119	6-31/2X2 STD A105 FLEX B SA/A105 Al 0.020 C 0.200 Co 0.002 Cr 0.030 Cu 0.030 Mn 1.050 Mo 0.002 Nb 0.015 Ni 0.020 P 0.009 S 0.017 Si 0.220 V 0.004 CE(Long Formula) = 0.39 T/S(PSI) 82,204 Y/S(PSI) 52,914 EL(%) 32.20 RA(%) 59.34 Brinell 147 BHN 147 BHN
2	25	50158	36-8X2 STD A105 FLEX B SA/A105 Al 0.026 C 0.200 Co 0.003 Cr 0.040 Cu 0.110 Mn 0.980 Mo 0.010 Nb 0.014 Ni 0.040 P 0.007 S 0.020 Si 0.240 V 0.003 CE(Long Formula) = 0.38 T/S(PSI) 75,105 Y/S(PSI) 49,486 EL(%) 32.00 RA(%) 63.76 Brinell 141 BHN 141 BHN
3	25	59920	36-4X11/2 XS A105 FLEX B SA/A105 Al 0.028 C 0.200 Co 0.005 Cr 0.090 Cu 0.150 Mn 0.990 Mo 0.011 Nb 0.014 Ni 0.060 P 0.010 S 0.025 Si 0.240 V 0.004 CE(Long Formula) = 0.40 T/S(PSI) 76,569 Y/S(PSI) 53,944 EL(%) 32.75 RA(%) 63.14 Brinell 141 BHN 139 BHN
4	10	50126	8-6 X 2 S160 A105 WELD B SA/A105 Al 0.030 C 0.190 Co 0.002 Cr 0.030 Cu 0.030 Mn 1.030 Mo 0.005 Nb 0.013 Ni 0.020 P 0.006 S 0.022 Si 0.220 V 0.003 CE(Long Formula) = 0.37 T/S(PSI) 81,423 Y/S(PSI) 51,597 EL(%) 33.70 RA(%) 63.76 Brinell 156 BHN 159 BHN

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

R. LEE

MAY 23 2018

PO# 636175

11048-300-19

HT# 50126

**CERTIFIED MILL TEST REPORT**

**The Best Value -  
Price, Quality, Service  
All The Time.**

LOG NO. F00000000098969

Page 2 of 10

BONNEY FORGE CORPORATION

P.O. BOX 330 • 14496 CROGHAN PIKE • MOUNT UNION, PA 17066-0330

(814) 542-2545 • (800) 345-7546 • FAX (814) 542-4908

www.bonneyforge.com

CUSTOMER: INDUSTRIAL PIPING SPECIALISTS

DATE 08/25/2017

CUSTOMER

BONNEY ORDER NO. B000227219

ORDER NO.: TP554851

SHIP TO: INDUSTRIAL PIPING SPECIALISTS

(TULSA)

606 NORTH 145TH EAST AVENUE

TULSA OK 74116

United States

ITEM	QUANTITY	LOT NO.	GRADE OR SPECIFICATION NO.	
			CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS:	
5	500	1491	36-1/2X1/4 3M A105 FLEX T	SA/A105
Al 0.031 C 0.200 Co 0.002 Cr 0.040 Cu 0.050 Mn 1.030 Mo 0.004 Nb 0.014				
Ni 0.020 P 0.006 S 0.027 Si 0.240 V 0.003				
CE(Long Formula) = 0.39				
T/S(PSI) 78,800 Y/S(PSI) 49,900 EL(%) 32.00 RA(%) 55.10				
Brinell 156 BHN 156 BHN				
6	25	50089	21/2-2 X 1/2 3000 A105 THRD T	SA/A105
Al 0.022 C 0.200 Co 0.003 Cr 0.030 Cu 0.060 Mn 1.010 Mo 0.006 Nb 0.015				
Ni 0.030 P 0.009 S 0.017 Si 0.230 V 0.003				
CE(Long Formula) = 0.38				
T/S(PSI) 73,500 Y/S(PSI) 49,100 EL(%) 33.00 RA(%) 68.00				
Brinell 138 BHN 146 BHN				
7	500	50200	36-3/4X1/2 3M A105 FLEX T	SA/A105
Al 0.024 C 0.200 Co 0.002 Cr 0.030 Cu 0.050 Mn 1.040 Mo 0.005 Nb 0.012				
Ni 0.020 P 0.006 S 0.022 Si 0.230 V 0.003				
CE(Long Formula) = 0.39				
T/S(PSI) 77,000 Y/S(PSI) 54,500 EL(%) 32.00 RA(%) 70.00				
Brinell 154 BHN 157 BHN				
8	300	50202	36-11/2X3/4 3M A105 FLEX T	SA/A105
Al 0.036 C 0.200 Co 0.002 Cr 0.040 Cu 0.020 Mn 1.050 Mo 0.002 Nb 0.015				
Ni 0.010 P 0.003 S 0.021 Si 0.240 V 0.003				
CE(Long Formula) = 0.39				
T/S(PSI) 76,862 Y/S(PSI) 53,371 EL(%) 34.90 RA(%) 59.85				
Brinell 141 BHN 144 BHN				

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

R. LEE

MAY 23 2018

PO#636175

11048-300-19

HT#50126

**CERTIFIED MILL TEST REPORT**

LOG NO. F00000000098969

Page 3 of 10



**The Best Value -  
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CUSTOMER: INDUSTRIAL PIPING SPECIALISTS

DATE 08/25/2017

CUSTOMER

BONNEY ORDER NO. B000227219

ORDER NO.: TP554851

SHIP TO: INDUSTRIAL PIPING SPECIALISTS  
(TULSA)  
606 NORTH 145TH EAST AVENUE  
TULSA OK 74116  
United States

ITEM	QUANTITY	LOT NO.	GRADE OR SPECIFICATION NO.	
			CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS:	
9	50	59582	FLATX 1/2 3000 A105 THRD T	SA/A105
Al 0.027 C 0.210 Cb 0.000 Co 0.004 Cr 0.040 Cu 0.050 Mn 1.020 Mo 0.006				
Nb 0.014 Ni 0.013 P 0.006 S 0.021 Si 0.210 V 0.004				
CE(Long Formula) = 0.39				
T/S(PSI) 74,222 Y/S(PSI) 51,763 EL(%) 34.45 RA(%) 63.23				
Brinell 137 BHN 135 BHN				
11	50	50078	21/2-11/4X1 3M A105 FLEX T	SA/A105
Al 0.024 C 0.200 Co 0.003 Cr 0.030 Cu 0.070 Mn 1.050 Mo 0.007 Nb 0.013				
Ni 0.030 P 0.010 S 0.021 Si 0.220 V 0.004				
CE(Long Formula) = 0.39				
T/S(PSI) 79,819 Y/S(PSI) 52,092 EL(%) 32.06 RA(%) 61.09				
Brinell 144 BHN 144 BHN				
12	25	50159	36-3 X 1 6M A105 FLEX T	SA/A105
Al 0.027 C 0.190 Co 0.004 Cr 0.040 Cu 0.140 Mn 0.980 Mo 0.008 Nb 0.012				
Ni 0.050 P 0.006 S 0.024 Si 0.240 V 0.003				
CE(Long Formula) = 0.38				
T/S(PSI) 74,788 Y/S(PSI) 50,314 EL(%) 35.45 RA(%) 62.56				
Brinell 139 BHN 139 BHN				
13	25	50007	FLATX 3/4 3000 A105 SOCK S	SA/A105
Al 0.021 C 0.210 Co 0.002 Cr 0.040 Cu 0.020 Mn 1.080 Mo 0.002 Nb 0.013				
Ni 0.010 P 0.008 S 0.021 Si 0.230 V 0.003				
CE(Long Formula) = 0.40				
T/S(PSI) 75,897 Y/S(PSI) 53,093 EL(%) 34.10 RA(%) 64.00				
Brinell 141 BHN 144 BHN				

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

11048-300-19

R. LEE

MAY 23 2010

PO#636175

Ht#50126

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(TULSA)

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United States

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			CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS	
14	6	50086	36 -3 X 2 3000 A105 LREO T	SA/A105
			Al 0.028 C 0.190 Co 0.003 Cr 0.050 Cu 0.070 Mn 0.970 Mo 0.011 Nb 0.014	
			Ni 0.040 P 0.010 S 0.018 Si 0.240 V 0.003	
			CE(Long Formula) = 0.37	
			T/S(PSI) 76,500 Y/S(PSI) 54,500 EL(%) 30.00 RA(%) 63.00	
			Brinell 159 BHN 149 BHN	
15	200	1445	3/4 3M/6M A105 HXPL T	SA/A105
			Al 0.025 C 0.140 Cb 0.000 Co 0.000 Cr 0.070 Cu 0.090 Mn 0.660 Mo 0.010	
			Nb 0.001 Ni 0.050 P 0.008 S 0.012 Si 0.160 V 0.003	
			CE(Long Formula) = 0.28	
			T/S(PSI) 0 Y/S(PSI) 0 EL(%) 0.00 RA(%) 0.00	
			Brinell 144 BHN 156 BHN	
16	25	1428	1 3000 A105 UNAR S	SA/A105
		MALE	Al 0.026 C 0.200 Co 0.002 Cr 0.030 Cu 0.030 Mn 1.010 Mo 0.004 Nb 0.011	
			Ni 0.020 P 0.008 S 0.020 Si 0.220 V 0.003	
			CE(Long Formula) = 0.38	
			T/S(PSI) 77,300 Y/S(PSI) 45,100 EL(%) 32.00 RA(%) 66.20	
			Brinell 156 BHN 152 BHN	
		1421	1 3000 A105 UNAR S	SA/A105
		FEMALE	Al 0.025 C 0.210 Co 0.003 Cr 0.040 Cu 0.070 Mn 1.030 Mo 0.006 Nb 0.012	
			Ni 0.030 P 0.009 S 0.019 Si 0.230 V 0.005	
			CE(Long Formula) = 0.40	
			T/S(PSI) 80,300 Y/S(PSI) 48,400 EL(%) 23.00 RA(%) 32.20	
			Brinell 156 BHN 152 BHN	

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by

Kylee Ruiz

QUALITY PROCESS MANAGER

CMTR: REV2

R. LEE

11048-300-19

HT#50126

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**CERTIFIED MILL TEST REPORT**

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DATE 08/25/2017

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BONNEY ORDER NO. B000227219

ORDER NO.: TP554851

SHIP TO: INDUSTRIAL PIPING SPECIALISTS

(TULSA)

606 NORTH 145TH EAST AVENUE

TULSA OK 74116

United States

ITEM		QUANTITY	LOT NO.	GRADE OR SPECIFICATION NO.							CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS:			
			MIBF	1 3000 A105 UNAR S	SA/A105									
			NUT	Al 0.002 C 0.200 Cb 0.003 Co 0.000 Cr 0.111 Cu 0.190 Mn 1.010 Mo 0.019 Ni 0.079 P 0.007 S 0.022 Si 0.230 V 0.027										
				CE(Long Formula) = 0.42										
				T/S(PSI) 84,100 Y/S(PSI) 57,700 EL(%) 31.00 RA(%) 59.70										
				Brinell 168 BHN 168 BHN										
17	100	1491	1/4 3000 A105 UNAR T	SA/A105										
		MALE	Al 0.031 C 0.200 Co 0.002 Cr 0.040 Cu 0.050 Mn 1.030 Mo 0.004 Nb 0.014 Ni 0.020 P 0.006 S 0.027 Si 0.240 V 0.003											
			CE(Long Formula) = 0.39											
			T/S(PSI) 78,800 Y/S(PSI) 49,900 EL(%) 32.00 RA(%) 55.10											
			Brinell 156 BHN 156 BHN											
		1343	1/4 3000 A105 UNAR T	SA/A105										
		FEMALE	Al 0.020 C 0.220 Co 0.002 Cr 0.070 Cu 0.010 Mn 1.040 Mo 0.002 Nb 0.012 Ni 0.010 P 0.008 S 0.022 Si 0.230 V 0.004											
			CE(Long Formula) = 0.41											
			T/S(PSI) 78,200 Y/S(PSI) 49,900 EL(%) 28.00 RA(%) 54.70											
			Brinell 149 BHN 149 BHN											
		1394	1/4 3000 A105 UNAR T	SA/A105										
		NUT	Al 0.034 C 0.200 Co 0.002 Cr 0.040 Cu 0.050 Mn 0.990 Mo 0.006 Nb 0.016 Ni 0.030 P 0.009 S 0.025 Si 0.230 V 0.003											
			CE(Long Formula) = 0.38											
			T/S(PSI) 78,300 Y/S(PSI) 45,200 EL(%) 28.00 RA(%) 44.70											
			Brinell 143 BHN 143 BHN											

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by

*Kylee Ruiz*

Kylee Ruiz

QUALITY PROCESS MANAGER

CMTR: REV2

**R. LEE**

PO#636175

11048-300-19

HT#50126

MAY 23 2018

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CUSTOMER

BONNEY ORDER NO. B000227219

ORDER NO.: TP554851

SHIP TO: INDUSTRIAL PIPING SPECIALISTS

(TULSA)

606 NORTH 145TH EAST AVENUE

TULSA OK 74116

United States

ITEM	QUANTITY	LOT NO.	GRADE OR SPECIFICATION NO.									
			CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS:									
18	100	1458	1/2 3000 A105 UNAR T	SA/A105								
				MALE	Al 0.026 C 0.210 Co 0.003 Cr 0.030 Cu 0.060 Mn 1.000 Mo 0.004 Nb 0.014							
		Ni 0.020 P 0.007 S 0.022 Si 0.250 V 0.003										
		CE(Long Formula) = 0.39										
		T/S(PSI) 78,800 Y/S(PSI) 45,500 EL(%) 24.00 RA(%) 40.70										
		Brinell 163 BHN 163 BHN										
		1430	1/2 3000 A105 UNAR T	SA/A105								
				FEMALE	Al 0.026 C 0.200 Co 0.002 Cr 0.030 Cu 0.030 Mn 1.010 Mo 0.004 Nb 0.011							
				Ni 0.020 P 0.008 S 0.020 Si 0.220 V 0.003								
				CE(Long Formula) = 0.38								
				T/S(PSI) 76,800 Y/S(PSI) 46,700 EL(%) 32.00 RA(%) 65.60								
				Brinell 156 BHN 149 BHN								
				M1BF	1/2 3000 A105 UNAR T	SA/A105						
NUT	Al 0.002 C 0.200 Co 0.003 Cr 0.111 Cu 0.190 Mn 1.010 Mo 0.019											
Ni 0.079 P 0.007 S 0.022 Si 0.230 V 0.027												
CE(Long Formula) = 0.42												
T/S(PSI) 84,100 Y/S(PSI) 57,700 EL(%) 31.00 RA(%) 59.70												
Brinell 168 BHN 168 BHN												
19	25	50050	2 3000 LF2 90EL S	SA/A350 LF2 CL1								
				Al 0.032 C 0.200 Co 0.003 Cr 0.040 Cu 0.100 Mn 1.080 Mo 0.008 Nb 0.013								
		Ni 0.040 P 0.011 S 0.022 Si 0.230 V 0.003										
		CE(Long Formula) = 0.40										
		T/S(PSI) 75,167 Y/S(PSI) 51,220 EL(%) 37.00 RA(%) 62.80										
		Brinell 141 BHN 141 BHN										
		Charpy -50 F 43/41/40 (Ft-Lbs)										
		Average 41.30										

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

R. LEE

MAY 23 2018

PO#636175 11048-300-19

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ITEM	QUANTITY	LOT NO.	GRADE OR SPECIFICATION NO.	
			CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS:	
20	25	59717	1X1X1/2 3000 LF2 TEE T	SA/A350 LF2 CL1
Al 0.027 C 0.200 Co 0.004 Cr 0.090 Cu 0.080 Mn 1.080 Mo 0.007 N 0.004				
Nb 0.012 Ni 0.030 P 0.007 S 0.018 Si 0.250 V 0.003				
CE(Long Formula) = 0.41				
T/S(PSI) 74,701 Y/S(PSI) 49,970 EL(%) 37.80 RA(%) 67.02				
Brinell 132 BHN 132 BHN				
Charpy -50 F 76/81/45 (Ft-Lbs)				
Average 67.30				
21	25	1483	1 3000 LF2 COUP T	SA/A350 LF2 CL1
Al 0.027 C 0.190 Co 0.004 Cr 0.040 Cu 0.140 Mn 0.980 Mo 0.008 Nb 0.012				
Ni 0.050 P 0.006 S 0.024 Si 0.240 V 0.003				
CE(Long Formula) = 0.38				
T/S(PSI) 73,196 Y/S(PSI) 52,041 EL(%) 33.45 RA(%) 63.28				
Brinell 137 BHN 137 BHN				
Charpy -50 F 79/79/37 (Ft-Lbs)				
Average 65.00				
22	25	1288	1 3000 LF2 COUP S	SA/A350 LF2 CL1
Al 0.028 C 0.210 Co 0.004 Cr 0.030 Cu 0.070 Mn 1.070 Mo 0.012 Nb 0.011				
Ni 0.040 P 0.006 S 0.024 Si 0.220 V 0.003				
CE(Long Formula) = 0.40				
T/S(PSI) 77,505 Y/S(PSI) 53,816 EL(%) 34.10 RA(%) 54.49				
Brinell 132 BHN 135 BHN				
Charpy -50 F 25/26/28 (Ft-Lbs)				
Average 26.30				

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PO#636175 11048-300-19

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606 NORTH 145TH EAST AVENUE

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ITEM	QUANTITY	LOT NO.	GRADE OR SPECIFICATION NO.	
			CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS:	
23	25	50176	36-3/4 X 1/2 3M LF2 FLEX T	SA/A350 LF2 CL1
Al 0.031 C 0.200 Co 0.002 Cr 0.040 Cu 0.050 Mn 1.030 Mo 0.004 Nb 0.014				
Ni 0.020 P 0.006 S 0.027 Si 0.240 V 0.003				
CE(Long Formula) = 0.39				
T/S(PSI) 72,000 Y/S(PSI) 49,200 EL(%) 33.00 RA(%) 67.00				
Brinell 139 BHN 139 BHN				
Charpy -50 F 87/58/51 (Ft-Lbs)				
Average 65.30				
24	50	50076	36-11/2X3/4 3M LF2 FLEX S	SA/A350 LF2 CL1
Al 0.027 C 0.200 Co 0.004 Cr 0.050 Cu 0.100 Mn 0.970 Mo 0.016 Nb 0.013				
Ni 0.060 P 0.011 S 0.019 Si 0.220 V 0.003				
CE(Long Formula) = 0.39				
T/S(PSI) 76,500 Y/S(PSI) 53,000 EL(%) 31.00 RA(%) 64.00				
Brinell 159 BHN 146 BHN				
Charpy -50 F 42/58/45 (Ft-Lbs)				
Average 48.30				
25	25	50075	36-11/2X3/4 3M LF2 FLEX T	SA/A350 LF2 CL1
Al 0.029 C 0.200 Co 0.003 Cr 0.040 Cu 0.090 Mn 1.000 Mo 0.015 Nb 0.011				
Ni 0.040 P 0.010 S 0.022 Si 0.230 V 0.004				
CE(Long Formula) = 0.39				
T/S(PSI) 77,000 Y/S(PSI) 53,500 EL(%) 31.00 RA(%) 66.00				
Brinell 157 BHN 154 BHN				
Charpy -50 F 46/31/44 (Ft-Lbs)				
Average 40.30				

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by

Kylee Ruiz

QUALITY PROCESS MANAGER

CMTR: REV2

R. LEE

PO#636175

11048-300-19

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ITEM	QUANTITY	LOT NO.	GRADE OR SPECIFICATION NO.	
			CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS:	
26	25	50196	36-3X1 3M LF2 FLEX T	SA/A350 LF2 CL1
Al 0.032 C 0.200 Co 0.002 Cr 0.040 Cu 0.030 Mn 1.050 Mo 0.003 Nb 0.014				
Ni 0.020 P 0.005 S 0.019 Si 0.270 V 0.003				
CE(Long Formula) = 0.39				
T/S(PSI) 71,610 Y/S(PSI) 47,449 EL(%) 36.85 RA(%) 57.04				
Brinell 135 BHN 135 BHN				
Charpy -50 F 77/66/56 (Ft-Lbs)				
Average 66.30				

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.

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CMTR: REV2

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11048-300-19

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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. THE PRODUCT SUPPLIED WAS INSPECTED IN ACCORDANCE WITH EN 10204:2004 EDITION TYPE 3.1 INSPECTION DOCUMENT. (EUROPEAN STANDARD)
3. ELONGATION TEST RESULTS ARE OBTAINED USING STANDARD ROUND SPECIMEN, 2 INCH OR 50 MM GAGE LENGTH.
4. ITEM - 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 18 -THE MATERIAL SUPPLIED MEETS THE REQUIREMENTS OF NACE MRO175/ISO 15156-2.
5. ITEM - 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 18 -CERTIFYING ASTM A105-14 / ASME SA105-15 EDITION.
6. ITEM - 19, 20, 21, 22, 23, 24, 25, 26 -CERTIFYING TO ASTM A350 LF2 07 REVISION.
7. ITEM - 19, 20, 21, 22, 23, 24, 25, 26 -THE MATERIAL OF THE FITTINGS SUPPLIED IS ASTM A350-LF2 BUT MEETS THE REQUIREMENTS OF ASME SA350-LF2.
8. ITEM - 19, 20, 21, 22, 23, 24, 25, 26 -THE CHARPY V-NOTCH IMPACT TEST WAS PERFORMED AT -50 DEGREES FAHRENHEIT IN ACCORDANCE WITH A350-LF2.
9. ITEM - 19, 20, 21, 22, 23, 24, 25, 26 -THE MATERIAL SUPPLIED AS A350 LF2 CL1 MEETS THE REQUIREMENTS OF BOTH NACE MRO103-2007 AND NACE MRO175/ISO 15156-2.
10. ITEM - 19, 20, 21, 22, 23, 24, 25, 26 -THE MATERIAL SUPPLIED WAS NORMALIZED IN ACCORDANCE WITH ASTM A350 HEAT TREATING REQUIREMENTS.
11. ITEM - 15 -THE MATERIAL SUPPLIED IDENTIFIED AS SA/A105-QT WAS QUENCHED AND TEMPERED IN ACCORDANCE WITH ASTM A105 HEAT TREATING REQUIREMENTS.

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

11048-300-19

PO#636175

HT#50126

LEE

MAY 23 2018



[ 636397 | 802674 ] [ IN: 3 ] T0416560-1 FSPET16XH


FSPET 16XH

Q. LEE  
JUN 12 2018

HT # 802674

11048-300-22-ECR1279

PO#636397

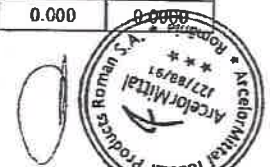
<b>Manufacturer:</b> ArcelorMittal Tubular Products Roman S.A. STEFAN CEL MARE ST, 15A/I ROMAN, NEAMT COUNTY. ROMANIA		<b>MILL TEST CERTIFICATE</b> according to EN 10204/3.1/2004				Page 1/5		 <b>ArcelorMittal</b>						
						B 6191/1								
						31.03.2015								
<b>Buyer:</b> ARCELORMITTAL INTERNATIONAL AMERICA. LLC 1 SOUTH DEARBORN STREET, 13TH FLOOR CHICAGO, IL 60603-9888 USA		<b>SEAMLESS STEEL PIPES</b>				Total weight:		Total Length:		Pieces	Bundles			
						99.155 tons		804.12 meters		65	-			
						218 600 lbs		2 638.17 feet						
<b>Standard:</b> API 5L-ed.45-2012- PSL 1: ASTM A106/A 106M-2014:ASTM A 53/A53M- 2012; ASME SA 106/SA 106M-2013; ASME SA 53/SA 53M-2013 NACE MR 0103-2012: NACE MR 0175/ISO 15156-1&2/2009														
<b>Buyer's reference:</b> AMI ORDER: 10090565 PO NUMBER: MIP00093 <b>Contract:</b> 50002098		<b>Dimensions:</b> 406.40 x 12.70 mm 16.000 X 0.500 inch		<b>Schedule:</b> 40		<b>Length:</b> 11.50 - 12.80 m		37.73 - 41.99 feet						
<table border="1"> <thead> <tr> <th>Item</th> <th>Item Client</th> </tr> </thead> <tbody> <tr> <td>6</td> <td>-</td> </tr> </tbody> </table>		Item	Item Client	6	-	<b>Hydro Test:</b>	<b>Bar</b> 154	<b>PSI</b> 2236	<b>MPa</b> 15.4	<b>Time(sec)</b> 5	<b>Steel Grade:</b> GrB/GrC/X42			
Item	Item Client													
6	-													

Chemical Analysis(%)


Heat	Bulletin No.	Product Req.	Max	C	Mn	Si	S	P	Cr	Ni	Cu	Mo	V	Nb	Ti	B
			Min	0.23	1.06	-	0.030	0.030	0.40	0.40	0.40	0.15	-	-	-	0.0010
				-	0.29	0.10	-	-	-	-	-	-	-	-	-	-
802670		Heat analysis		0.18	1.03	0.22	0.004	0.009	0.08	0.07	0.15	0.02	0.003	0.002	0.003	0.0001
802674		Heat analysis		0.19	1.07	0.22	0.004	0.007	0.08	0.06	0.15	0.01	0.004	0.003	0.002	0.0001
802676		Heat analysis		0.18	1.05	0.22	0.004	0.008	0.13	0.07	0.15	0.05	0.004	0.003	0.002	0.0001
802673		Heat analysis		0.18	1.05	0.24	0.003	0.006	0.09	0.07	0.16	0.02	0.003	0.002	0.003	0.0001
802668		Heat analysis		0.18	1.03	0.23	0.004	0.010	0.09	0.06	0.14	0.03	0.004	0.002	0.003	0.0001
53409		Heat analysis		0.19	1.00	0.23	0.005	0.002	0.05	0.08	0.18	0.02	0.007	0.001	0.002	0.0003
802670	15-602	Product analysis		0.18	1.03	0.21	0.005	0.010	0.13	0.07	0.15	0.04	0.001	0.002	0.000	0.0000
802670	15-602	Product analysis		0.19	1.02	0.21	0.005	0.009	0.13	0.07	0.15	0.04	0.001	0.002	0.000	0.0000
802674	15-602	Product analysis		0.19	0.99	0.20	0.004	0.008	0.08	0.06	0.14	0.01	0.001	0.002	0.000	0.0000
802674	15-602	Product analysis		0.20	0.98	0.20	0.004	0.008	0.08	0.06	0.14	0.01	0.001	0.002	0.000	0.0000
802676	15-602	Product analysis		0.18	0.99	0.19	0.005	0.009	0.13	0.06	0.14	0.04	0.000	0.002	0.000	0.0000
802676	15-602	Product analysis		0.18	1.00	0.20	0.005	0.009	0.13	0.06	0.14	0.04	0.000	0.002	0.000	0.0000
802673	15-524	Product analysis		0.19	0.99	0.23	0.005	0.012	0.08	0.06	0.15	0.02	0.002	0.002	0.000	0.0000
802673	15-524	Product analysis		0.19	0.99	0.23	0.006	0.011	0.08	0.06	0.16	0.02	0.002	0.002	0.000	0.0000
802668	15-524	Product analysis		0.19	1.04	0.24	0.005	0.012	0.09	0.06	0.14	0.02	0.002	0.002	0.000	0.0000
802668	15-524	Product analysis		0.18	1.04	0.23	0.005	0.011	0.09	0.06	0.14	0.02	0.002	0.002	0.000	0.0000
53409	15-756	Product analysis		0.18	1.04	0.20	0.005	0.010	0.06	0.05	0.15	0.02	0.000	0.002	0.000	0.0000
53409	15-756	Product analysis		0.19	1.05	0.20	0.005	0.009	0.06	0.05	0.14	0.02	0.000	0.002	0.000	0.0000

We state on our sole responsibility that the delivered products are in conformity with the order requirements.

Quality Control Representative  
Eng. Iesanu Cristian



[ 636397 | 802674 ] [ LN: 3 ] [ T0416560-1 | FSPET16XH ]

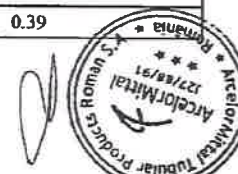
<b>Manufacturer:</b> ArcelorMittal Tubular Products Roman S.A. STEFAN CEL MARE ST, 15A/1 ROMAN, NEAMT COUNTY, ROMANIA		<b>MILL TEST CERTIFICATE</b> according to EN 10204/3.1/2004				Page 2/5		 <b>ArcelorMittal</b>	
						B 6191/1			
						31.03.2015			
<b>Buyer:</b> ARCELORMITTAL INTERNATIONAL AMERICA, LLC 1 SOUTH DEARBORN STREET, 13TH FLOOR CHICAGO, IL 60603-9888 USA		SEAMLESS STEEL PIPES				Total weight: 99.155 tons 218 600 lbs	Total Length: 804.12 meters 2 638.17 feet	Pieces 65	Bundles -
						<b>Standard:</b> API 5L-cd45-2012- PSL 1; ASTM A106/A 106M-2014;ASTM A 53/A53M- 2012; ASME SA 106/SA 106M-2013; ASME SA 53/SA 53M-2013 NACE MR 0103-2012; NACE MR 0175/ISO 15156-1&2/2009			
Buyer's AMI ORDER: 10090565 reference PO NUMBER: MIP00093 Contract 50002098		Dimensions: 406.40 x 12.70 mm 16.000 X 0.500 inch				Schedule: 40		Length: 11.50 - 12.80 m 37.73 - 41.99 feet	
Item	Item Client	Hydro Test:	Bar	PSI	MPa	Time(sec)	Steel Grade: GrB/GrC/X42		
6	-		154	2236	15.4	5			

Chemical Analysis(%)

Heat	Bulletin No.	Product Req.	Max Min	Nb + V	Nb + Ti + V	Cr + Mo + Ni + Cu + V	CE, IIW
				0.060	0.150	1.000	0.41
802670		Heat analysis		0.005	0.008	0.323	0.39
802674		Heat analysis		0.007	0.009	0.304	0.41
802676		Heat analysis		0.007	0.009	0.404	0.41
802673		Heat analysis		0.005	0.008	0.343	0.39
802668		Heat analysis		0.006	0.009	0.324	0.39
53409		Heat analysis		0.008	0.010	0.337	0.39
802670	15-602	Product analysis		0.003	0.003	0.391	0.40
802670	15-602	Product analysis		0.003	0.003	0.391	0.41
802674	15-602	Product analysis		0.003	0.003	0.291	0.39
802674	15-602	Product analysis		0.003	0.003	0.291	0.39
802676	15-602	Product analysis		0.002	0.002	0.370	0.39
802676	15-602	Product analysis		0.002	0.002	0.370	0.39
802673	15-524	Product analysis		0.004	0.004	0.312	0.39
802673	15-524	Product analysis		0.004	0.004	0.322	0.39
802668	15-524	Product analysis		0.004	0.004	0.312	0.40
802668	15-524	Product analysis		0.004	0.004	0.312	0.39
53409	15-756	Product analysis		0.002	0.002	0.280	0.38
53409	15-756	Product analysis		0.002	0.002	0.270	0.39

We state on our sole responsibility that the delivered products are in conformity with the order requirements.

Quality Control Representative  
 Eng. Iesanu Cristian



R. LEE

JUN 12 2018

HT# 802674

11048-360-22-FCR1279

PO# 636397


R. LEE

JUN 12 2018

H74802674

11048-300-22-ECR1279

P04636397

<b>Manufacturer:</b> ArcelorMittal Tubular Products Roman S.A. STEFAN CEL MARE ST, 15A/1 ROMAN, NEAMT COUNTY, ROMANIA		<b>MILL TEST CERTIFICATE</b> according to EN 10204/3.1/2004				Page 3/5		 <b>ArcelorMittal</b>		
						B 6191/1				
						31.03.2015				
<b>Buyer:</b> ARCELORMITTAL INTERNATIONAL AMERICA, LLC 1 SOUTH DEARBORN STREET, 13TH FLOOR CHICAGO. IL 60603-9888 USA		<b>SEAMLESS STEEL PIPES</b>				<b>Total weight:</b> 99.155 tons 218 600 lbs	<b>Total Length:</b> 804.12 meters 2 638.17 feet	<b>Pieces</b> 65	<b>Bundles</b> -	
						<b>Standard:</b> API 5L-cd.45-2012-PSL 1; ASTM A106/A 106M-2014; ASTM A 53/A53M- 2012; ASME SA 106/SA 106M-2013; ASME SA 53/SA 53M-2013 NACE MR 0103-2012; NACE MR 0175/ISO 15156-1&2/2009				
<b>Buyer's AMI ORDER:</b> 10090565 <b>reference PO NUMBER:</b> MIP00093 <b>Contract</b> 50002098		<b>Dimensions:</b> 406.40 x 12.70 mm 16.000 X 0.500 inch				<b>Schedule:</b> 40		<b>Length:</b> 11.50 - 12.80 m 37.73 - 41.99 feet		
<b>Item</b> 6		<b>Item Client</b> -		<b>Hydro Test:</b>		<b>Bar</b> 154	<b>PSI</b> 2236	<b>MPa</b> 15.4	<b>Time(sec)</b> 5	<b>Steel Grade:</b> GrB/GrC/X42

## Chemical Analysis(%)

Heat	Bulletin No.	Product Req.	Max	Nb + V	Nb + Ti + V	Cr + Mo + Ni + Cu + V	CE IIW
			Min	0.060	0.150	1.000	0.41
				-	-	-	-

$$CE_{pcn} = C + Si/30 + Mn/20 + Cu/20 + Ni/60 + Cr/20 + Mo/15 + V/10 + 5B$$

$$CE_S = C + Mn/6$$

$$CE_{IIW} = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$$

## Tensile Test

Heat	Orientation	Length		Width/Diameter		Thickness		Section		Mechanical test Bulletin No.	YS MPa	YS (PSI:1000)	UTS MPa	UTS (PSI:1000)	E %	YS/UTS max: -
		mm	inch	mm	inch	mm	inch	mm <sup>2</sup>	inch <sup>2</sup>							
802670	Longitudinal Flat	50.8	2	40.00	1.575	14.00	0.551	560.0	22.047	15-1106	362.00	52.5	529.00	76.7	52.20	0.68
802674	Longitudinal Flat	50.8	2	40.00	1.575	12.40	0.488	496.0	19.528	15-1106	361.00	52.4	562.00	81.5	52.80	0.64
802676	Longitudinal Flat	50.8	2	40.00	1.575	12.70	0.500	508.0	20.000	15-1106	327.00	47.4	514.00	74.5	55.30	0.64
802673	Longitudinal Flat	50.8	2	40.00	1.575	12.80	0.504	512.0	20.157	15-933	362.00	52.5	533.00	77.3	52.30	0.68
802668	Longitudinal Flat	50.8	2	40.00	1.575	12.60	0.496	504.0	19.843	15-933	384.00	55.7	571.00	82.8	48.90	0.67
53409	Longitudinal Flat	50.8	2	40.00	1.575	13.60	0.535	544.0	21.417	15-1467	329.00	47.7	541.00	78.5	53.50	0.61

We state on our sole responsibility that the delivered products are in conformity with the order requirements.


Quality Control Representative  
 Eng. Iesanu Cristian



[ 636397 | 802674 ] [ IN. 3 ] T0416560-1 FSPET16XH



[ 636397 | 802674 ] [ LN: 3 ] [ T0416560-1 ] FSPET16XH

<b>Manufacturer:</b> ArcelorMittal Tubular Products Roman S.A. STEFAN CEL MARE ST, 15A/I ROMAN, NEAMT COUNTY, ROMANIA		<b>MILL TEST CERTIFICATE</b> according to EN 10204/3.1/2004				Page 4/5 <b>B 6191/1</b> <b>31.03.2015</b>		 <b>ArcelorMittal</b>			
<b>Buyer:</b> ARCELORMITTAL INTERNATIONAL AMERICA, LLC 1 SOUTH DEARBORN STREET, 13TH FLOOR CHICAGO. IL 60603-9888 USA		SEAMLESS STEEL PIPES				<b>Total weight:</b> 99.155 tons 218 600 lbs		<b>Total Length:</b> 804.12 meters 2 638.17 feet		<b>Pieces</b> 65	<b>Bundles</b> -
<b>Standard:</b> API 5L-ed.45-2012- PSL 1; ASTM A106/A 106M-2014:ASTM A 53/A53M- 2012: ASME SA 106/SA 106M-2013; ASME SA 53/SA 53M-2013 NACE MR 0103-2012; NACE MR 0175/ISO 15156-1&2/2009		<b>Dimensions:</b> 406.40 x 12.70 mm 16.000 X 0.500 inch				<b>Schedule:</b> 40		<b>Length:</b> 11.50 - 12.80 m		37.73 - 41.99 feet	
<b>Buyer's AMI ORDER:</b> 10090565 <b>reference PO NUMBER:</b> MIP00093 <b>Contract</b> 50002098		<b>Hydro Test:</b>		<b>Bar</b> 154	<b>PSI</b> 2236	<b>MPa</b> 15.4	<b>Time(sec)</b> 5	<b>Steel Grade:</b> GrB/GrC/X42			
<b>Item</b> 6	<b>Item Client</b> -										

### Hardness Test

Heat	Hardness Test Bulletin No.	HB max.-	HV 10 max.-	HV 10 max.-					HRC max.22
				OD	Midwall	ID	End A	End B	
802670	15-819	-	-	-	-	-	-	-	<22
802674	15-819	-	-	-	-	-	-	-	<22
802676	15-819	-	-	-	-	-	-	-	<22
802673	15-722	-	-	-	-	-	-	-	<22
802668	15-722	-	-	-	-	-	-	-	<22
53409	15-1073	-	-	-	-	-	-	-	<22

### Technological/Microstructure Test

Heat	Flattening Test Bulletin No.	Flattening Test
802670	15-882	OK
802674	15-882	OK
802676	15-882	OK
802673	15-732	OK
802668	15-732	OK
53409	15-1256	OK

We state on our sole responsibility that the delivered products are in conformity with the order requirements.

Quality Control Representative  
 Eng. Iesanu Cristian



LEE

JUN 1 2 2018


HT# 802674

11048-300-22-ECR1279

PO# 636397



[ 636397 | 802674 | T0416160-1 | FSPET16XH ]

<b>Manufacturer:</b> ArcelorMittal Tubular Products Roman S.A. STEFAN CEL MARE ST, 15A/I ROMAN, NEAMT COUNTY, ROMANIA		<b>MILL TEST CERTIFICATE</b> according to EN 10204/3.1/2004				Page 5/5		 <b>ArcelorMittal</b>			
						B 6191/I					
						31.03.2015					
<b>Buyer:</b> ARCELORMITTAL INTERNATIONAL AMERICA, LLC 1 SOUTH DEARBORN STREET, 13TH FLOOR CHICAGO, IL 60603-9888 USA		SEAMLESS STEEL PIPES				Total weight:		Total Length:		Pieces	Bundles
						99.155 tons		804.12 meters		65	-
						218 600 lbs		2 638.17 feet			
<b>Standard:</b> API 5L-ed.45-2012- PSL 1: ASTM A 106/A 106M-2014; ASTM A 53/A 53M- 2012; ASME SA 106/SA 106M-2013; ASME SA 53/SA 53M-2013 NACE MR 0103-2012; NACE MR 0175/ISO 15156-1&2/2009		<b>Dimensions:</b> 406.40 x 12.70 mm 16.000 X 0.500 inch				<b>Schedule:</b> 40		<b>Length:</b> 11.50 - 12.80 m		37.73 - 41.99 feet	
<b>Buyer's reference:</b> AMI ORDER: 10090565 PO NUMBER: MIP00093 <b>Contract:</b> 50002098		<b>Hydro Test:</b>		<b>Bar</b> 154	<b>PSI</b> 2236	<b>MPa</b> 15.4	<b>Time(sec)</b> 5	<b>Steel Grade:</b> GrB/GrC/X42			
<b>Item</b> 6		<b>Item Client</b> -									

Heat	Pieces	Length (m)	Weight (kg)
802670	12	-	-
802674	19	-	-
802676	30	-	-
802673	2	-	-
802668	1	-	-
53409	1	-	-

**Remarks** Manufacturing process -- hot rolling.  
 Hot finished, steel is fully killed, fine grained and produced by electric furnace, Arcelor Mittal Hunedoara S A -- Piata Iancu de Hunedoara,  
 nr.1 --Hunedoara and ABS Sisak d.o.o B Kavurica 12,44010 Sisak Republica Hravatska  
 Hydrostatic test hold for 5 sec. no leakage noticed.  
 For each reduction of 0.01% below the specified carbon maximum, on increase of 0.06 manganese above the specified maximum will be permitted up to  
 a maximum of 1.35%.

We state on our sole responsibility that the delivered products are in conformity with the order requirements.

Quality Control Representative  
 Eng. Iesanu Cristian



J. LEE  
 JUN 1 2 2018  
 802674 HT#  
 11048-300-22-ECR1279  
 PO#636397



6509 Sierra Lane, Dublin, CA 94568  
Phone 925-551-7000 Fax 925-551-7011  
[www.valinonline.com](http://www.valinonline.com)

<b>Date:</b>	04/27/18
<b>Customer:</b>	GasTech Engineering
<b>Customer P.O. #:</b>	635657
<b>Valin Order #:</b>	2637887

### **Certificate of Compliance**

This is to certify that Jamesbury part number:  
(3) ½ 5H-22HBRT Customer pn: 11048-100-0001  
was manufactured, inspected, assembled and tested in accordance to the  
manufacturer's standard procedures and in compliance with the above  
customer purchase order.

**Valin Corporation**  
**Richard Ferdon**

A handwritten signature in black ink, appearing to read "Richard Ferdon", written over a horizontal line.

**R. LEE**

**MAY 18 2018**

PO#635657

11048-100-1



845 S.E. 29<sup>TH</sup> STREET 73129  
PO BOX 94700  
OKC, OK. 73143  
PHONE: 405-631-1321  
FAX: 405-629-0420

### CERTIFICATE OF CONFORMANCE / TEST REPORTS

For: SUNBELT SUPPLY CO Date: April 10, 2018  
Purchase Order: 630379-00 Sales Order: 3600450

**COMPLIANCE:** This is to certify that at the time of manufacture, these items were manufactured in accordance with Cameron Valves and Measurement standard procedures and practices. Additionally, these items are in full conformance with product specification API 6D 24th Edition, Addendum 1 March 2015 and Addendum 2 June 2016.

#### TEST REPORTS / ACCEPTANCE:

	<u>Pressure</u>	<u>Duration</u>	<u>Results</u>
<u>Hydrostatic Tests</u>			
Shell Test	2400 psi	2 minutes	OK
Seat Test Top Right	1700 psi	2 minutes	OK
Seat Test Bottom Left	1700 psi	2 minutes	OK
DBB Seat Test	1700 psi	2 minutes	OK
<u>Air Tests</u>			
Air Test Seat Top Right	84 psi	2 Min	OK
Air Test Seat Bottom Left	84 psi	2 Min	OK

#### INCLUDED IN THIS CERTIFICATION:

7 Each P/N - 2365466-3111316 - BV 2X2 RF WKM 370D6 600 24YRF24 WHP LP

<u>Serial#</u>	<u>Body Heat#</u>	<u>Tailpiece Heat#</u>
121112682-005 —	R35180	20414
121112682-017 —	R35416	20393
121112682-023 —	R34783	20422
121112682-026 —	R35416	20414
121112682-037 —	R35679	20396
121112682-038 —	R34783	20587
121112682-052 —	R34783	20551

This certifies that the statement and values specified are true, correct and conform to the original data on file at Cameron Valves and Measurement.

Bea Yates  
Quality Assurance

Delivery Note # 87862864  
Line Item 10

PO# 635618

Schlumberger-Private  
11048-100-2

APR 19 2018

**Jiangsu Wanheng Casting Industry Co.,Ltd**

## MILL TEST CERTIFICATE REPORT

No. 9 Century Avenue, North Industrial Park, Economical Development Zone, Binhai County, Jiangsu Province, China

**Purchaser:**

**CAM DISTRIBUTED VALVES - OKC**

Corr. No.

BH18123-49

Date: \_\_\_\_\_

22-Jan-2018

USA17033252RUM

PO No.:	4511630849		Certificate type	EN 10204, 3.1, 2004		Cert. No.	BH18023-49				Date:	22-Jan-2018																		
Material Specification	ASTM A216/A216M-16 WCC MS-021010-01 Rev.10		Melting Practice	E.F.		Tensile Test bar	Dimension (mm)	Section (mm <sup>2</sup> )	Gage Length (mm)	Testing Temperature (°C)	Brinell Hardness	Load (Kg.f)	Location	Impact Test	Type	Dim. (mm)	Orientation													
			Test performed on	QTC III	Place □	Actual	12.5	122.72	50	Room	Actual	3000	QTC	Actual	V-Notch	10 x 10 x 55	Longitudinal													
PO Item No.	Part No.	Description					Chemical Composition										Mechanical Properties					Impact Test								
00020	2365342-03-01-01	BODY 2 6C RF 370D6 WCC/A105, NACE					C	Si	Mn	P	S	Cr*	Mo*	Ni*	Cu*	V*	Al	SUM*	C.E.	UTS	YS	EL	ROA	Hardness	Energy value (J)			Avg		
Heat Treatment	Temperatures (°C)	Time (h)	Cooling Method																			(Mpa)	(Mpa)	(%)	(%)	(HBW)	No. 1	No. 2	No. 3	(J)
Required	Normalized	1	1																											
Actual	Normalized 920	3	Air																											
Heat No.	Heat Treatment Lot No.	Qty.	Min																		485	275	22	35	143					
			Max	0.23	0.66	1.26	0.035	0.035	0.58	0.20	0.30	0.30	0.03	0.06	1.00	0.43	685				237									
R34783	2017092002	13		0.197	0.434	0.850	0.026	0.013	0.060	0.015	0.037	0.032	0.006	0.046	0.150	0.359	548	329	28	62	157									
R34869	2017092402	4		0.189	0.390	0.810	0.023	0.010	0.051	0.011	0.024	0.023	0.005	0.031	0.114	0.341	536	351	29	62	156									
R35041	2017100502	3		0.192	0.417	0.871	0.021	0.006	0.035	0.006	0.023	0.023	0.021	0.041	0.108	0.353	525	326	31	62	157									
R35052	2017100601	1		0.197	0.518	0.888	0.029	0.008	0.049	0.006	0.038	0.018	0.017	0.044	0.128	0.365	558	348	28	62	162									
R35088	2017100801	2		0.202	0.390	0.810	0.022	0.009	0.038	0.006	0.026	0.023	0.020	0.040	0.113	0.353	549	341	29	58	152									
R35149	2017101302	9		0.195	0.430	0.877	0.025	0.008	0.042	0.006	0.048	0.022	0.019	0.041	0.137	0.359	593	364	33	58	163									
R35180	2017101301	13		0.180	0.420	0.895	0.023	0.008	0.037	0.008	0.068	0.019	0.017	0.047	0.149	0.347	557	340	29	62	161									
R35181	2017101302	8		0.184	0.422	0.855	0.026	0.007	0.037	0.006	0.026	0.021	0.018	0.043	0.108	0.342	539	315	32	62	161									
R35224	2017101401	2		0.200	0.481	0.817	0.026	0.007	0.040	0.010	0.034	0.021	0.019	0.046	0.124	0.354	539	335	29	58	159									
R35232	2017101701	12		0.207	0.435	0.915	0.028	0.008	0.041	0.006	0.061	0.022	0.020	0.043	0.150	0.378	556	334	32	62	164									
R35281	2017101801	13		0.197	0.444	0.892	0.027	0.009	0.035	0.005	0.038	0.024	0.019	0.044	0.121	0.362	568	357	33	60	152									
R35305	2017102001	2		0.197	0.455	0.932	0.025	0.012	0.039	0.007	0.049	0.027	0.022	0.047	0.144	0.371	516	332	31	61	163									
R35372	2017102501	4		0.200	0.458	0.864	0.026	0.009	0.047	0.006	0.036	0.020	0.018	0.040	0.127	0.362	554	329	33	62	162									
R35416	2017102901	10		0.189	0.395	0.878	0.025	0.008	0.056	0.010	0.033	0.024	0.017	0.048	0.140	0.356	526	321	29	62	163									
R35566	2017110601	6		0.193	0.482	0.887	0.026	0.010	0.057	0.008	0.079	0.023	0.018	0.045	0.185	0.378	522	321	33	62	157									
R36640	2017111002	10		0.209	0.478	0.818	0.024	0.009	0.038	0.005	0.027	0.020	0.019	0.040	0.109	0.361	514	312	32	60	151									
R35679	2017111402	11		0.200	0.428	0.851	0.026	0.007	0.052	0.011	0.035	0.024	0.019	0.043	0.141	0.362	552	332	33	62	163									

We hereby certify that the material provided complies with all CVM requirements as stated in the applicable purchase order.

Surveyor's Name, Signature & Date:

2018-1-22

**Inspector's Name, Signature & Date:**

2018-1-22



REVIEWED

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APR 19 2018

1107A-100-2

PC# 635618



# RRK ALLOYS

SITE NO:50&51,SRI SUBAGANESH INDUSTRIAL ESTATES  
KUPPEPALAYAM POST.. VIA SATHY ROAD - SS KULLAM,  
COIMBATORE,TAMILNADU, INDIA

Phone :+91 422 2974 888; 999 Email :sales@rrkalloys.com Web : www.rrkalloys.com



## INSPECTION CERTIFICATE "EN 10204:-"Type 3.1"

<b>Customer</b> : CAMERON INTL CORP..		<b>T.C. No.</b> : 2634/17-18
		<b>T.C.Date</b> : 21/12/2017
<b>P.Order No.</b> : 4511630856 DI. 08/09/2017	<b>Heat No.</b> : 20414	
<b>Specification</b> : ASTM A 216 Gr :- WCC - 2016 & MS-021010-01(Rev.10) -Rev.08	<b>Pouring Date</b> : 12/10/2017	
<b>Casting Processed By</b> : INDUCTION MELTING	<b>Foundry Identification</b> : RRK	

### CHEMICAL COMPOSITION %

Element		C	Si	Mn	S	P	Cr	Ni	Mo	Cu	V	TRE	CE	Al	
Req.	Min	—	—	—	—	—	—	—	—	—	—	—	—	—	
	Max	0.230	0.600	1.200	0.035	0.035	0.500	0.500	0.200	0.300	0.030	1.000	0.430	0.060	
Actual		0.189	0.469	0.862	0.009	0.013	0.120	0.030	0.006	0.030	0.012	0.198	0.364	0.042	

Total Residual Elements = Cr+Ni+Mo+V+Cu

CE = C+Mn / 6+(Cr+Mo+V)/5+(Ni+Cu) / 15

### HEAT TREATMENT

Type of Heat Treatment	Temperature	Soaking Time	Cooling Medium
Normalising	920°C	3 Hrs	Air

### MECHANICAL PROPERTIES

Properties		Yield Strength	Tensile Strength	% Elongation		% of Reduction Area	Hardness BHN	Bend Test	Impact Test in (Joules) (10mm X 10mm X 55mm)			
		MPa	MPa	GL=4D	GL=5D							
		0.2% Rp	-	-	-	-	-	-	CVN 2mm 45 °			
Req.	Min	275	485	22.00	—	35.00	143	-				
	Max	—	655	—	—	—	237	-	1	2	3	Avg
Actual		304	510	33.00	—	64.72	149	-	-	-	-	-

### ITEM DESCRIPTION

Sl.No.	Description	Drawing No.	Part No.	Quantity
1	BODY CAST 2" 600 370 D6	X-345977-03-00 R03 / X-345977-03-	2365342-03-01-01	4
2	TAIL PIECE CAST 2"600 370 D6	X-345978-03-00 R02 / X-345978-03-	2365343-03-01-01	2

VERIFIED BY

MAR 07 2018

**Remarks :** Castings are Dimensionally acceptable , Visual inspection carried out as per MSS SP 55 & X-008060 and found acceptable  
Casting Meets the Requirements of NACE MR 0175/ISO 15156, Hardness : 22 HRC = 237 BHN  
Castings Meets the requirements of MS-021010-01 (Rev.10)-Rev.08 , Fully killed steel  
Radioactivity level measured on the above casting by using GAMMA SCOUT and found acceptable limit

We hereby certify that the items mentioned above was manufactured , sampled, tested, inspected and found to be in accordance with Customer's drawing, specification, purchase order and satisfy the requirements of ASTM A 216 Gr :- WCC - 2016 & MS-021010-01(Rev.10) -Rev.08

ISO 9001:2015,PED,WO Certified Company.

For RRK ALLOYS

Prepared By  
P.SIVAKUMAR  
Lab Incharge

Approved By  
MANI.NAVARASAN  
Dy.Manager-QA

11048-100-2

APR 19 2018

10# 635618



# RRK ALLOYS

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## INSPECTION CERTIFICATE "EN 10204:-Type 3.1"

**Customer** : CAMERON INTL CORP.. **T.C. No.** : 2620/17-18  
**T.C.Date** : 21/12/2017  
**P.Order No.** : 4511630856 Dt. 08/09/2017 **Heat No.** : 20393  
**Specification** : ASTM A 216 Gr :- WCC - 2016 & MS-021010-01(Rev.10) -Rev.08 **Pouring Date** : 09/10/2017  
**Casting Processed By** : INDUCTION MELTING **Foundry Identification** : RRK

### CHEMICAL COMPOSITION %

Element	C	Si	Mn	S	P	Cr	Ni	Mo	Cu	V	TRE	CE	Al
Req. Min	—	—	—	—	—	—	—	—	—	—	—	—	—
Max	0.230	0.600	1.200	0.035	0.035	0.500	0.500	0.200	0.300	0.030	1.000	0.430	0.060
Actual	0.201	0.514	0.902	0.010	0.015	0.160	0.030	0.004	0.028	0.011	0.233	0.390	0.043

Total Residual Elements = Cr+Ni+Mo+V+Cu

CE = C+Mn / 6+(Cr+Mo+V)/5+(Ni+Cu) / 15

### HEAT TREATMENT

Type of Heat Treatment	Temperature	Soaking Time	Cooling Medium
Normalising	920°C	3 Hrs	Air

### MECHANICAL PROPERTIES

Properties	Yield Strength	Tensile Strength	% Elongation		% of Reduction Area	Hardness	Bend Test	Impact Test in (Joules)			
	MPa	MPa	GL=4D	GL=5D		BHN		(10mm X 10mm X 55mm)			
	0.2% Rp							CVN 2mm 45 °			
Req. Min	275	485	22.00	—	35.00	143	-				
Max	—	655	—	—	—	237	-	1	2	3	Avg
Actual	312	526	34.84	—	61.61	156	.	—	—	—	—

### ITEM DESCRIPTION

SL.No.	Description	Drawing No.	Part No.	Quantity
1	BODY CAST 2" 600 370 D6	X-345977-03-00 R03 / X-345977-03-	2365342-03-01-01	4
2	TAIL PIECE CAST 2"600 370 D6	X-345978-03-00 R02 / X-345978-03-	2365343-03-01-01	2

VERIFIED BY

MAR 07 2018

**Remarks** : Castings are Dimensionally acceptable , Visual Inspection carried out as per MSS SP 55 & X-008060 and found acceptable  
Casting Meets the Requirements of NACE MR 0175/ISO 15156, Hardness : 22 HRC = 237 BHN  
Castings Meets the requirements of MS-021010-01 (Rev.10)-Rev.08 , Fully killed steel  
Radioactivity level measured on the above casting by using GAMMA SCOUT and found acceptable limit

We here by certify that the items mentioned above was manufactured , sampled, tested, inspected and found to be in accordance with Customer's drawing, specification, purchase order and satisfy the requirements of ASTM A 216 Gr :- WCC - 2016 & MS-021010-01(Rev.10) -Rev.08

ISO 9001-2015,PED.WO Certified Company.

For RRK ALLOYS

Prepared By  
P.SIVAKUMAR  
Lab Incharge

Approved By  
MANI.NAVARASAN  
Dy.Manager-QA

PO# 635618

11048-100-2

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## INSPECTION CERTIFICATE "EN 10204:-"Type 3.1"

**Customer** : CAMERON INTL CORP.. **T.C. No.** : 2641/17-18  
**T.C. Date** : 21/12/2017  
**P. Order No.** : 4511630856 Dt. 08/09/2017 **Heat No.** : 20422  
**Specification** : ASTM A 216 Gr :- WCC - 2016 & MS-021010-01 (Rev.10) -Rev.08 **Pouring Date** : 13/10/2017  
**Casting Processed By** : INDUCTION MELTING **Foundry Identification** : RRK

### CHEMICAL COMPOSITION %

Element	C	Si	Mn	S	P	Cr	Ni	Mo	Cu	V	TRE	CE	Al	
Req. Min	—	—	—	—	—	—	—	—	—	—	—	—	—	
Max	0.230	0.600	1.200	0.035	0.035	0.500	0.500	0.200	0.300	0.030	1.000	0.430	0.060	
Actual	0.202	0.508	0.863	0.011	0.015	0.120	0.030	0.005	0.028	0.013	0.196	0.377	0.032	

Total Residual Elements = Cr+Ni+Mo+V+Cu

CE = C+Mn / 6+(Cr+Mo+V)/5+(Ni+Cu) / 15

### HEAT TREATMENT

Type of Heat Treatment	Temperature	Soaking Time	Cooling Medium
Normalising	920°C	3 Hrs	Air

### MECHANICAL PROPERTIES

Properties	Yield Strength		Tensile Strength		% Elongation		% of Reduction Area	Hardness BHN	Bend Test	Impact Test In (Joules)			
	MPa		MPa		GL=4D	GL=5D				(10mm X 10mm X 55mm)			
	0.2% Rp									CVN 2mm 45 °			
Req. Min	275		485		22.00	—	35.00	143	—				
Max	—		655		—	—	—	237	—	1	2	3	Avg
Actual	324		519		32.84	—	59.69	153	—	—	—	—	—

### ITEM DESCRIPTION

SL.No.	Description	Drawing No.	Part No.	Quantity
1	BODY CAST 2" 600 370 D6	X-345977-03-00 R03 / X-345977-03-	2365342-03-01-01	4
2	TAIL PIECE CAST 2"600 370 D6	X-345978-03-00 R02 / X-345978-03-	2365343-03-01-01	2

VERIFIED BY

MAR 07 2018

**Remarks :** Castings are Dimensionally acceptable , Visual inspection carried out as per MSS SP 55 & X-008060 and found acceptable  
Casting Meets the Requirements of NACE MR 0175/ISO 15156, Hardness : 22 HRC = 237 BHN  
Castings Meets the requirements of MS-021010-01 (Rev.10)-Rev.08 , Fully killed steel  
Radioactivity level measured on the above casting by using GAMMA SCOUT and found acceptable limit

We hereby certify that the items mentioned above was manufactured , sampled, tested, inspected and found to be in accordance with Customer's drawing, specification, purchase order and satisfy the requirements of ASTM A 216 Gr :- WCC - 2016 & MS-021010-01 (Rev.10) -Rev.08

ISO 9001:2015, PED, WO Certified Company.

For RRK ALLOYS

Prepared By  
P.SIVAKUMAR  
Lab Incharge

Approved By  
MANI.NAVARASAN  
Dy.Manager-QA

11048-100-2

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# RRK ALLOYS

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## INSPECTION CERTIFICATE "EN 10204:-"Type 3.1"

**Customer** : CAMERON INTL CORP., **T.C. No.** : 2623/17-18  
**T.C.Date** : 21/12/2017  
**P.Order No.** : 4511630856 Dt. 08/09/2017 **Heat No.** : 20396  
**Specification** : ASTM A 216 Gr :- WCC - 2016 & MS-021010-01(Rev.10) -Rev.08 **Pouring Date** : 10/10/2017  
**Casting Processed By** : INDUCTION MELTING **Foundry Identification** : RRK

### CHEMICAL COMPOSITION %

Element	C	Si	Mn	S	P	Cr	Ni	Mo	Cu	V	TRE	CE	Al
Req. Min	—	—	—	—	—	—	—	—	—	—	—	—	—
Max	0.230	0.600	1.200	0.035	0.035	0.500	0.500	0.200	0.300	0.030	1.000	0.430	0.060
Actual	0.187	0.561	0.930	0.009	0.013	0.120	0.030	0.005	0.023	0.009	0.187	0.372	0.050

Total Residual Elements = Cr+Ni+Mo+V+Cu

CE = C+Mn / 6+(Cr+Mo+V)/5+(Ni+Cu) / 15

### HEAT TREATMENT

Type of Heat Treatment	Temperature	Soaking Time	Cooling Medium
Normalising	920°C	3 Hrs	Air

### MECHANICAL PROPERTIES

Properties	Yield Strength	Tensile Strength	% Elongation		% of Reduction Area	Hardness BHN	Bend Test	Impact Test in (Joules)			
	MPa	MPa	GL=4D	GL=5D				(10mm X 10mm X 55mm)			
	0.2% Rp							CVN 2mm 45 °			
Req. Min	275	485	22.00	—	35.00	143	—				
Max	—	655	—	—	—	237	—	1	2	3	Avg
Actual	334	536	33.52	—	60.39	165	—	—	—	—	—

### ITEM DESCRIPTION

SL.No.	Description	Drawing No.	Part No.	Quantity
1	BODY CAST 2" 600 370 D8	X-345977-03-00 R03 / X-345977-03-	2365342-03-01-01	4
2	TAIL PIECE CAST 2"600 370 D8	X-345978-03-00 R02 / X-345978-03-	2365343-03-01-01	2

VERIFIED BY

MAR 07 2018

**Remarks** : Castings are Dimensionally acceptable . Visual inspection carried out as per MSS SP 55 & X-008060 and found acceptable  
Casting Meets the Requirements of NACE MR 0175/ISO 15156, Hardness : 22 HRC = 237 BHN  
Castings Meets the requirements of MS-021010-01 (Rev.10)-Rev.08 , Fully killed steel  
Radioactivity level measured on the above casting by using GAMMA SCOUT and found acceptable limit

We here by certify that the items mentioned above was manufactured , sampled, tested, inspected and found to be in accordance with Customer's drawing, specification, purchase order and satisfy the requirements of ASTM A 216 Gr :- WCC - 2016 & MS-021010-01(Rev.10) -Rev.08

ISO 9001-2015,PED,WO Certified Company.

For RRK ALLOYS

Prepared By  
P.SIVAKUMAR  
Lab Incharge

Approved By  
MANI.NAVARASAN  
Dy.Manager-QA

PO# 635618

11048-100-2

APR 19 2018





# RRK ALLOYS

SITE NO:50&51,SRI SUBAGANESH INDUSTRIAL ESTATES  
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## INSPECTION CERTIFICATE "EN 10204:-"Type 3.1"

**Customer** : CAMERON INTL CORP., **T.C. No.** : 2652/17-16  
**P.Order No.** : 45116282195.. Dt 04/10/2017, 4511630856 Dt 08/09/2017 **T.C.Date** : 21/12/2017  
**Specification** : ASTM A 216 Gr :- WCC - 2016 & MS-021010-01(Rev.10)-Rev.08 **Heat No.** : 20587  
**Casting Processed By** : INDUCTION MELTING **Pouring Date** : 04/11/2017  
**Foundry Identification** : RRK

### CHEMICAL COMPOSITION %

Element	C	Si	Mn	S	P	Cr	Ni	Mo	Cu	V	TRE	CE	Al
Req. Min	—	—	—	—	—	—	—	—	—	—	—	—	—
Max	0.230	0.600	1.200	0.035	0.035	0.500	0.500	0.200	0.300	0.030	1.000	0.430	0.060
Actual	0.194	0.501	0.908	0.007	0.011	0.120	0.030	0.006	0.024	0.011	0.191	0.376	0.039

Total Residual Elements = Cr+Ni+Mo+V+Cu

CE = C+Mn / 6+(Cr+Mo+V)/5+(Ni+Cu) / 15

### HEAT TREATMENT

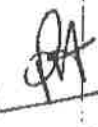
**Type of Heat Treatment** : Normalising **Temperature** : 920°C **Soaking Time** : 3 Hrs **Cooling Medium** : Air

### MECHANICAL PROPERTIES

Properties	Yield Strength	Tensile Strength	% Elongation		% of Reduction Area	Hardness	Bend Test	Impact Test in (Joules)			
	MPa	MPa	GL=4D	GL=5D		BHN		(10mm X 10mm X 55mm)			
	0.2% Rp							CVN 2mm 45 °			
Req. Min	275	485	22.00	—	35.00	143	—	1	2	3	Avg
Max	—	655	—	—	—	237	—	—	—	—	—
Actual	302	487	34.72	—	84.15	153	—	—	—	—	—

### ITEM DESCRIPTION

SL.No.	Description	Drawing No.	Part No.	Quantity
1	TAIL PIECE CAST 2" 800 370 D6	X-345978-03-00 R02 / X-345978-03-	2365343-03-01-01	6
2	TAIL PIECE CAST 2" 150 370 D6 RF	X-345978-F1-00 R01 / X-345978-F1-	2365343-F1-M1-01	4

VERIFIED BY   
JAN 08 2018

**Remarks** : Castings are Dimensionally acceptable , Visual inspection carried out as per MSS SP 55 & X-008060 and found acceptable  
Casting Meets the Requirements of NACE MR 0175/ISO 15156, Hardness : 22 HRC = 237 BHN  
Castings Meets the requirements of MS-021010-01 (Rev.10)-Rev.08 , Fully killed steel  
Radioactivity level measured on the above casting by using GAMMA SCOUT and found acceptable limit

We hereby certify that the items mentioned above was manufactured , sampled, tested, inspected and found to be in accordance with Customer's drawing, specification, purchase order and satisfy the requirements of **ASTM A 216 Gr :- WCC - 2016 & MS-021010-01(Rev.10) -Rev.08**

ISO 9001-2015,PED,WO Certified Company.

For RRK ALLOYS



Prepared By  
P.SIVAKUMAR  
Lab Incharge



Approved By  
MANI.NAVARASAN  
Dy.Manager-QA

11048-100-2

APR 19 2018

104 635618



# RRK ALLOYS

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## INSPECTION CERTIFICATE "EN 10204:-"Type 3.1"

**Customer** : CAMERON INTL CORP..  
**T.C. No.** : 2647/17-18  
**T.C. Date** : 21/12/2017  
**P. Order No.** : 4511630396 Dt. 08/09/2017, 4511630858 Dt. 08/09/2017  
**Heat No.** : 20581  
**Specification** : ASTM A 216 Gr :- WCC - 2016 & MS-021010-01(Rev.10) -Rev.08  
**Pouring Date** : 02/11/2017  
**Casting Processed By** : INDUCTION MELTING  
**Foundry Identification** : RRK

### CHEMICAL COMPOSITION %

Element	C	Si	Mn	S	P	Cr	Ni	Mo	Cu	V	TRE	CE	Al
Req. Min	—	—	—	—	—	—	—	—	—	—	—	—	—
Max	0.230	0.600	1.200	0.035	0.035	0.500	0.500	0.200	0.300	0.030	1.000	0.430	0.060
Actual	0.189	0.456	0.923	0.007	0.013	0.130	0.040	0.008	0.028	0.011	0.217	0.377	0.036

Total Residual Elements = Cr+Ni+Mo+V+Cu

CE = C+Mn / 6+(Cr+Mo+V)/5+(Ni+Cu) / 15

### HEAT TREATMENT

Type of Heat Treatment	Temperature	Soaking Time	Cooling Medium
Normalizing	920°C	3 Hrs	Air

### MECHANICAL PROPERTIES

Properties	Yield Strength	Tensile Strength	% Elongation		% of Reduction Area	Hardness BHN	Bend Test	Impact Test in (Joules)			
	MPa	MPa	GL=4D	GL=5D				(10mm X 10mm X 55mm)			
	0.2% Rp							CVN 2mm 45 °			
Req. Min	275	485	22.00	—	35.00	143	—	1	2	3	Avg
Max	—	655	—	—	—	237	—	—	—	—	—
Actual	312	532	34.36	—	60.28	175	—	—	—	—	—

### ITEM DESCRIPTION

SL.No.	Description	Drawing No.	Part No.	Quantity
1	TAIL PIECE CAST 2"600 370 D6	X-345978-03-00 R02 / X-345978-03-	2365343-03-01-01	6
2	TAIL PIECE CAST 2" 150 370 D6 RF	X-345978-F1-00 R01 / X-345978-F1-	2365343-F1-M1-01	4

VERIFIED BY *PA*  
JAN 08 2018

**Remarks** : Castings are Dimensionally acceptable , Visual inspection carried out as per MSS SP 55 & X-008060 and found acceptable  
Casting Meets the Requirements of NACE MR 0175/ISO 15156, Hardness : 22 HRC = 237 BHN  
Castings Meets the requirements of MS-021010-01 (Rev.10)-Rev.08 , Fully killed steel  
Radioactivity level measured on the above casting by using GAMMA SCOUT and found acceptable limit

We hereby certify that the items mentioned above was manufactured , sampled, tested, inspected and found to be in accordance with Customer's drawing, specification, purchase order and satisfy the requirements of ASTM A 216 Gr :- WCC - 2016 & MS-021010-01(Rev.10) -Rev.08

ISO 9001-2015,PED,WO Certified Company.

For RRK ALLOYS

*Sivakumar P*

Prepared By  
P.SIVAKUMAR  
Lab Incharge

*Mani Navarasan*

Approved By  
MANI.NAVARASAN  
Dy.Manager-QA

10th  
635618

11048-100-2

APR 19 2018

# Magtech

**EMERSON**  
Process Management

3902 Magnolia Road  
Pearland, Texas 77584 USA  
(Phone) 281-488-0788  
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(E-mail) [magtech@isemagtech.com](mailto:magtech@isemagtech.com)  
(Web) [www.isemagtech.com](http://www.isemagtech.com)

## LTM Specification / Configuration Sheet

**Customer:** Rosemount / GasTech Engineering **Sales Order:** 572235-A  
**Customer PO:** 4254314385 **Date Completed:** 5/21/18  
**Tag:** \_\_\_\_\_

**Model No.** LTM-350-G LTM350zzTR1E02400C1E8Z  
**Serial No.** 57223500301 **Threshold (V):** 1.5 V  
**L Dimension:** 24" **Total Dimension:** 33"

### Transmitter Mounting:

☒ **Gage Mount:** Gage S/N: 57223500201  
**Transmitter Dimensions:** A=5" B=4" L=24"

☐ **Stand-alone:** **Process Connection:** \_\_\_\_\_  
**Float(s):** \_\_\_\_\_

**Transmitter Dimensions:** A= B= C= L= D=

### Operating Conditions:

**Temperature:** 200 F  
**Pressure:** 860 psi

### Output Condition:

☒ **Single Output** **SG:** 0.58  
☐ **Dual Output (level / interface):** **Upper SG:** \_\_\_\_\_ **Lower SG:** \_\_\_\_\_  
☐ **Dual Output (level / temperature):** **SG:** \_\_\_\_\_ **Temp. Range:** \_\_\_\_\_  
☐ **All Outputs (level/interface/temp):** **Upper SG:** \_\_\_\_\_ **Lower SG:** \_\_\_\_\_  
**Temp. Range:** \_\_\_\_\_

### ORIENTATION Top Mount Right with elbow

#### Protocol Information:

☒ **HART ID=** 6889  
☐ **FF ID=** \_\_\_\_\_  
☐ **Other:** \_\_\_\_\_ **ID=** \_\_\_\_\_

#### Approvals:

☒ **cCSAus (Exp: CL I, Grp. B, C, D-CL II, Grp. E, F, G-CL III)**  
☐ **ATEX / IECEx (Ex d IIC T5 Gb)**  
☐ **FM (Exp: CL I, Grp. B, C, D-CL II, Grp. E, F, G-CL III)**

#### Notes: Deadzone=4"

**SW Rev.:** 1.03.06 **HW Rev.:** 2.00.01

**Energy:** 20%  
**DC Offset:** 2.5 V  
**Hold Time:** 12 uS

#### Calibration Points (Model 250/350 only):

**Upper:** 286  
**Lower:** 1151  
**Gain:** -36.042

Record No. R009, Rev. 06

**R. LEE**

MAY 31 2018

PO# 635757

11048-100-3,4

Pot# 635603

11048-100-5

APR 24 2018



Emerson Automation Solutions Final Control US LP  
3950 Greenbriar Drive, Stafford, Texas 77477

ASME Manufacturer's Certificate of Conformance for Pressure Relief Valves  
Form UV-1 (Section VIII)

1. Table of Certificate mark stamped items:

ID (Serial No)	Year Built	NB Cert #	QTY	Type	Size (NPS)	Set Pressure PSIG	Capacity	Test Fluid	Date Code	CI Name	CI Signature
1101-1804-132399	2018	15208	1	JOS-E	2.0 X 3.0	860.000	13,511.00 SCFM	GAS	See I.D. #	Richard Aleman	

Set Pressure:		Capacity:	
Customer Specified Unit of Measure: Metric units		Customer Specified Unit of Measure: Metric units	

3. Remarks: Sales Order & Item: 290189-010

CERTIFICATE OF SHOP COMPLIANCE

By the signature of the Certified Individual (CI) noted above, we certify that the statements made in this report are correct and that all details for design, material, construction and workmanship of the pressure relief devices conform with the requirements of Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code.

UV Certificate of Authorization    No. 3793    Expires: December 31, 2019

Date: 4-18-18    Signed: (Responsible Representative)

# Material Test Certificate (EN 10204 3.1)

材质检验证书

Certificate No.: H1703109

证书号

Supplier:

HST (WUHAN HAISINGTECH INTERNATIONAL CO.,LTD.

Shipment No:

供应商:

批号:

Purchaser: Pentair Valves & Controls US

Order No.: 4500256266-00190

LP STAFFORD Plant  
3950 Greenbriar  
Stafford, TX 77477 US

采购商:

订单号码:

Product:

136980C5 -10062959

Material: ASME SA479-316/316L/02.1530-09

产品名称:

材料:

Item 序号	Heat No. 炉号	Qty. 数量	Size 尺寸	Weight 重量	Melting Furnace 熔炉	Condition of Delivery 交货状态
	JY1609-314	72	Φ35mm		Furnace	CFA

## Chemical Composition / 化学成份

Item 序号	Heat No. 炉号	C %	Mn %	Si %	S %	P %	Cr %	Mo %	Ni %	N %	Inspected By: HAITRINH MAY 15 2017 Hai Trinh
	Heat analysis Overcheck Analysis in house JY1609-314	0.02 MAX 0.03	1.36 MAX 1.35	0.48 MAX 0.49	0.023 MAX 0.020	0.043 MAX 0.038	16.7 MAX 16.13	2.08 MAX 2.21	10.2 MAX 10.48	0.07 MAX 0.08	

## Mechanical Properties / 机械性能

Item 序号	Heat No. 炉号	Tensile Strength (N/mm²) 抗拉强度 MIN 207	Elongation % (L0=5D0) 延伸率 MIN 30	Reduction of Area % 断面收缩 MIN 40	Hardness (HB or HRC) 硬度(HB) MAX 237
	Heat analysis Overcheck Analysis in house JY1609-314	650	53	74	176 MAX 185

We hereby certify that the material described above has been tested and complies with the terms of the order contract.

兹证明, 上述材料经已试验并符合合同所载要求。

Date / 日期

Name / 姓名

Signature / 签名

Supplier  
供应商

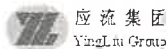
WUHAN HAISINGTECH  
INTERNATIONAL CO.,LTD

Factory Inspector  
工厂检验员

黄春英

11048-100-5

RC  
APR 24 2019



# ANHUI YINGLIU ELECTROMECHANICAL CO.,LTD

## CHEMICAL ANALYSIS AND MECHANICAL TEST TYPE 3.1 CERTIFICATE

ADD-N.26 QTYUN ROAD PRIVATE SCIENTIFIC TECHNICAL ECONOMIC PARK HEFEI ECONOMIC TECHNICAL DEVELOPMENT ZONE-ANHUI CHINA

TEL:0086-564-5036508 FAX:0086-564-5036500

### Inspection Certificate

CUSTOMER:STAFFORD

MATERIAL SPECIFICATION:ASME SA216 WCB/WCC/ASME SA352 LCB/LCC-2015

Heat Treatment:Q:940℃× 2.5h+ T:700℃×3.0h

Certificate-No.:2017-09-268

Drawing-No.:14882

Order-No.:4500290952 210

### A) Chemical analysis

### B) Mechanical Property

Heat No.	Test Temp	Part No.	Qty.	C %	Mn %	Si %	P %	S %	Cr %	Mo %	Ni %	Cu %	V %	CE	Cr+Mo+Ni+Cu+V %	Yield Strength	Tensile Strength	Elongation	Reduction	Hardness	Energy Charpy Impact (-50℃)		
	℃			≤	≤	≤	≤	≤	≤	≤	≤	≤	≤	≤	≤	N/mm2 (MPa)	N/mm2 (MPa)	%	%	HB			
				0.25	1.00*	0.60	0.035	0.035	0.50	0.20	0.50	0.30	0.03	0.43	1.00	≥275	485-620	≥24	≥35	≤237	≥27(J)		
H4486	RT	11122299	2	0.19	1.23	0.43	0.019	0.008	0.050	0.010	0.052	0.020	0.008	0.41	0.140	375	522	33	68	159	41	35	28
H4671	RT	11122299	20	0.19	1.15	0.45	0.018	0.009	0.055	0.013	0.132	0.016	0.003	0.40	0.219	408	538	36	64	156	50	48	52

REMARK:1.WCB/WCC:\*As per A216/A216M page 2 TABLE 1, For each reduction of 0.01 % below the specified maximum carbon content, an increase of 0.04 % Mn above the specified maximum will be permitted up to a maximum of 1.28 %.

2.LCB/LCC:\* As per A 352/A 352M page 3 TABLE 1, For each reduction of 0.01% below the specified maximum carbon content, an increase of 0.04% manganese above the specified maximum will be permitted up to a maximum of 1.10% for LCA, 1.28% for LCB, and 1.40% for LCC.

3.NACE MR0103-2012 & MR0175/ISO 15156 2nd Edition 2009-10-15

### C) Dimensional check and NDT

Testing	Details	Result
Visual inspection	MSS-SP-55	OK
Dimension inspection	DWG	OK

### D) Delivery Condition: QT

We confirm that inspection, visual, and nondestructive tests specified in the purchase order have been done and are in conformity with requirements and that the material was manufactured, sampled, tested, and inspected in accordance with the material specification(ASME SA216 WCB/WCC/ASME SA352 LCB/LCC), and was found to meet the requirements. We confirm that the report is also in accordance with EN 10204 type 3.1 certificate.

Place: *Wang*

Date:September 15,2017

Work inspector: *Yang feng qin*

RC  
APR 24 2018

11048-100-5

104635603



Emerson Automation Solutions Final Control US LP  
3950 Greenbriar Drive  
Stafford, TX 77477  
Tele: 281-274-4400  
Fax: 281-241-1800

## Quality Assurance Documentation Package

Customer: VINSON PROCESS CONTROLS COMPANY LP Customer P/O #: 8000201003  
Sales Order #: 290189 Item #: 10 Production Order #: 11040129

### Titles of QA Documents Included in this Data Package

#### Functional Test Report(s)

Item 1 Functional Test Report



Item 2 Hydrostatic Test Report



#### Valve Certification

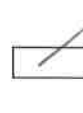
Item 3 ASME C of C of PRV - Form UV



Item 4 Certificate of Conformance

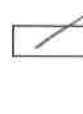


Item 5 Certificate of Origin



#### Material Test Report(s)

Item 6 Certified Material Test Reports (CMTRs) BS EN 10204 - Standard



Body, Bonnet, Nozzle, Disc

QA Data Specialist: \_\_\_\_\_

Date: \_\_\_\_\_

11048-100-5

RL  
APR 24 2018

PO# 635603





# ANHUI YINGLIU ELECTROMECHANICAL CO.,LTD

## CHEMICAL ANALYSIS AND MECHANICAL TEST TYPE 3.1 CERTIFICATE

ADD-N.26 QTYUN ROAD PRIVATE SCIENTIFIC TECHNICAL ECONOMIC PARK HEFEI ECONOMIC TECHNICAL DEVELOPMENT ZONE-ANHUI CHINA

TEL:0086-564-5036508 FAX:0086-564-5036500

### Inspection Certificate

CUSTOMER:STAFFORD

MATERIAL SPECIFICATION:ASME SA216 WCB/WCC/ASME SA352 LCB/LCC-2015

Heat Treatment:Q:940℃×2.5h+ T:700℃×3.0h

Certificate-No.:2018-02-059

Drawing-No.:14691-1

Order-No.:4500317693 180

### A) Chemical analysis

Heat No.	Test Temp	Part No.	Qty.	C %	Mn %	Si %	P %	S %	Cr %	Mo %	Ni %	Cu %	V %	CE	Cr+Mo+Ni+Cu+V %	Yield Strength	Tensile Strength	Elongation	Reduction	Hardness	Energy Charpy Impact (-50℃)		
	℃			≤	≤	≤	≤	≤	≤	≤	≤	≤	≤	≤	≤	N/mm2 (MPa)	N/mm2 (MPa)	%	%	HB			
				0.25	1.00*	0.60	0.035	0.035	0.50	0.20	0.50	0.30	0.03	0.43	1.00	≥275	485-620	≥24	≥35	≤237	≥27(J)		
H5858	RT	11122288	5	0.20	1.14	0.49	0.019	0.009	0.043	0.003	0.016	0.030	0.006	0.40	0.098	375	538	34	66	156	65	30	48
H5868	RT	11122288	3	0.18	1.10	0.40	0.023	0.010	0.056	0.002	0.019	0.020	0.004	0.37	0.101	391	530	33	61	152	77	61	62
H5971	RT	11122288	1	0.18	1.20	0.46	0.024	0.017	0.045	0.003	0.031	0.024	0.005	0.39	0.108	417	538	30	64	159	46	42	42
5004P	RT	11122288	1	0.20	1.22	0.38	0.019	0.012	0.062	0.001	0.158	0.031	0.001	0.43	0.253	385	546	33	69	152	46	48	35

REMARK:1.WCB/WCC:\* As per A216/A216M page 2 TABLE 1, For each reduction of 0.01 % below the specified maximum carbon content, an increase of 0.04 % Mn above the specified maximum will be permitted up to a maximum of 1.28 %.

2.LCB/LCC:\* As per A 352/A 352M page 3 TABLE 1, For each reduction of 0.01% below the specified maximum carbon content, an increase of 0.04% manganese above the specified maximum will be permitted up to a maximum of 1.10% for LCA, 1.28% for LCB, and 1.40% for LCC.

3.NACE MR0103-2012 & MR0175/ISO 15156 2nd Edition 2009-10-15

### C) Dimensional check and NDT

Testing	Details	Result
Visual inspection	MSS-SP-55	OK
Dimension inspection	DWG	OK

### D) Delivery Condition: QT

We confirm that inspection, visual, and nondestructive tests specified in the purchase order have been done and are in conformity with requirements and that the material was manufactured, sampled, tested, and inspected in accordance with the material specification(ASME SA216 WCB/WCC/ASME SA352 LCB/LCC), and was found to meet the requirements. We confirm that the report is also in accordance with EN 10204 type 3.1 certificate.

Place: *Wang*

Date:February 6,2018

Work inspector: *Yang fangbin*

APR 24 2018

1048-100-5

635603



## Material Test Certificate (EN 10204 3.1)

25591

材质检验证书

Certificate No.: SD16102908-W9087

证书号

Shipment No:

Order /Item No: 4500218218/20

批号:

订单号码:

Supplier: Zhejiang Shidai Casting Co., Ltd

Purchaser: Pentair Valves &amp; Controls Qingpu Plant

Jinqiao Industry Zone, Taoshan Town,

No.777,778, Jiuye Road Qingpu

Rui'an City, Zhejiang Province, China

Industrial Park Shanghai 201700

Tel: +86 0577-65465891 Fax: +86 0577-65460087

Tel: 86-21-3920 2552 Fax: 86-21-6922 5625

供应商:

采购商:

Product: NOZZLE\_2"H-ORIF.JOS/JBS-45.46.5().6() RF

Material Specification: ASTM A351-15

产品名称: 10051890

材料标准:

ASME SA351

Item 序号	Heat No. 炉号	Qty. 数量	Pattern No. 模具号	Material 材料	Melting Furnace 熔炉	Condition of Delivery 交货状态
1	SD279A	3	E-106207	CF8M	Medium Induction Furnace	Heat Treatment: Solution annealing: temperature at 1055 °C±10°C, and then water quench.

## Chemical Composition / 化学成份 (Test Temperature=20±5 °C)

Item 序号	Heat No. 炉号	C% Max	Si% Max	Mn % Max	P% Max	S% Max	Cr% 18.0	Ni% 9.0	Mo% 2.0	-	-	-	-
1	SD279A	0.08	1.50	1.50	0.04	0.04	21.0	12.0	3.0				
		0.054	0.66	0.05	0.030	0.006	18.5	9.2	2.3				

## Mechanical Properties / 机械性能 (Test Temperature=20±5 °C)

Item 序号	Heat No. 炉号	Yield Strength 0.2% offset method 屈服强度 Min 205 Mpa	Tensile Strength 抗拉强度 Min 485 Mpa	Elongation % (L0=5D0) 延伸率 Min 30	Reduction of Area % 断面收缩率 Min	Impact Test ISO V °C Min J	Hardness (HB) 硬度
1	SD279A	250	525	51	-	-	140

Visual Inspection: Accepted according to MSS SP-55. 外观检验满足MSS SP-55

Acceptable to NACE MR0175-2003. 材料同时满足NACE MR0175-2003

Other information: No major weld repairs were carried out 其他: 该批铸件无重大缺陷补焊

We hereby certify that the material described above has been tested and complies with the terms of the order contract.

兹证明, 上述材料经已试验并符合合同所载要求

Date / 日期

2016-10-29

Name / 姓名

Signature / 签名



Factory Inspector

工厂检验员

林建造

Inspected By

Hongmei Yang

At 10.08 am, Nov 16, 2016

11048-100-5

RC  
APR 24 2018

PG# 635603

## CERTIFICATE OF ORIGIN

<b>1. SELLER:</b> Emerson Automation Solutions Final Control US LP 3950 Greenbriar Stafford, Tx 77477	<b>2. DATE</b> April 18, 2018 <b>4. SO NUMBER</b> 290189	<b>3. CARRIER or BILL OF LADING NO.</b>  <b>5. CUSTOMER PO NUMBER</b> 8000201003
<b>6. SOLD TO</b> VINSON PROCESS CONTROLS COMPANY LP 2747 HIGHPOINT OAKS DR LEWISVILLE, TX 75067-8190, USA	<b>7. SHIP TO (if different than Sold To)</b>  GASTECH ENGINEERING CORP 2110 N. INDUSTRIAL ROAD SAPULPA, OK 74066, USA	
<b>PRODUCER OF GOODS</b>  <i>Available Upon Request</i>		

[illegible]

**Diversion Statement:**

Exports – These commodities, technology or software were exported from the United States in accordance with the Export Administration Regulations. Diversion contrary to U.S. law is prohibited.


Domestic Destinations - The purchaser of items shipping to USA destinations is solely responsible for complying with applicable U.S. export laws and regulations

I certify that:

The information on this document is true and accurate to the best of my knowledge and I assume the responsibility for proving such representations. I understand that I am liable for any false statements or material omissions made on or in connection with this document:

I agree to maintain, and present upon request, documentation necessary to support this certificate, and to inform, in writing, all persons to whom the certificate was given of any changes that could affect the accuracy or validity of this certificate:

This certificate consists of  page(s), including all attachments.

15. Authorized Signature: 		16. Company: <b>Emerson Automation Solutions Final Control US LP</b>	
Print Name: <b>Recia Cooper</b>		Date: <b>April 18, 2018</b>	
Title: <b>QA Data Specialist</b>			
Tel: <b>281-274-4486</b> Fax: <b>281-274-4664</b>			

4/18/2018		VINSON PROCESS CONTROLS COMPANY LP					
Sales Order:		290189-10					
		Body	Bonnet	Nozzle	Disc	Bellow	Spring
SERIAL NUMBERS	1101-1804-132399	H5971	H4671	SD279A	JY1609-314		

QA COMPLETED

APR 18 2018

RC  
APR 24 2018

11048-100-5

P# 635603



## Emerson Automation Solutions Final Control US LP

3950 Greenbriar Drive, Stafford, TX 77477

### Hydrostatic Test Report

Location Performing Test: STAFFORD TEXAS

Purchase Order No.: 8000201003

Sales Order No.: 290189

Sales Order line: 10

Serial Number: 1101-1804-132399

Production Order No.: 11040129

Part Description: 2H3JOS-E45J

Tag No.: PSV-1414

Test Procedure: ☒ X\_05.9045.092 ☐ Other

Hold Time: 1 MIN

Primary Pressure Zone	
Test Pressure with UOM:	4125
Test Gauge:	D10M-01
Test Result:	PASS

Secondary Pressure Zone	
Test Pressure with UOM:	450
Test Gauge:	D10M-01
Test Result:	PASS

COMPONENTS	
Test Pressure with UOM:	
Test Gauge:	
Test Result:	

Hydro Stamp Verified By: WYCLIFF O.

Verified Date: 4/18/2018

Third Party Witness:

Witness Date:



## Emerson Automation Solutions Final Control US LP

3950 Greenbriar Drive, Stafford, TX 77477

April 18, 2018

Sold To: VINSON PROCESS CONTROLS COMPANY LP

PO #: 8000201003

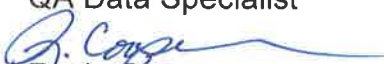
SO #: 290189 - 10

Serial #: 1101-1804-132399

### Certificate of Conformance

I hereby certify that the valve(s) furnished on the above referenced purchase order were manufactured to Quality Control Standards, and meet the requirements of the purchase order for which they are supplied.

QA Data Specialist

  
Recia Cooper



Emerson Automation Solutions Final Control US LP  
3950 Greenbriar Drive, Stafford, TX 77477

# FUNCTIONAL TEST REPORT

SALES ORDER NO: 290189  
LINE ITEM: 10

PRODUCT NUMBER: 2H3JOS-E45J  
PRODUCTION ORDER NO: 11040129

DATE: 4/18/2018

CUSTOMER: VINSON PROCESS CONTROLS COMPANY LP  
PO NUMBER: 8000201003

GAUGE NO: **SA 144008**  
TEST PROCEDURE T-16170

pc  
APR 24 2018

SERIAL NO	TAG	PRIMARY PRESSURE PARTS TEST <sup>1</sup>	ASSY TECH <sup>+</sup>	BELLOWS OR O- RING TEST	SHELL PNEUMATIC TEST PRESSURE (PSIG)	NAMEPLATE		NOZZLE RING SETTING <sup>2</sup> (NOTCHES), FIXED	LEAK TEST PRESSURE (PSIG)	LEAKAGE RATE <sup>3</sup> (BUBBLES PER MINUTE)	FINAL TECH
						SET PSIG				WAIT TIME OF 2 Minutes	
						860					
						CDTP PSIG					
						N/A			774.00		
1101-1804-132399	PSV-1414	ASME	JL	N/A	90	861	PSIG	-5	774.00	10	TH

## TRACEABILITY REQUIREMENTS - HEAT/CODE NUMBERS FOR TRACEABLE COMPONENTS

SERIAL NO	Body	Bonnet	Nozzle	Disc	Bellow	Spring	Body RT	Body MT	Body PT	Nozzle PT	Nozzle MT
1101-1804-132399	H5971	H4671	SD279A	JY1609-314							

ALL PRESSURE IS PSIG UNLESS OTHERWISE SPECIFIED.

<sup>\*</sup> TECHNICIAN PERFORMING THESE OPERATIONS WILL INITIAL TO INDICATE COMPLETION.

<sup>1</sup> HYDROSTATIC TEST CONDUCTED PER "ASME", "CUST" OR "N/A". SEE FORM 404 IF APPLICABLE.

<sup>2</sup> ENTER FINAL RING SETTING (TURNS/NOTCHES) FOR EMPIRICAL SETTINGS.

<sup>3</sup> BUBBLES PER MINUTE (AIR), CUBIC CENTIMETERS PER MINUTE (LIQUID), ACCEPTABLE "0" STEAM

UNITS OF MEASURE			TEST MEDIUM		
UNITS	PRES.	VAC.	AIR	STEAM	Water
PSIG	<b>X</b>		<b>X</b>		
WC					

Inspected By:  
RICHARD ALEMAN

APR 18 2018

*Richard Aleman*

PO# 635603

11048-100-5

**NUCOR**  
PLATE MILL

P.O.Box 279  
Winton, NC 27986  
(252) 356-3700

# Mill Test Report

Page 1

1505 River Rd  
Coffield, NC 27922  
(252) 356-3700

**NUCOR**  
It's Our Nature

R. LEE

JUN 06 2018

Issuing Date : 04/13/2018 B/L No. : 499802 Load No. : 509835 Our Order No. : 155358/1 Cust. Order No. : 107146  
Vehicle No: ALY 91755 Sold To: PORT CITY METALS SERVICES INC A Ship To: PORT CITY METAL SERVICES, INC.  
Specification: 1.0000" x 96.000" x 480.000" DIVISION OF METALS USA JUNCTION 12  
ASTM A36-14/ASTM A709 Grade 36-17ASME SA36 2015/2017 SI .15-.25 TULSA,OK 74127 (2) HALE,OK 74127

Marking :

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	Ceq	Pcm
8502289	0.18	0.83	0.009	0.002	0.19	0.17	0.06	0.07	0.01	0.032	0.003	0.001	0.001		0.0028	0.0001	0.009	0.34	0.24

Plate Serial No	Pieces	Tons	Tensile Test			
			Dir.	(psi) Yield	(psi) Tensile	Elong. % in 2" / 8"
8502289-01	4	26.13	T	41,800	69,100	27.2
			T	42,100	68,200	26.2

GASTECH HT#8502289  
PO#636171  
SO#354449 ITEM#1 1PCS  
4 1PCS

HT# 8502289

11048-361-3  
11048-360-3

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification. For Mexico shipments: nhc-SalesMX@Nucor.com  
Yield by 0.5EUL method unless otherwise specified. Ceq = C+(Mn/6)+((Cr+Mo+V)/5)+((Cu+Ni)/15)  
Pcm = C+(Si/30)+(Mn/20)+(Cu/20)+(Ni/60)+(Cr/20)+(Mo/15)+(V/10)+5B  
Melted and Manufactured in the USA. ISO 9001:2008 certified (#010940) by SRI Quality System Registrar (#0985-09). PED 97/23/EC 7/2 Annex 1, Para. 4.3 Compliant.  
DIN 50049 3.1.B/E 10204 3.1B(2004), DIN EN 10204 3.1(2005) compliant. For ABS grades only. Quality Assurance certificate 14-MMPQA-723

We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

*T. A. Depretis*  
T. A. Depretis, Metallurgist

4/13/2018 2:28:29 PM

Q.A. APPROVED  
By *[Signature]* Date 4/13/2018

PO# 636171





SPS Coil Processing Tulsa  
5275 Bird Creek Ave.  
Port of Catoosa, OK 74015

# METALLURGICAL TEST REPORT

PAGE 1 of 1  
DATE 02/20/2018  
TIME 09:33:12  
USER GIANGRER

PO#107165

R. LEE

JUN 06 2018

SOLD TO  
17962  
Metals USA - Port City  
3101 Charles Page Blvd. #102  
#102  
TULSA OK 74127-8327

SHIP TO

GASTECH ENGINEERING HT# A718771  
PO# 636171  
SO# 354449 ITM# 2, 3, 5, 6  
TULSA OK 74127-8327

Order	Material No.	Description	Quantity	Weight	Customer Part	Customer PO	Ship Date
2220093-0010	701672XXTM	1/2 X 72 X 158 A36 TM STP MIL PLT	31.000	50,009.200		107165	02/20/2018

Heat No. A71E771 Vendor STEEL DYNAMICS COLUMBUS

Chemical Analysis  
DOMESTIC Mill STEEL DYNAMICS COLUMBUS

Melted and Manufactured in the USA  
Produced from Coil  
Country of Origin: USA

Carbon	Manganese	Phosphorus	Sulphur	Silicon	Nickel	Chromium	Molybdenum	Boron	Copper	Aluminum	Titanium	Vanadium	Columbium	Nitrogen	Tin
0.0600	0.8200	0.0120	0.0040	0.0200	0.0400	0.1000	0.0100	0.0000	0.0900	0.0220	0.0020	0.0030	0.0150	0.0078	0.0040

Mill Coil No. 17B833414

Mechanical / Physical Properties

Tensile	Yield	Elong	Rckwl	Grain	Charpy	Charpy Dr	Charpy Sz	Temperature	Olsen
69700.000	56700.000	37.40			0	NA			
70800.000	58700.000	35.80			0	NA			
68700.000	55100.000	39.60			0	NA			
69300.000	57300.000	36.90			0	NA			

Batch 0005163008 12 EA 19,358.400 LB

Batch 0005163024 12 EA 19,358.400 LB

Batch 0005163056 7 EA 11,292.400 LB

Q.A. APPROVED

By PI Date 3/5/18

THE CHEMICAL, PHYSICAL, OR MECHANICAL TESTS REPORTED ABOVE ACCURATELY REFLECT INFORMATION AS CONTAINED IN THE RECORDS OF THE CORPORATION.  
The material is in compliance with EN 10204 Section 4.1 Inspection Certificate Type 3.1

HT# A718771

11048 361-415  
11048-360-415

PO# 636171





1945 Airport Road  
Columbus, MS 39701  
Phone: 662-245-4200  
Fax: 662-245-4297

# Metallurgical Certification

R. LEE

JUN 06 2018

Order Number: 371196

Order Dimensions: 0.4900X72.0000 (in) (MIN)

Ordered Product: A36 MODIFIED "CONVERSION TO"  
PRIME HOT ROLLED BAND - PRIME

Part Number: 701672999M3-A

Alt Part#:

Sold To: STEEL AND PIPE SUPPLY CO INC  
MANHATTAN, KS

Ship To: STEEL & PIPE SUPPLY COIL DI  
TULSA PORT AUTHORITY, OK 74

Customer PO #: 4500299849-10

Load #: S788158

Ship Date: 01/07/2018

Chemical Analysis:

Coil Number:	Heat:	C	Mn	P	S	Si	Cu	Sn	Ni	Cr	Mo	Al	N	V	Nb	Ti	B	Ca	C(eq)
17B838417	A718771	.06	.82	.012	.004	.02	.05	.0040	.04	.10	.010	.022	.0078	.003	.015	.002	<.0001	.0026	.232

Mechanical Properties:

	English	Metric
Yield Strength	63.1 ksi	435 MPa
Tensile Strength	69.5 ksi	479 MPa
Elongation	36 %	36 %
N-Value	Not Reported	
Hardness - HRBW	Not Reported	
Direction	Transverse	
Linear Footage	428 ft	130 m
Actual Gauge	.4943 in	12.56 mm

Modified wt % Mn 0.80-1.20; Conversion to - meets chemistry requirements additional testing required

We hereby certify the above is correct as contained in the records of the company.  
All tests performed according to ASTM standard E8, A370, E18, E415, E1019,  
E646, E517 and E23 (yield strength determined using 0.2% offset method) or JIS  
Z2241 or DIN EN10325. All heats are Al-killed and Ca treated.

THIS PRODUCT WAS MELTED AND MANUFACTURED IN THE USA

Certified by:

*Keegan D Wright*

Certificate Date: 01/07/2018

Keegan Wright  
Hot Mill Metallurgical Engineer

Q.A. APPROVED

By *[Signature]* Date 3/5/18

HTA A718771

11048-361-4.5  
11048-360-4.5

PO#636171

POF: 18-1428-DS Pack#: 546228 Order#: 1117648 Lot#: ULM B07V4 Desc: 2 600 RF BLIND FLG AISA 105 NORM ULM

CLIENTE / Customer / Client

# CERTIFICADO DE INSPECCION Inspection Certificate - Certificat de Réception

DIN EN 10204 / 3.1  
 ISO 10474 / 3.1

FECHA: 04/11/2015  
 Date:

N.º

176130

HOJA: 1  
 Page:



Management Systems certified by LRQA

Bº Zubillaga, 3 - Apdo. 14  
 20560 ORATÍ (Gipuzkoa) SPAIN  
 Tel.: 34 - 943 760552  
 Fax: 34 - 943 761608  
 E-mail: ulma@ulmapiping.com

Packing List: 120719

PRODUCTO  
 Article - Produit

FLANGES

SU PEDIDO N.º  
 Your Order No.  
 Votre Cds. N.º

205240-HOUSTON

DE  
 dt. - de 21/11/2014

NORMAS APLICABLES  
 Requirements - Normes Applicables

ASME B16.5-13

MATERIAL CORRESPONDIENTE

ASME SA105M-15, ASTM A105M-14

MATERIAL Correspondant - Qualité

MODO DE FUSION (\*)

Steel Making - Elaboration de l'acier  
 E = Elec. Y = Oxygeno básico

NACE MR0175/ISO 15156-02-09 & MR0103-12

Certified acc. PED 87/23/EC-AD2000-WO  
 by TÜV Rheinland  
 N.º 01 202 EQ 02 7443

MARCA DEL FABRICANTE  
 Mark of factory  
 Marque du fabricant



DEPARTAMENTO QUALITY ASSURANCE  
 Section  
 Département

PARTIDA Item Poste	CANTIDAD Quantity Quantité	DESCRIPCION Description Description	OBSERVACIONES Remarks Observations (*)	COLADA N. Heat No. N.º Cauda	RESISTENCIA T.Strength Résist. Tens. MPa	YIELD STRENGTH Y.Strength Limite Éc. MPa	ELONGATION Elongation Allongement %	RED. AREA Red. Area Réduct. Sect. %	RESILUENCIA Impact test Résistance Joules	CHART V 10x10mm AISI Temper. Measure °C	DUREZA Hardness Dureté HBW
11 F16WA160	112	WN 16 160LB STD30 RF A105N	NE	C08A5	510	304	28,30	58,10			152 155
17 F18A010	780	BLIND 1 160LB RF A105N	NE	B77A4	500	300	30,30	60,60			182 159
18 F18A040	576	BLIND 4 160LB RF A105N	NE	B83A5	510	312	30,60	63,10			189 163
50 F68WA050	24	WN 6 800LB XS/80 RF A105N	NE	C08A5	512	308	29,90	61,40			151 163
50 F68WA060	96	WN 6 800LB XS/80 RF A105N	NE	C08A5	515	306	31,20	49,30			158 160
54 F68A020	480	BLIND 2 800LB RF A105N	NE	B07V4	513	318	29,80	53,60			155 160

COLADA N. Heat No. N.º Cauda	COMPOSICION QUIMICA - STEEL MAKER'S LADLE ANALYSIS - ANALYSE CHIMIQUE														Origin of Steel
	C %	Si %	Mn %	P %	S %	Cr %	Ni %	Mo %	Nb %	V %	Cu %	Al %	Ti %	CEq %	
B07V4	0,180	0,180	1,200	0,020	0,009	0,030	0,020	0,010	0,030	0,030	0,000	0,000	0,397		Spain
B77A4	0,280	0,250	0,970	0,010	0,003	0,081	0,100	0,044	0,000	0,001	0,240	0,042	0,410		France
B83A5	0,180	0,210	1,040	0,007	0,002	0,070	0,100	0,017	0,003	0,002	0,200	0,036	0,381		France
C08A5	0,180	0,230	0,980	0,009	0,004	0,108	0,134	0,022	0,001	0,000	0,298	0,032	0,398		Spain
C08A5	0,180	0,230	0,980	0,012	0,005	0,100	0,140	0,030	0,003	0,004	0,270	0,026	0,408		Spain
C08A5	0,180	0,220	0,970	0,008	0,004	0,083	0,182	0,036	0,001	0,000	0,286	0,035	0,405		Spain

- Las dimensiones y la condición superficial se hallaron satisfactorias.  
 - Dimension and surface condition were found acceptable.  
 - Les dimensions et l'état de surface sont satisfaisants.

- Las materialidades citadas cumplen las normas aplicables.  
 - Manufacturing requirements are satisfied.  
 - Les normes applicables sont respectées.

EL INSPECTOR  
 Works Inspector - L'Inspecteur  
  
 ULMA FORJA S. COOP.  
 Dpto. de Garantía de calidad  
 Quality Assurance Dept.

(\*) OBSERVACIONES:  
 Remarks  
 Observations

N NORMALIZED AT 800 C AND ALLOWED TO COOL IN STILL AIR.

R. LEE

JUL 23 2018

H7# B07V4

11048-500-2

Demo (http://www.verypdf.com)  
 P0#636812



Capitol Manufacturing  
1125 Capitol Avenue  
Crowley, LA 70526

0160SML / 1/2 X 3" S160 SMLS NIPL F

Phoenix Capitol Camco

## CapProducts

### Certified Mill Test Report

Commanding a Higher Standard<sub>sm</sub>

Printed: 5/19/2017

Customer

LEE SUPPLY CO

PO BOX 1475

TULSA, OK 74101

Certified: 02/10/2017

P.O. 17-2522-ds

Tag

Heat No 5F4412

Heat Code 74U7

Phoenix Order # 1282105

Material ASTM A106-2014 / ASME SA106-2015 Edition

Part Number

15130506

Description

1/2 X 3" SCH 160 SMLS NIPL TBE

#### Chemical Properties

C	Mn	P	S	Si	Cu	Ni	Cr	C Eq. Long	
0.2500	0.7500	0.0090	0.0080	0.2500	0.2300	0.1400	0.1000	0.4257	
Mo	V	Co	Al	Cb	N	Pb	Sn	Ta	Ti
0.0200	0.0100		0.0000	0.0000					

#### Additional Chemical Properties

					Cr + Cu + Ni	
					0.4700	

#### Mechanical Properties

Tensile (PSI)	Yield (PSI)	Elong. % in 2 in. or 4D	R of A	HBW	HBW2
78,000	49,000	43.0%	0.0%	0	0

#### Charpy Minimum Impact - ft/lbs

Test 1	Test 2	Test 3	Average	Test Temp.
N/A	N/A	N/A	N/A	N/A

\* Eddy Current test passed.

\* Bend test passed.

We hereby certify that these parts were manufactured, sampled, tested, and inspected in accordance with the product specifications stated and were found to meet the requirements.

We further certify that this material was inspected using independent inspectors conforming to the requirements of EN 10204 3.1. These products meet the requirements of the latest editions of NACE MR0175, NACE MR0103, and ISO 15156. No weld repair has been performed on these products. This material was not exposed to mercury or any other metal alloy that is liquid at ambient temperatures during processing or while in our possession.

Meets ASME SA 106 Grade B Requirements.

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<http://www.verypdf.com>

JUL 23 2018

PO#636812

11048-500-3/SP-102

HT#74U7



Capitol Manufacturing  
1125 Capitol Avenue  
Crowley, LA 70526

CAN 122282 / 76Y6 / 503MCPLTD / 1/2" 3000# THRD COUPLER A105

Phoenix Capitol Cameo

## CapProducts

### Certified Mill Test Report

Commanding a Higher Standard<sub>sm</sub>

Printed: 5/18/2018

Customer

LEE SUPPLY CO

PO BOX 1475

TULSA, OK 74101

Certified: 04/25/2018

P.O. 18-2948-DS

Tag

Material ASTM A105-2014 / ASME SA105-2015 Edition

Heat No 188250

Heat Code 76Y6

Phoenix Order # 1370656

#### Part Number

12205605

#### Description

1/2 3M THD COUPLER

#### Chemical Properties

C	Mn	P	S	Si	Cu	Ni	Cr	C Eq. Long	
0.1900	0.9300	0.0080	0.0220	0.2300	0.1700	0.0820	0.1380	0.4030	
Mo	V	Co	Al	Cb	N	Pb	Sn	Ta	Ti
0.0320	0.0360		0.0020	0.0030					

#### Additional Chemical Properties

					Cr + Cu + Ni	
					0.3900	

#### Mechanical Properties

Tensile (PSI)	Yield (PSI)	Elong. % in 2 in. or 4D	R of A	HBW	HBW2
81,500	61,200	29.0%	63.0%	153	162

#### Charpy Minimum Impact - ft/lbs

Test 1	Test 2	Test 3	Average	Test Temp.
N/A	N/A	N/A	N/A	N/A

We hereby certify that these parts were manufactured, sampled, tested, and inspected in accordance with the product specifications stated and were found to meet the requirements.

We further certify that this material was inspected using independent inspectors conforming to the requirements of EN 10204 3.1. These products meet the requirements of the latest editions of NACE MR0175, NACE MR0103, and ISO 15156. No weld repair has been performed on these products. This material was not exposed to mercury or any other metal alloy that is liquid at ambient temperatures during processing or while in our possession.

Meets ASME SA-181-70 2017 Edition. Manufactured in the USA.

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**Awaji****INSPECTION CERTIFICATE**

EN 10204 3.1 : 2004

**AWAJI MATERIA (THAILAND) CO.,LTD.**81,MOO4, PRAKASA ROAD, TAMBOL BANGMUANG, AMPHUR MUANG  
SAMUTPRAKARN THAILAND 10270. Tel : (662)701-5226ISO 9001 :2008 Manufacturing Company  
Certified by BV. Certificate No. TH004535Material manufacturer QMS acc.  
PED 97/23/EC Annex 1, Part 3/AD2000W0  
Certified by Lloyd's Register  
Certificate No. 50207/1

Date : AUGUST 11, 2015

Certificate No. : T15-80383/1

Purchaser :

**MADE FROM SEAMLESS STEEL PIPE**

Order No.		Job No.		Product				Raw Material Pipe Maker																
913140AW/11		-		CARBON STEEL BUTT WELDING FITTINGS				TPCO (CHINA)																
Inspection Standard		Material Standard						Pipe Heat No. : 547516																
ASME B16.9-12, ASME B16.25-07 ASTM A900-14a NACE MR-0175/ISO 15156-09 MR-0103-12		ASTM A234-14, WPB ASME SA234-13, Sec. II, Part A except nuclear usage		Visual		Dimension		*4 UT Inspection		Magnetic Particle Test														
				GOOD		GOOD		W.T. INSPECTED		-														
Manufacturing No. (Heat code.)	Product Code	Material	Article & Size				Quantity		Nota.															
52M40	-	WPB	XS 90 LONG RADIUS ELBOW 3"				253 Pcs.																	
<div>Specification</div> <div>Min.</div> <div>Max.</div> <div>Heat No.</div>	*1 Chemical Composition (%)																*2 Mechanical Test			Hardness				
	C	Si	*3 Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	Ti	B	Ca	N	Al	C.E.		Y.S.	T.S.	E			
	X100	X100	X100	X1000	X1000	X100	X100	X100	X100	X100	X100	X100	X10000	X10000	X1000	X1000	X100			MPa			%	HB
	-	10	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50		240	415	30	-	
	30	-	165	50	58	40	40	40	15	8	2	-	-	-	-	-	-	50		-	-	-	197	
	L	18	25	110	11	4	5	4	10	3	0	0	4	14	8	11	40			342	514	43	146	
	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					131	

$$C.E = C + \frac{Mn}{8} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$$

\*4 UT = Ultrasonic thickness inspection

\*1 Equivalent for A234 WPB

\*2 Y.S.= Yield Strength (0.2% offset). T.S. = Tensile Strength. E = Elongation (in 50mm)

\*3 As per foot note D of ASTM A234 Table 1.

L = Ladle Analysis. P = Product Analysis

Weld repair is not applied to our products.

Steel Making by Vacuum degassed, fully silicon aluminium killed &amp; fine grain.

ELBOW / Forming temperature 850°C - 945°C and cooled in still air

TEE, REDUCER &amp; CAP / Normalizing (cold Forming) : 910°C (Holding Time : (Nominal Wall Thickness/1mm) x 1.5 min.)

\*We certify that the fitting was manufactured, sampled, tested and inspected

in accordance with the specification and was found to meet the requirements.

Surveyor to

QA OM / Work Inspector S. MAEKAWA

Maekawa@awaji.co.th

PO# 636813

11040-601-2

HT# 52M40

JUL 24 2018

LEE

AT-24(2)24



6600 South Harlem Avenue  
Argo, IL 60501-1930

# Material Test Report

LEE SUPPLY  
821 EAST INDEPENDENCE  
TULSA, OK 741065350  
PO: 16-2754-DS

**Quantity**      **Product**      **Heat Code**      **Heat Treatment Info**      **Steel Mill**

6      1½" Class 600 Welding Neck XSB RF      JYN      Heat Treat: Normalized      CMC STEEL  
A 105-10A  
Dimensional Specification: B16.5

C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Al	Ti	B	Cb	Tens.	Yield	Elong	ROA	BHN	BHN2
0.20	1.00	0.010	0.019	0.24	0.24	0.08	0.07	0.025	0.00	-	-	-	0.002	79,500	39,900	32.00	59.20	156	156

CE (IIW): 0.408

6      1" Class 600 Welding Neck XSB RF      3D404      Heat Treat: Normalized      RIVA  
A 105-10  
Dimensional Specification: B16.5

C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Al	Ti	B	Cb	Tens.	Yield	Elong	ROA	BHN	BHN2
0.20	0.98	0.012	0.003	0.22	0.10	0.04	0.06	0.010	0.00	-	0.017	-	0.002	70,000	39,900	34.00	69.90	137	125

CE (IIW): 0.387

6      1" Class 600 Blind RF      B      Heat Treat: Normalized      GERDAU COURTICE  
A 105-13  
Dimensional Specification: B16.5

C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Al	Ti	B	Cb	Tens.	Yield	Elong	ROA	BHN	BHN2
0.21	0.81	0.006	0.017	0.21	0.16	0.07	0.12	0.017	0.03	-	-	-	-	84,300	39,900	25.30	44.90	168	177

CE (IIW): 0.394

6      1½" Class 600 Threaded RF      1381      Heat Treat: Normalized      ADHUNIK  
A 105-03  
Dimensional Specification: B16.5

C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Al	Ti	B	Cb	Tens.	Yield	Elong	ROA	BHN	BHN2
0.20	0.86	0.018	0.013	0.24	0.01	0.01	0.21	0.000	0.00	-	-	-	0.001	77,594	39,900	30.71	62.00	165	

CE (IIW): 0.387

We hereby certify that the material meets the following:

- All fittings and flanges meet NACE MRO-175/ISO 15156-Latest Revision.
- All fittings and flanges meet NACE MRO-103 - Latest Revision.
- All non high-yield fittings meet the requirements of ASTM A-234 WPB (AND SA-234).
- All fittings are seamless except as noted;
- All non-high yield flanges meet the requirements of ASTM A-105 (AND SA-105)
- Starting Material Seamless Pipe for elbows, tees and reducers;
- Plate for caps and welded fittings.
- Bars, Billets or Blooms for flanges and certain caps and tees.

*Mark Torres*

Mark Torres

Quality Assurance Department

6/20/2016



Scan For Online  
Report

We hereby certify that the material meets the following:

- ISO 9001:2008 CERTIFIED MANUFACTURER
- Test Results herein are correct as contained in test records retained by the company in accordance with EN 10 204 Para 3.1 in accordance with PED 97/23/EC, 7/2
- No Weld Repair Performed. No Lead Content. No Mercury Content.
- Knowingly making false, fictitious, or fraudulent statements on a MTR may result in legal liability.
- Material has been manufactured/supplied and tested in accordance with the Weldbend Quality System Program 01/25/2015 Rev. 3

Page 17 of 18

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<http://www.verypdf.com>

**CLIENTE / Customer / Client**

FECHA: 30/01/2015 AL: 10000 HOJA: 2000



DE  
# 31/12/2011

ASME B41000-13, ASTM A105M-14

**MARCA DEL FABRICANTE**  
Mark of factory  
Marché du fabricant

DEPARTAMENTO QUALITY ASSURANCE  
 Spolice  
 Dirección deCOLADA N.º

- Las superficies y la condición superficial en interiores satisfactorias
- Discrepancias and surface condition were found acceptable.
- Las superficies et état de surface sont satisfaisantes
- Les revêtements citades conviènt les normes aplicables
- Manufacturing requirements are satisfied
- Les normes aplicables son respectées

EL INSPECTOR  
Mente Inspector - L'Espresso

**ULMA**

ULMA FORBIS, COOP.  
Dpto. de Garantía de Calidad  
Quality Assurance Dept.

17) OBSERVACIONES: H\_ NORMALIZED AT 900 C AND ALLOWED TO COOL IN STILL AIR.

CLIENTE / Customer / Client

**CERTIFICADO DE INSPECCION**  
Inspection Certificate - Certificat de Réception

DIN EN 10204 / 3.1  
ISO 10474 / 3.1

FECHA:  
Date:

09/07/2014

N.º  
No.

169984

HOJA:  
Page: 1



Management Systems certified by LRQA

Certified acc. PED 97/23/EC AD2000-WD  
by TUV Rheinland  
N.º 01 202 EQ 02 7443

MARCA DEL FABRICANTE  
Mark of factory  
Marque du fabricant



8ª Zurbilaga, 3 - Apdo. 14  
20580 ORMAI (Gipuzkoa) SPAIN  
Tel: 34 - 943 790552  
Fax: 34 - 943 791808  
E-mail: ulma@ulmapiping.com

Packing List: 110596

DEPARTAMENTO QUALITY ASSURANCE  
Section  
Département

PRODUCTO  
Article - Produit

FLANGES

SU PEDIDO N.º

Your Order No. 201672-INDIANAPOLIS

DE

cl. - de 04/04/2014

NORMAS APLICABLES  
Requirements - Normes Applicables

ASME B16.5-13

MATERIAL CORRESPONDIENTE  
Material Correspondant - Matière

ASME SA105M-13, ASTM A105M-13

MODO DE FUSION (\*)

Steel Making - Elaboration de l'acier  
E = Elec. Y = Origine ácida

NACE MR0175/ISO15156-3-03 & MR0103-12

PARTIDA Item Poste	CANTIDAD Quantity Quantité	DESCRIPCION Description Description	OBSERVACIONES Remarks Observations	COLADA N.º Heat No. N.º Coudée	RESISTENCIA T.Strength Résistance Résist	LONG. CLAVE Y.Strength Long. Clave Long. Clave	ALARGUE Elongation Allongement Elongation	RESILUENCIA Impact test Résilience Impact	CHARTY V 1000mm MEDI Average Moyenne	DUREZA Hardness Dureté HBW
7 F100WA01D	70	WN 1.1/2 150LB XOS RF A105N	NE	A23A3	510	319	29,30	60,70		152 156
7 F100WA01D	50	WN 1.1/2 150LB XOS RF A105N	NE	A83V4	517	323	29,20	50,80		148 160
15 F18WA030	19	WN 3 150LB STD40 RF A105N	NE	A52T4	513	307	30,80	50,80		150 161
15 F14WA050	322	WN 5 150LB STD40 RF A105N	NE	B05T3	512	323	28,90	53,10		148 155
40 F18A050	30	BLIND 5 150LB RF A105N	NE	A47T4	510	304	29,70	53,60		185 189
40 F18A050	204	BLIND 6 150LB RF A105N	NE	A36T4	510	307	28,50	65,50		167 161
53 F14SWA01B	30	SW 1.1/4 150LB STD40 RF A105N	NE	A36A5	513	307	31,80	64,00		151 150
53 F34WA00E	50	WN 3/4 300LB STD40 RF A105N	NE	82T2	509	310	28,90	62,30		151 155

COLADA N.º Heat No. N.º Coudée	COMPOSICION QUIMICA - STEEL MAKER'S LADLE ANALYSIS - ANALYSE CHIMIQUE														Origin of Steel	
	C %	Si %	Mn %	P %	S %	Cr %	Ni %	Mo %	Alb %	V %	Cu %	Al %	Ti %	CEq %		
A36A5	0,200	0,180	0,020	0,007	0,010	0,040	0,140	0,020	0,000	0,002	0,190	0,002	0,000	0,404		Spain
82T2	0,190	0,210	0,050	0,013	0,022	0,060	0,080	0,010	0,000	0,002	0,220	0,003	0,000	0,355		Spain
A23A3	0,200	0,250	0,060	0,008	0,003	0,221	0,099	0,048	0,000	0,002	0,204	0,030	0,000	0,418		Spain
A36T4	0,210	0,160	0,080	0,014	0,014	0,070	0,160	0,026	0,006	0,001	0,320	0,000	0,001	0,410		France
A47T4	0,200	0,280	0,090	0,017	0,012	0,100	0,170	0,025	0,005	0,001	0,370	0,000	0,001	0,411		France
A52T4	0,200	0,190	0,070	0,020	0,012	0,090	0,130	0,025	0,001	0,001	0,310	0,000	0,002	0,404		Spain
A36V4	0,195	0,200	0,083	0,015	0,008	0,115	0,094	0,018	0,000	0,002	0,198	0,015	0,000	0,405		Spain
B05T3	0,210	0,220	0,090	0,014	0,011	0,090	0,130	0,019	0,005	0,001	0,250	0,000	0,000	0,400		France

(\*) OBSERVACIONES:  
Remarks  
Observations

N NORMALIZED AT 800 C AND ALLOWED TO COOL IN STILL AIR

- Les dimensions y la condition superficielle se hallaron satisfactorias.
- Dimensions and surface condition were found satisfactory.
- Les dimensions et états de surface sont satisfaisantes.
- Les matériaux checked cumplen las normas aplicables.
- Manufacturing requirements are satisfied.
- Les normes applicables sont respectées.

EL INSPECTOR  
Wrote Inspector - L'inspecteur  
**ULMA**  
ULMA FORJA S. COOP.  
Dpto. de Garantía de calidad  
Quality Assurance Dept.





CA 122108 / 76RF / 50X3.0160SML / 1/2 X 3" S160 SMLS NIPPLE  
Capitol Manufacturing  
1125 Capitol Avenue  
Crowley, LA 70526

Phoenix Capitol Nipple  
**CapProducts**

## Certified Mill Test Report

Commanding a Higher Standard<sub>SM</sub>

Printed: 5/3/2018

**Customer**

I.EE SUPPLY CO

PO BOX 1475

TULSA, OK 74101

Certified: 02/16/2018

P.O. 18-2027-ds

**Tag**

**Material** ASTM A106-2014 / ASME SA106-2015 Edition

Heat No 3702782

Heat Code 76RF

Phoenix Order # 1360076

**Part Number**

15130506

**Description**

1/2 X 3" SCH 160 SMLS NIPL TBE

### Chemical Properties

C	Mn	P	S	Si	Cu	Ni	Cr	C Eq. Long	
0.1800	0.6400	0.0220	0.0020	0.2000	0.0050	0.0040	0.0150	0.2917	

Mo	V	Co	Al	Cb	N	Pb	Sn	Ta	Ti
0.0030	0.0040		0.0270	0.0000					

### Additional Chemical Properties

					Cr + Cu + Ni	
					0.0240	

### Mechanical Properties

Tensile (PSI)	Yield (PSI)	Elong. % in 2 in. or 4D	R of A	HBW	HBW2
70,303	56,939	38.0%	0.0%	131	0

### Charpy Minimum Impact - ft/lbs

Test 1	Test 2	Test 3	Average	Test Temp.
N/A	N/A	N/A	N/A	N/A

\* Hydro test passed. at 2500 psi.

\* Bend test passed.

We hereby certify that these parts were manufactured, sampled, tested, and inspected in accordance with the product specifications stated and were found to meet the requirements.

We further certify that this material was inspected using independent inspectors conforming to the requirements of EN 10204 3.1. These products meet the requirements of the latest editions of NACE MR0175, NACE MR0103, and ISO 15156. No weld repair has been performed on these products. This material was not exposed to mercury or any other metal alloy that is liquid at ambient temperatures during processing or while in our possession.

Meets ASME SA 106 Grade B Requirements.

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JUL 24 2018

PO#636813

11048-601-9

HT#76RF

R. LEE

ArcelorMittal South Africa Limited  
Tubular Products  
273 Genl. Hertzog Rd.  
Peacehaven Vereeniging 1939  
P O Box 48 Vereeniging 1930  
South Africa

# MATERIAL TEST CERTIFICATE SEAMLESS TUBE

Telephone +27 (0)16 450 4220  
Fax +27 (0)16 423 4906



Licensed under  
API Spec. 5L and 5CT  
5L - 0319  
5CT - 0419

ISO 9001:2008

DE-205987 CM

Test Certificate  
EN 10204:2004 TYPE 3.1

ArcelorMittal

R. LEE

JUL 24 2018

Customer: 4000023015  
Order No: 040062097415  
Certificate Reference No:  
Product: FULLY KILLED HOT FINISHED CARBON STEEL SEAMLESS TUBES  
Specification: ISO3183:2012/API 5L/2012 L245/L290/B/X42 PSL1 ASTM A53B.12 A106B/C.15 A53B.12 ASME SA53B.15 SA106B/C.15 SA53B.12  
Product Marking: ARCELORMITTAL SA ISO3183/SPEC. 5L-0319 MONOGRAM 02-17 ASTM/ASME A/SA106B/C A53B 1.900 0.281 20.000 L245/B L290/X42 PSL1 SMLS TESTED 3000  
psi CAST NO: 1609594 PROD/O NO: TR142301510 MADE IN SOUTH AFRICA NDE

Customer Order/Contract No: SUS2 155193  
Material No: 1000039844  
Cast/Heat No: 1609594

Page 1 of 1

## General Information

Quantity	Mass	Dimensions			Total Length
		Tube OD	Thickness	Length	
294	24,756,203(lb)	1.900(")	0.281(")	20,000 (ft)	5,080,000(ft)

Steel making process	Final Rolling Operation
Electric Arc	As Rolled
	Final hot rolling finished above 1580°F and cooled in still air

## Chemical Composition

R22-(V+Nb+Ti)

R24-(Nb+V)

Element(%)	C	Si	Mn	S	P	Cr	Ni	Mo	Cu	V	Al	Ti	Sn	Ce	N	B	Nb	CE	R22	R24
Minimum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Maximum	0.200	-	1.30	0.030	0.030	0.50	0.50	0.150	0.500	-	-	-	-	-	-	-	-	0.41	0.15	0.000
Heat	0.175	0.26	0.83	0.003	0.018	0.02	0.01	0.001	0.005	0.002	0.026	0.004	0.001	0.0000	0.0030	0.0000	0.0010	0.32	0.01	0.003
Product	0.1750	0.2640	0.8330	0.0030	0.0160	0.0230	0.0100	0.0010	0.0050	0.0020	0.0260	0.0040	0.0010	-	0.0030	-	0.0010	0.3200	-	-
Product (ADD)	0.1750	0.2640	0.8330	0.0030	0.0160	0.0230	0.0100	0.0010	0.0050	0.0020	0.0260	0.0040	0.0010	-	0.0030	-	0.0010	0.3200	-	-

## Mechanical Properties

Specification	UTS (Rm)		Yield (0.2%)		% EL 2 inch
Limits	MPa	psi	MPa	psi	
Minimum		70000		42000	30.0
Maximum					
(1) Actual		70778		46412	35.0
(2) Actual		71068		47717	37.0
(3) Actual					
(4) Actual					

	UTS (Rm)		Yield (0.2%)		% EL 2 inch
	MPa	psi	MPa	psi	
(5) Actual					
(6) Actual					
(7) Actual					
Orientation & type of tensile test	Longitudinal, Strip				
Width of tensile piece (inch)	0.75 inch				
Orientation of impact test piece					

OTHER TESTS	
Category	Result
Bending	Passed
Flattening	Passed
Hydrostatic	3000 psi for 5 Set
NDI: EMI	PASS - ASTM E570 - 12.5% NOTCH
NDI: UT	UT not required
HV 22 lbs	149 152 152

## Remarks:

Material in accordance with NACE MR0175:2015/ISO15156-2:2015, MR0103:2015. Dimensions to ASME B36.10M-2015.  
The material conform to the hot yield strength requirements as per ASME, Sect II, Pt D, Table Y-1, 2015. All the material conform to the visual and dimensional requirements and is made to a suitable fine grain practice.

Quality Assurance Manager: PJ Venter

Date of Release: 2017.02.16

Certified by: *[Signature]*

We hereby certify that the material was manufactured, tested and inspected to and fully comply with the requirements of referenced specifications. No changes, amendments or additions may be made to this document. Any changes which are entered shall invalidate this certificate.

HT#1609594

11040-001-12

PO#636813  
Demo (<http://www.verypdf.com>)





# CERTIFICATE OF TESTING

## IPSCO KOPPEL TUBULARS, LLC

### Chemistry

Page 1

Certificate Number:	330165-1
Monday, May 14, 2018, 10:03:00 AM	

Diameter: <b>3.500 in</b>			Gage: <b>0.300 in</b>			Grade: <b>BCX42SML</b>			Mill Order No: <b>085552-002</b>			Customer PO: <b>10P-28144</b>														
Specification: <b>ASME ASTM SA53/A53-12 GR B/ASME-SA106-15 GR B/C</b>			Customer:																							
<b>ASTM A106-15 GR B/C</b>																										
<b>API 5L PSL2 GR B/X42 FORTY-FIFTH EDITION</b>																										
Heat	Product ID	Type	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Sn	Al	V	Cb	N	Ti	B	Ca	API	Sb	Pb	As	GS		
403715		HEAT	0.21	0.62	0.008	0.007	0.30	0.23	0.13	0.09	0.03	0.010	0.016	0.004	0.001	0.0083	0.002	0.0004	0.0017	0.362	0.003	0.0001	0.0046			
	KO-085552-002 P1-5552-2	PRODUCT	0.21	0.61	0.008	0.004	0.29	0.20	0.12	0.09	0.03	0.012	0.017	0.002	0.001	0.0068	0.002	0.0001	0.0017	0.357	0.003	0.0001	0.0064			
	KO-085552-002 P2-5552-2	PRODUCT	0.22	0.61	0.009	0.004	0.29	0.20	0.12	0.09	0.03	0.012	0.017	0.002	0.001	0.0077	0.002	0.0001	0.0016	0.367	0.004	0.0001	0.0065			
403716		HEAT	0.22	0.63	0.009	0.011	0.34	0.22	0.11	0.10	0.04	0.010	0.017	0.004	0.001	0.0091	0.003	0.0004	0.0014	0.376	0.003	0.0001	0.0048			
	KO-085552-002 P1-5552-2	PRODUCT	0.22	0.63	0.010	0.006	0.30	0.20	0.11	0.10	0.04	0.012	0.017	0.002	0.001	0.0081	0.002	0.0001	0.0010	0.374	0.003	0.0001	0.0067			
	KO-085552-002 P2-5552-2	PRODUCT	0.21	0.61	0.009	0.006	0.29	0.19	0.10	0.10	0.04	0.012	0.017	0.002	0.001	0.0082	0.002	0.0001	0.0015	0.359	0.004	0.0001	0.0062			
403717		HEAT	0.22	0.61	0.010	0.010	0.35	0.22	0.16	0.24	0.04	0.009	0.024	0.004	0.001	0.0087	0.003	0.0002	0.0015	0.404	0.004	0.0006	0.0044			
	KO-085552-002 P1-5552-2	PRODUCT	0.22	0.62	0.011	0.007	0.32	0.19	0.15	0.24	0.04	0.008	0.024	0.002	0.001	0.0089	0.003	0.0001	0.0012	0.402	0.003	0.0001	0.0064			
	KO-085552-002 P2-5552-2	PRODUCT	0.21	0.62	0.012	0.007	0.32	0.19	0.15	0.24	0.04	0.007	0.027	0.002	0.001	0.0094	0.003	0.0001	0.0018	0.392	0.004	0.0001	0.0062			
403718		HEAT	0.22	0.58	0.007	0.011	0.33	0.23	0.18	0.15	0.04	0.009	0.019	0.004	0.001	0.0090	0.002	0.0003	0.0018	0.383	0.003	0.0013	0.0045			
	KO-085552-002 P1-5552-2	PRODUCT	0.22	0.58	0.009	0.007	0.31	0.21	0.17	0.15	0.04	0.009	0.021	0.002	0.001	0.0092	0.002	0.0001	0.0020	0.380	0.003	0.0001	0.0063			
	KO-085552-002 P2-5552-2	PRODUCT	0.22	0.58	0.009	0.008	0.30	0.20	0.17	0.15	0.04	0.006	0.019	0.001	0.001	0.0106	0.002	0.0001	0.0020	0.380	0.004	0.0001	0.0060			

Test Method Used: ASTM E415  
 Fine Grain Melt Practice  
 FBN - Full Body Normalized  
 Q&T - Quench & Tempered  
 Material was not exposed to mercury during processing  
 No welding or weld repair performed on this material  
 Material is free of harmful radiation  
 This certification may not be reproduced except in full

Hydrostatic Test Pressure: 3000 PSI for 5 secs  
 GS - Grain Size  
 Grain Size Test Method ASTM E112  
 API - API Carbon Equivalent  
 CEQ - Canadian Carbon Equivalent

Melted and Manufactured in the USA

We certify that the product described above has been manufactured, sampled, inspected, and tested in accordance to the referenced specification. The product has been found to be in compliance with all requirements.

Melinda Ayers  
 Quality Coordinator

Tuesday, May 15, 2018, 10:50:51 AM

form CRTR3003

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11040-601-13

PO #636813



# CERTIFICATE OF TESTING

## IPSCO KOPPEL TUBULARS, LLC

### Macro Hardness

Page 1

Certificate Number: **330165-2**  
 Monday, May 14, 2018, 10:03:00 AM

Diameter: <b>3.500 in</b>		Gage: <b>0.300 in</b>		Grade: <b>BCX42SML</b>		Mill Order No: <b>085552-002</b>		Customer PO: <b>10P-28144</b>		
Specification: <b>ASME ASTM SA53/A53-12 GR B/ASME-SA106-15 GR B/C</b> <b>ASTM A106-15 GR B/C</b> <b>API 5L PSL2 GR B/X42 FORTY-FIFTH EDITION</b>										
Heat	Product ID	Test Type	Scale	MS	Location	Q1	Q2	Q3	Q4	AVG
403715	KO-085552-002 NV	APPLY/TEST	Rockwell		MID	79.0	80.0	79.0		79.3
403716	KO-085552-002 PQ	APPLY/TEST	Rockwell		MID	77.0	77.0	79.0		77.7
403717	KO-085552-002 RL	APPLY/TEST	Rockwell		MID	81.0	81.0	81.0		81.0
403718	KO-085552-002 MW	APPLY/TEST	Rockwell		MID	80.0	81.0	81.0		80.7

MS = Micro Structure

☐ - Measurement Taken In Rc☐ - Measurement Taken In Rb

Test Method Used: ASTM E18

Fine Grain Melt Practice

Material was not exposed to mercury during processing

No welding or weld repair performed on this material

Material is free of harmful radiation

This certification may not be reproduced except in full

form CRTR3006

Melted and Manufactured in the USA

We certify that the product described above has been manufactured, sampled, inspected, and tested in accordance to the referenced specification. The product has been found to be in compliance with all requirements.

Melinda Ayers  
 Quality Coordinator

Tuesday, May 15, 2018, 10:50:53 AM

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R. LEE

JUL 24 2018

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PO# 636813



# CERTIFICATE OF TESTING

## IPSCO KOPPEL TUBULARS, LLC

### General Comments

Page 1

Certificate Number:	330165-G
Monday, May 14, 2018, 10:03:00 AM	

Diameter: <b>3.500 in</b>	Gage: <b>0.300 in</b>	Grade: <b>BCX42SML</b>	Mill Order No: <b>085552-002</b>	Customer PO: <b>10P-28144</b>
Specification: <b>ASME ASTM SA53/A53-12 GR B/ASME-SA106-15 GR B/C</b> <b>ASTM A106-15 GR B/C</b> <b>API 5L PSL2 GR B/X42 FORTY-FIFTH EDITION</b>				
<p>BEND(S) - SATISFACTORY</p> <p>EMI INSPECTION WITH OD N10 NOTCHES</p> <p>LONGITUDINAL - SATISFACTORY</p> <p>MATERIAL COMPLIES WITH EN10204 TYPE 3.1 REQUIREMENT</p> <p>TMK IPSCO IS NOT PED CERTIFIED</p> <p>MEETS 22 HRC MAX STATED IN</p> <p>ANSI/NACE MR0175/MR0103/ISO 15156-1:2015 (E) - ANNEX A/TABLE A1</p> <p>MANUFACTURING AND FINISHING MILL:</p> <p>TMK IPSCO AMBRIDGE PLANT 2225 DUSS AVE AMBRIDGE, PA 150003</p> <p>STEEL SUPPLIER:</p> <p>TMK IPSCO KOPPEL PLANT 6403 SIXTH AVE, KOPPEL PA 16136</p>				

Material was not exposed to mercury during processing  
 No welding or weld repair performed on this material  
 Material is free of harmful radiation  
 This certification may not be reproduced except in full

Melted and Manufactured in the USA

We certify that the product described above has been manufactured, sampled, inspected, and tested in accordance to the referenced specification. The product has been found to be in compliance with all requirements.

Melinda Ayers

Quality Coordinator

Tuesday, May 15, 2018, 10:50:54 AM

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form crtr3013

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JUL 24 2018  
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HT #403718

11048-601-13

PO#636813



MACHINED: TO 2" XH x 1" S160 CONC RED A234

## MATERIAL TEST &amp; INSPECTION CERTIFICATE



SUNGKWANG BEND CO., LTD. (SKB)

26, Noksansandan 262-ro, Gangseo-Gu, Busan, Korea

TEL : 82-051-3300-450

FAX : 82-051-3300-335

http://www.skband.com

CUSTOMER:  
PROJECT NAME: N/A

According to

DIN 50049 3.1 / EN 10204 3.1 / ISO 10474 3.1

PURCHASE ORDER NO.	2199/M	SPEC. FOR MATERIAL	ASTMASME A234WPB-S 15/15ED	CERTIFICATE NO.	QCLB2018010218
PJT NO.	N/A	SPEC. FOR INSPECTION	ASME B16.9	DATE OF ISSUE	2017.11.29
STARTING MATERIAL	SEAMLESS PIPE	SKB NO.	2017052608	VISUAL & DIMENSION	SATISFACTORY

NO.	SEQ/LIN/ITEM NO	DESCRIPTION	QTY	HEAT NO.	WFG ID NO.	FOR CODE/TAG NO
49		CON REDUCER S160*S160 2"3/4" B.W SMLS Black	40	016851	016851	
50		CON REDUCER S160*S160 2"1" B.W SMLS Black	70	016851	016851	
51		CON REDUCER S160*S160 2"1 1/2" B.W SMLS Black	40	016851	016851	

CHEMICAL COMPOSITION(%) (L : LADLE, P : PRODUCT)																					TENSILE TEST(Gauge Length :50)					
HEAT NO.	STD.	SPEC.	C	Si	Mn	P	S	As	Cr	Mo	Cu	V	Nb	N	Al	B	Zr	Fe	Ti	C.E	SPEC.	Y.S 0.2% offset	T.S	EL	RA	
				0.18	0.25																	KSI	KSI	%	%	
		MIN																				MIN	35.0	80.0	30.0	
		MAX	0.30		1.05	0.050	0.005	0.40	0.40	0.15	0.40	0.05											MAX		95.0	
018051	L	0.18	0.22	0.05	0.010	0.005	0.05	0.05	0.04	0.05	0.01	0.01								0.30		44.2	88.9	41.0		
	P																									
	L																									
	P																									

HEAT NO.	TEST TEMP.	SIZE OF SPECIMEN(mm)	ABSORBED ENERGY		LATERAL EXPANSION		PERCENT SHEAR		HARDNESS HBW		HEAT TREATMENT	NORMALIZED: 900°C, 30Min, "N"		
			VALUE	AVG.	VALUE	AVG.	VALUE	AVG.	MIN	MAX		N/A	N/A	N/A
016851		BAR								197	PM			
		HAZ								141	FLATTENING TEST	N/A		**MEMO
		WEL									BENDING TEST	N/A		
		BAR									HYDROSTATIC TEST	N/A		
		HAZ									CORROSION TEST	N/A		
		WEL									GRAIN SIZE TEST	N/A		
											MC TEST	N/A		

MATERIAL MEETS THE REQUIREMENTS OF NACE MR0175 & 0103 / ISO 15156.  
MATERIAL ALL MANUFACTURED IN KOREA / FREE OF MERCURY & FREE OF RADIATION  
PED201468/EU

WE CERTIFY THIS MATERIAL HAS BEEN MANUFACTURED AND EXAMINED IN ACCORDANCE WITH ALL REQUIREMENTS OF THE SPECIFICATION AND THE RESULTS OF ALL EXAMINATION ARE ACCEPTABLE.

REVIEWED BY :  
WITNESSED BY :

CHIEF QUALITY OFFICER

SKE-3903

\*본 검사증명서에 열거한 규격용외 사용시 안전성 문제가 발생할 수 있으며, 검사증명서 위 변조시 사문서 위조(형법231조)로 불이익을 당하실 수 있습니다.

H. LEE

JUL 24 2018

HT#016851

11048-601-16

PO#636813